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Model Mechanics

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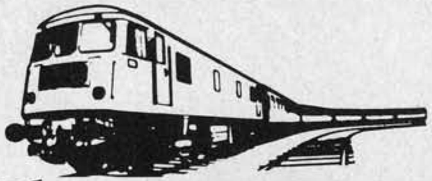

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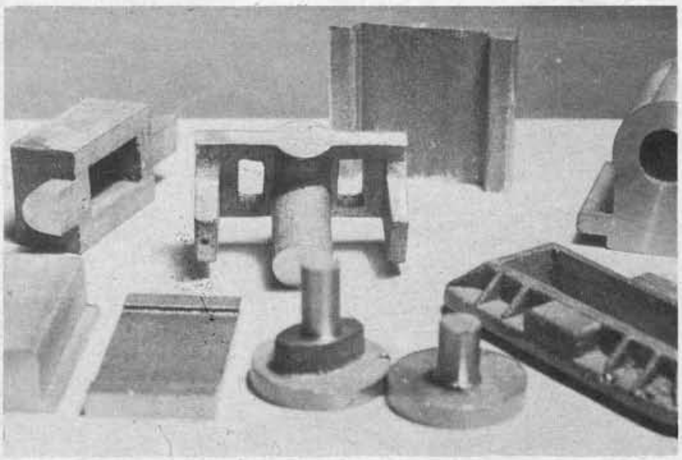
Model Mechanics

Volume 1 Number 8
September 1979

Castings for 'Eagle'



Left is a sample of castings received by Martin Evans from both Live Steam Services, 422 Upper Richmond Road West, East Sheen, London SW14, and Dave Goodwin, 43 High Street, Rishton, Nr. Blackburn, Lancashire. He found both sets to be made from good metal and easy to machine.

Forthcoming events

Mr. John Haigh who is the exhibition co-ordinator for the Hanwell & District Model Society has written informing me of their forthcoming Model Exhibition to be held on the 20th and 21st october, 1979. This is to be held at Hanwell Community Centre, Westcott Crescent, Cuckoo Avenue W7. All types of models are welcome. For further details, please contact either. Mr. J. Haigh, 141 Leas Drive, Iver, Bucks. SL0 9RP (Tel: 6754431), or Mr. J. Bidgood, 27 Barnham Road, Greenford, Middlesex (Tel: 01-578 5033).

On 6th September, the Hull S.M.E. are having a talk on Planing Bevel Gears, by Guy Wilson. This is to be held at the Trades & Labour Club (Room 3), Beverley Road, Hull at 7.45 p.m.

The Editor

Editorial Director **Ron Moulton**
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Cover picture of the hot air balloon, to make in this issue. Photo by John Wade.

Page 426 Slot-car racing for the beginner by Ian Jensen.

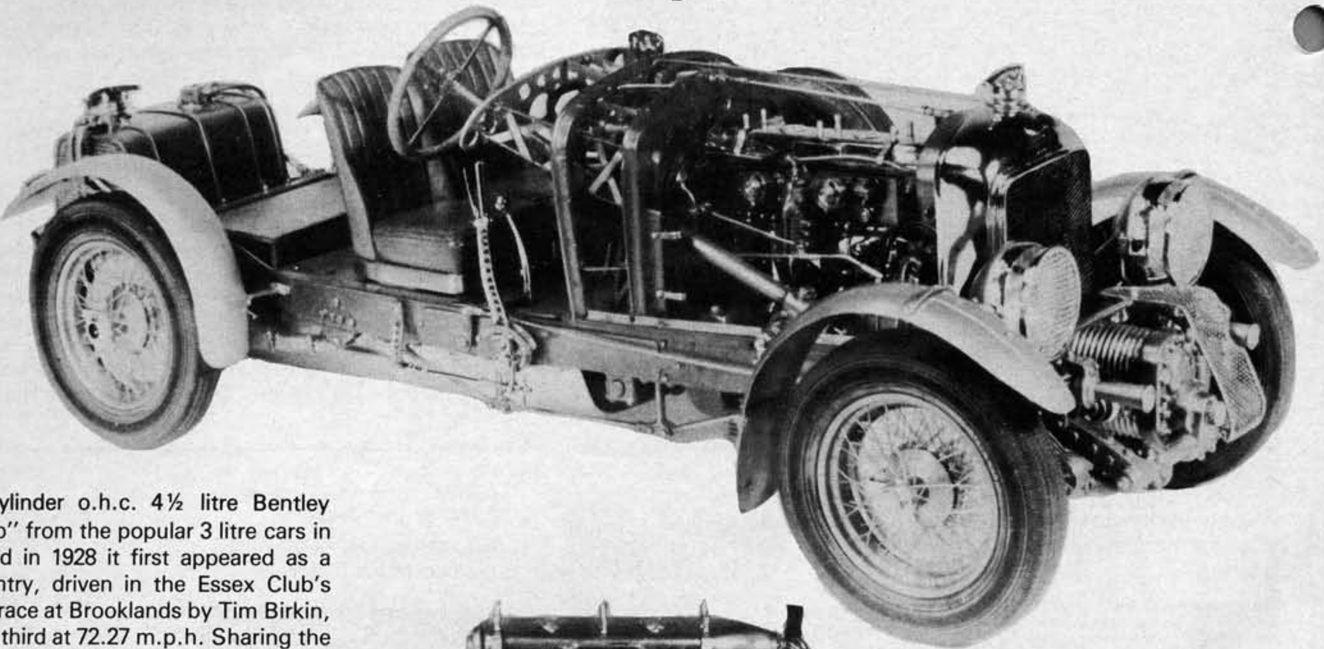
Next month I am hoping to include an article on kits which will include some aerial photographs. Also the construction of a working steam -powered lorry made from Meccano. Eagle will of course continue as well as our Sweet 16 traction engine.

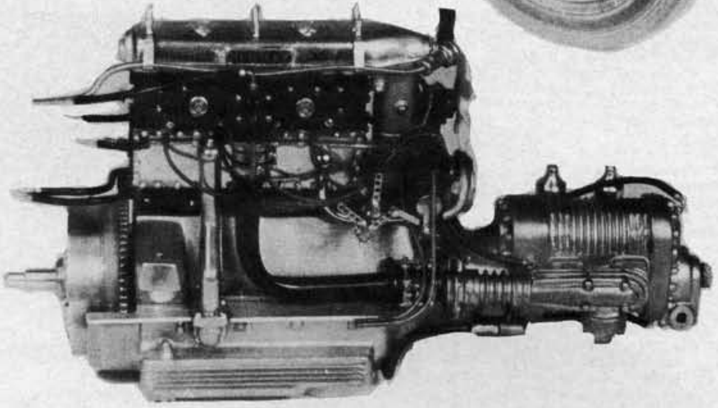
Contents

MM Query Coupon
Sept. 1979

Scale projects
The 4½ litre Bentley

Below a model of a 4½ litre Bentley built by Gerald Wingrove, author of the Complete Car Modeller, published by Associated Book Publishers Ltd.





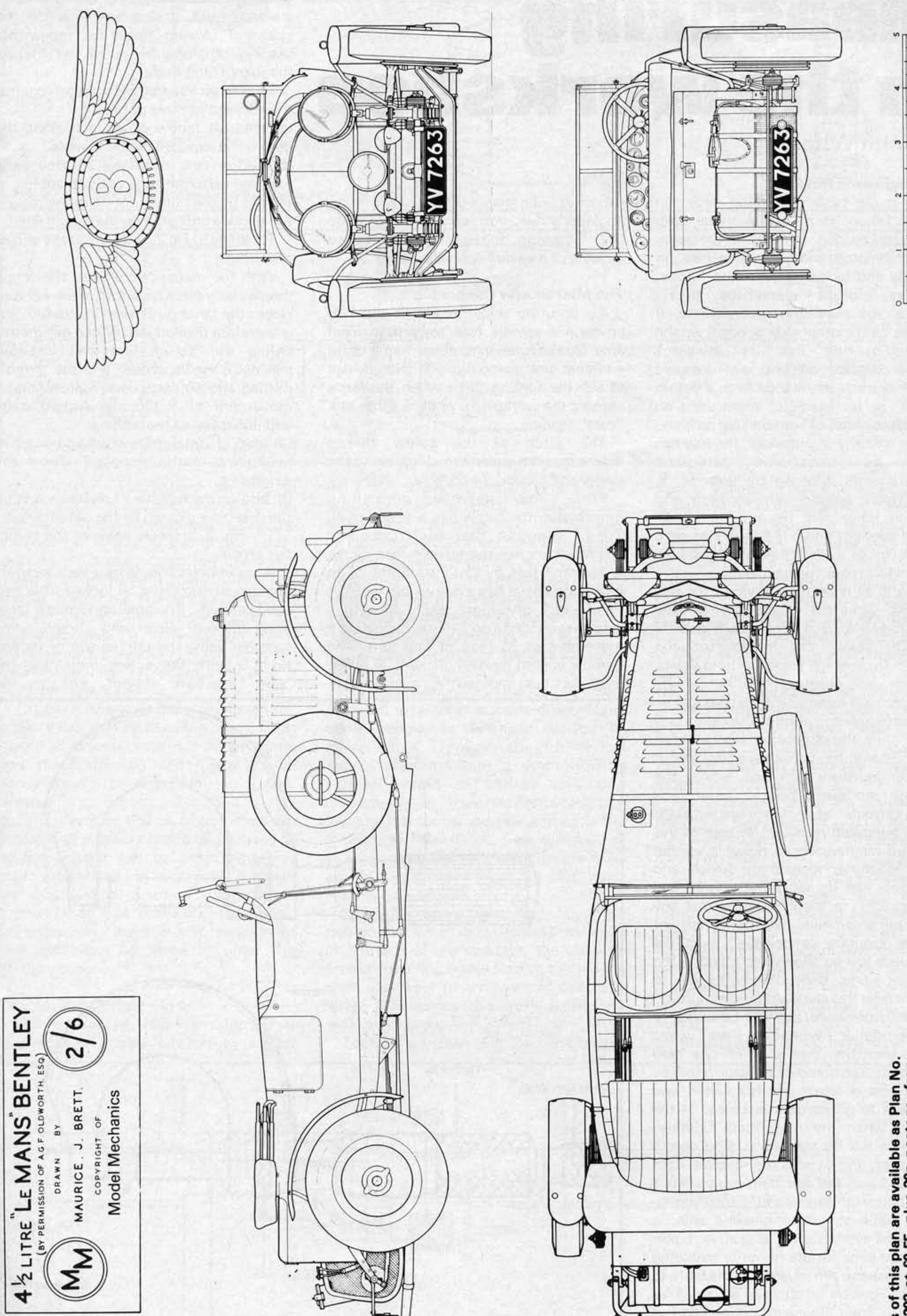
THE 4-cylinder o.h.c. 4½ litre Bentley "grew up" from the popular 3 litre cars in 1927, and in 1928 it first appeared as a works entry, driven in the Essex Club's six-hour race at Brooklands by Tim Birkin, finishing third at 72.27 m.p.h. Sharing the wheel with Jean Chassagne at Le Mans, Tim encountered fearsome tyre trouble, broke the lap record and finished 5th. Fifth position and fastest lap seemed to be this car's speciality during 1928 for the same story repeated itself in the Tourist Trophy, and at Boulogne, where Tim's 73.16 m.p.h. in the Georges Boillot Cup was an all-time record for the course. In 1929 the Hon. Mrs. Victor Bruce broke the Class C 24 Hour record at Montlhèry in the same car, at 89.57 m.p.h., and it was then hurriedly prepared for Le Mans, in order to take the place of one of the blower cars, which were withdrawn. It's drivers, Lord Howe and Bernard Rubin, did not regard their chances of finishing as rosy, in view of the somewhat sketchy preparation, and their pessimism was justified when a magneto cross-shaft broke in the early stages of the race, and they had to retire. This brief biography of the Bentley as a "team" car concludes on a somewhat melancholy note with the retirement of Williams and Durant in the 1930 "Double Twelve" after a minor fire and axle trouble, but is more than sufficient to justify its place among the great ones of the past.

As perhaps, together with the 30/98 Vauxhall, the best known sports car of the old school, the general technical details of the 4½ litre Bentley will be familiar to most readers, although if its development were to be discussed in detail many pages could be written. A more sturdy frame and the large wide shouldered radiator marked these cars as bigger brothers of the 3-litre and for Le Mans in 1928 the bodies were somewhat different from that shown in our drawing, having tank and spare wheels enclosed in a short "manxed" tail fairing. The classic open body is shown here, plus the addition of a luggage boot ahead of the fuel tank. The wings extend in a more generous arc than those fitted for Le Mans, and the third central headlamp is replaced by a lower placed pass-light carried above the front cross-bracing. The typically Bentley lever-and-cam-action filler caps are fitted to the radiator and fuel tank, and another reminder of its racing days is the wheel adjuster for the brakes in the driving compartment floor. Other interesting external features for the modeller are the double Hartford shock absorbers, two pairs ahead of the front axle, and a pair before and behind the rear axle, and the trussing of the chassis side members, rather reminiscent of a railway coach! An external filler for the scuttle oil tank projects on the near side of the scuttle top, and the two-panel windscreen folds forward. The Rudge hub caps are of the offset ear variety, and these, in fact, form the *motif* of the Bentley Drivers' Club.

There are no valances below the frame, and the exhaust system is visible from the near side, terminating in the massive fan-tail, which used to be sprayed heartily with a fire extinguisher during refilling operations!

The dashboard is a most satisfying sight, with an array of instruments, all of which had to be read and memorised by the well disciplined team drivers in days gone by. The large revolution counter is centrally mounted, and reads to 6,000 r.p.m. though for practical purposes the needle is "in the red" between 3,500 and 4,000.

In addition to pressure and temperature gauges, speedometer, clock and ammeter the instrument panel carries the air pump for the fuel system on the left of the rev. counter, and an array of switches for the lighting and dual magnetos. The large spring spoked wheel is corded, and has centrally mounted ball-ended controls for ignition and throttle, under a domed cover. A leather grab handle is fitted to the scuttle beading, the gear lever works in a gate on the driver's right, inside the body, with the handbrake external. An interesting feature is the brake linkage, which passes through the rear passenger compartment.



Prints of this plan are available as Plan No. M.M.202 at £0.55, plus 20p postage, from M.M. Plans Service, P.O. Box 35, Hemel Hempstead, Herts.

Measuring in the workshop

By John Wheeler

The Engineer's Rule

This is the basic measuring device in the workshop, it is a thin metal strip accurately divided into small divisions, often millimetres and half-millimetres, on one side and inches divided into halves, quarters, eighths, sixteenths, thirty-seconds and sometimes sixty-fourths of an inch, on the other side or edge. As the engineer's rule has its divisions commencing from one end, it can be used to take or measure directly from a datum surface, as for example, when used on the surface plate, or with odd-leg calipers. For the majority of purposes, the rule can easily be used to determine measurements differing by $\frac{1}{32}$ in. or ½ mm. These spaces can be seen and counted fairly well by a person with normal eyesight and it is possible to set a sharp point of a surface gauge or odd-leg calipers to a required dimension.

As with all measuring devices, the rule has its greatest accuracy at the recognised standard temperature of 60°F (15.5°C), below this temperature the material from which the measuring device is made will contract and hence the dimension will be smaller than it should be and conversely, above the standard temperature the dimension will be larger than it should be. Small variations about this temperature will not worry the average modeller, but in Toolrooms where extremes of accuracy are required, the air temperature is kept as near to this standard temperature as possible so that every machine, measuring device and workpiece can be set up, measured and worked upon in the knowledge that any measurements made will be consistent and as accurate as possible. Even the workpiece will be allowed to stand in the room for a time, depending on its size, to fully achieve this standard temperature.

This temperature/size can be useful to the modeller whenever we want interference fits, that is when one item must be locked immovably inside another. If one item is warmed in hot water, and the piece to go inside it is cooled in the freezer, when they are fitted together, less force will be needed to slide one in the other and when the cooled item expands, and the hot item contracts, a much better interference fit is achieved.

But back to our engineer's rule, a dimension even as small as $\frac{1}{32}$ in. or ½ mm is still too large for the fitting or matching parts. Here the aim must be to measure to a much greater accuracy; as small as 1/1000 in. (one thousandth of an inch) or 1/100mm (one hundredth of a millimetre) and if you have ever tried to separate the $\frac{1}{50}$th of an inch marks often shown on an engineer's rule, you will soon appreciate the following measuring devices to indicate or measure such accuracy.

The Micrometer Caliper Fig 1

An accurate screw thread is used to advance a spindle face towards a fixed anvil face secured in a robust frame using a ratchet arrangement or a friction device to slip the turning force when the faces contact the workpiece, or each other at a "zero" reading.

The pitch of the screw thread determines the scale of readings along the sleeve and around the thimble.

With the Imperial measuring micrometer, the screw has a thread of 40 T.P.I., ensuring that each complete revolution moves the spindle face closer to the anvil face by 25-thousandths of an inch. The sleeve has a datum line with 0.1 in. ($\frac{1}{10}$ in.) divisions, each of which is further divided into 4 parts, indicating a movement of 25 thou or one turn. The thimble is then marked off with 25 parts, each part now representing a movement of the spindle of 'one thou'. A micrometer is always used, closing onto an article, the constant closing force for repeatable reading obtained by using the friction thimble or ratchet slip.

To read an Imperial micrometer requires the addition of three parts:

(a) read off tenths of an inch along the datum line exposed by the thimble.
(b) add on any additional 25 thou parts exposed up to the edge of the thimble.
(c) add on the number of divisions around the thimble indicated by the datum line.

Try those in Fig 2, answers at the end of this article.

With the metric micrometer the screw thread has a pitch of ½ mm, each full turn closes the faces by ½ mm. The datum line is therefore divided into whole millimetres below the datum line and one-half millimetre marks above, and the thimble divided into 50 parts each representing a movement of 1/100mm. A two-stage addition gives us the reading:

(a) read off total millimetres and any half millimetre marks exposed along the datum line.
(b) add on the number of divisions around the thimble indicated by the datum line.

Try Fig. 3, answers again at the end of this article.

A micrometer should be a very accurate instrument and must be looked after and used carefully. The anvil and spindle faces must be kept clean and should come together using the ratchet slip or friction thimble with the scales indicating the 'zero' position. If not, consult the

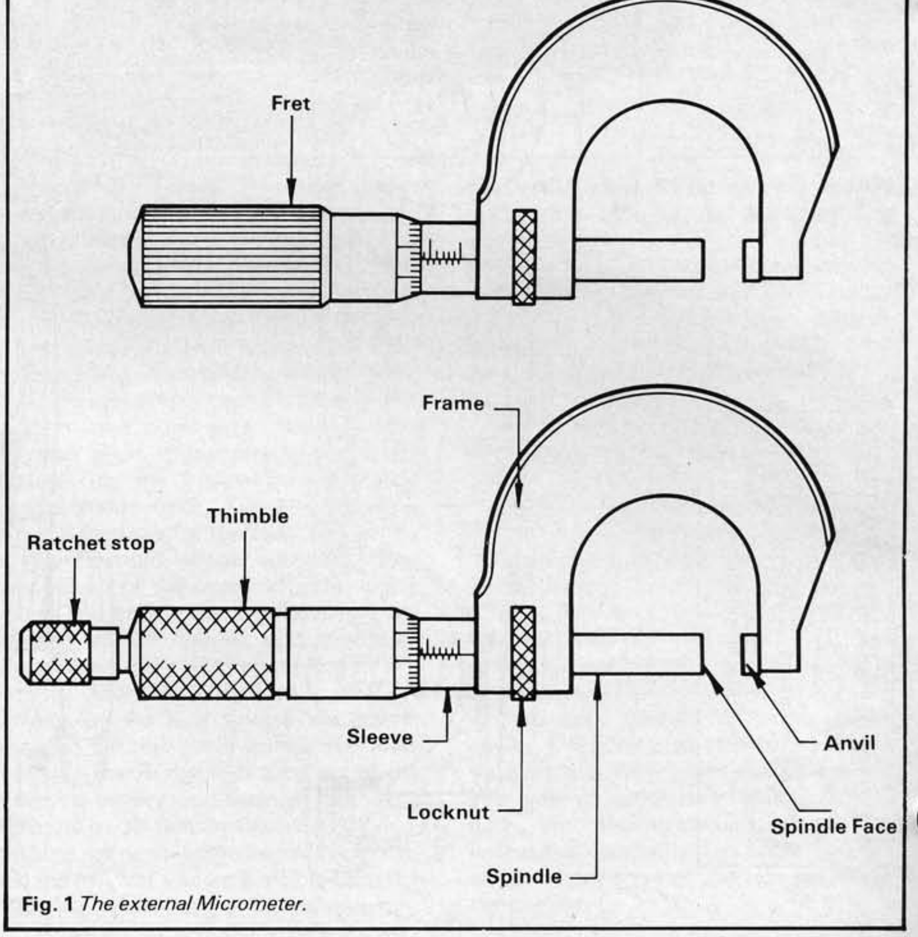


Fig. 1 *The external Micrometer.*

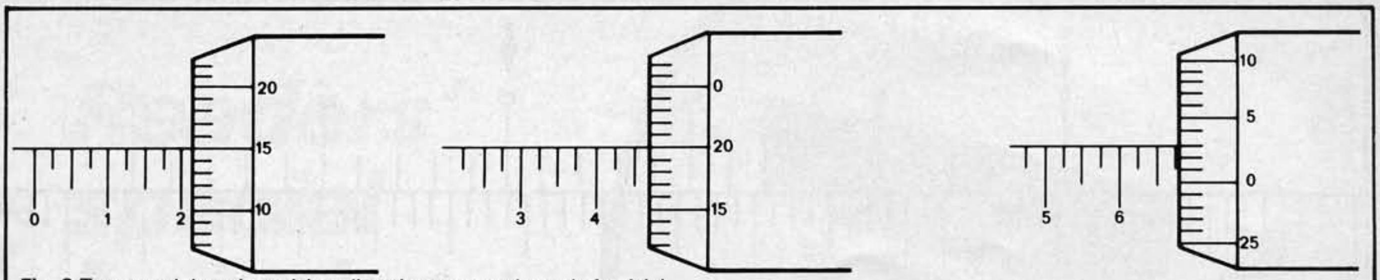


Fig. 2 *Try to read these Imperial readings (answers at the end of article).*

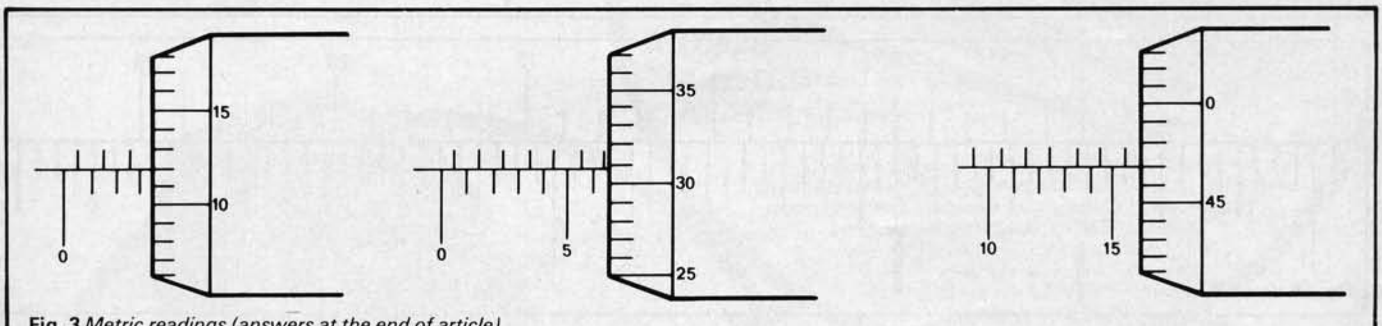


Fig. 3 *Metric readings (answers at the end of article).*

manufacturer's instructions on how to correct this error and also how to take up any slack on the screwthread. Using the micrometer like a G-clamp will soon damage the screw, strain the frame and *make* the instrument inaccurate. You should close the micrometer anvil and spindle faces onto the work to be measured using the *ratchet slip or friction* thimble, note the reading, then open the micrometer slightly *before* removing it from the workpiece.

The main disadvantage of a micrometer is that it can only be accurate over a short length of a screw, about 1 in. or 25mm and therefore you will need several micrometers to cover the range up to 6 in. in steps, e.g., 0-1 in., 1-2 in., 2-3 in., 3-4 in., etc. Additionally, as micrometers are available to measure inside dimensions or depths, again in 1 in. or 25mm steps, you could require a set of each again to cover the range. What a lot of micrometers, eighteen in all, just for the Imperial range!

Fortunately, there is one instrument that combines all these in one: The Vernier caliper.

The Vernier Caliper Fig 4

This instrument uses the principle of two engraved scales, one sliding against the other; the larger scale is engraved in inches and tenths which themselves are divided into four parts each representing an increment of 25 'thou'; the shorter and moving scale is engraved with a length equal to 24 parts of the main scale into 25 parts. Any slight movement of the sliding scale can be measured by comparison of *the engraved lines with the main scale.*

The more expensive verniers are also engraved with a metric scale making them direct dual reading instruments and when designed to be used as inside calipers and depth gauges as well, can replace 36 micrometers. I always suggest to my school students that a good quality vernier caliper should be an early investment in their apprenticeships, because it is such a versatile and accurate measuring instrument that will last a lifetime, wear of the sliding scales is automatically taken up by the light internal hairsprings.

Reading a vernier takes a little longer to master and the closing pressure depends on the skill of the operator, the verniers fitted with a fine screw feed to the sliding scale are easier to achieve that constant 'drag' feel across the work similar to ordinary calipers.

To 'read' a vernier (Fig. 5a), first take a note of where the zero of the sliding scale is against the main scale, remember each of the small divisions on this main scale represents 25 thou. The indicated reading is 0.375 *plus* a little bit that will be indicated by the only co-incident lines between the two scales. In our case, that is at 15, or put more accurately, we must *add this 15 as thousandths of an inch to* 0.375 in. which gives us a reading equal to 0.390 in. Normally there can only ever be one set of co-incident lines between the scales. The exception is when the zero and 25 on the sliding scale match up with lines on the main scale; at every tenth of an inch and each line indicating an increment of 25 thou.

Fig 5b shows part of the scales and a reading of 1.300 plus the little bit indicated by the co-incident lines of the scales i.e., 5 thou or 0.005.

On the metric scales, you normally find millimetres and half-millimetres on the main scale, with a sliding scale equal in length to 49 parts of the main scale divided up into groups of five, each mark representing an increment of two-hundredths of a millimetre ($\frac{1}{50}$ mm.). A similar two-stage addition will give a reading:

(a) Measurement along main scale *up to*

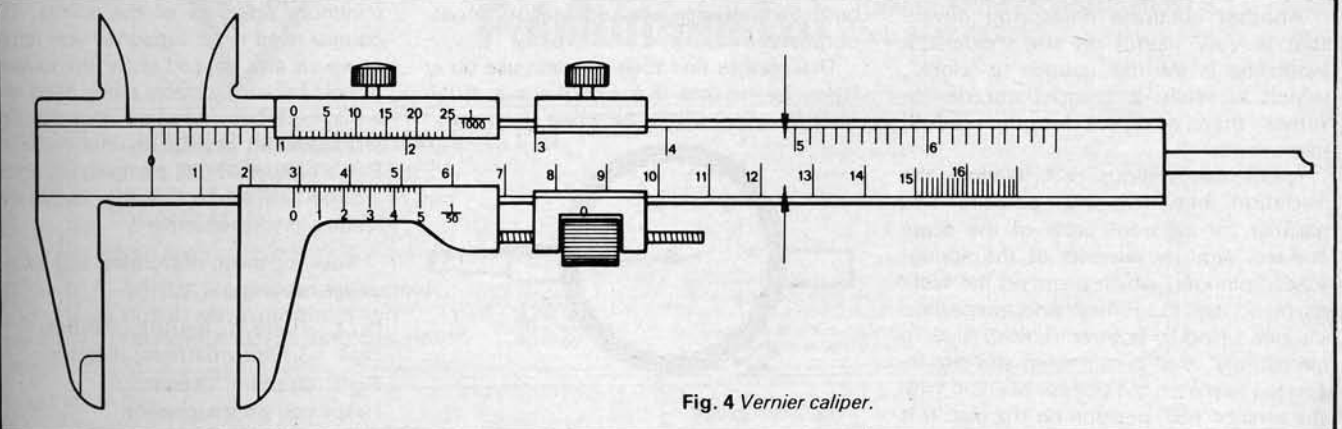


Fig. 4 *Vernier caliper.*

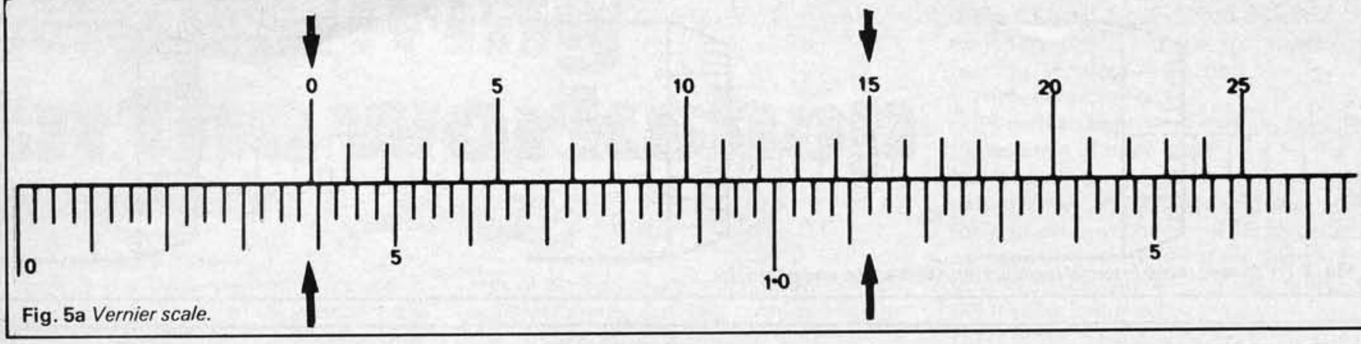


Fig. 5a *Vernier scale.*

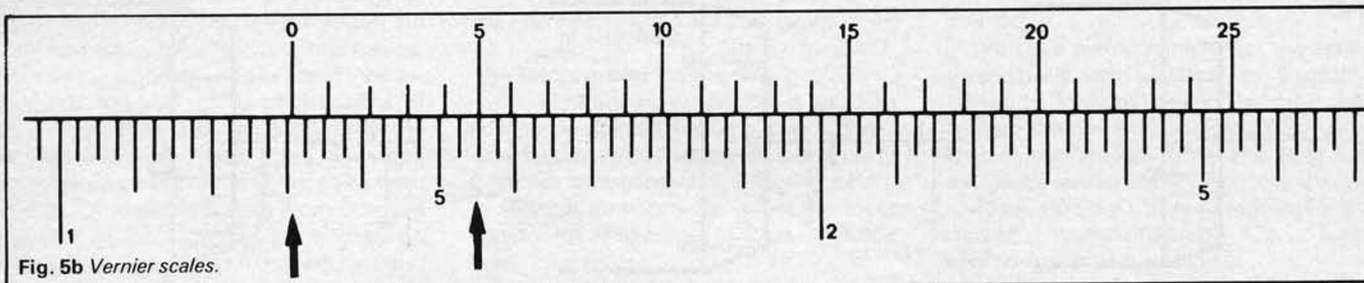


Fig. 5b *Vernier scales.*

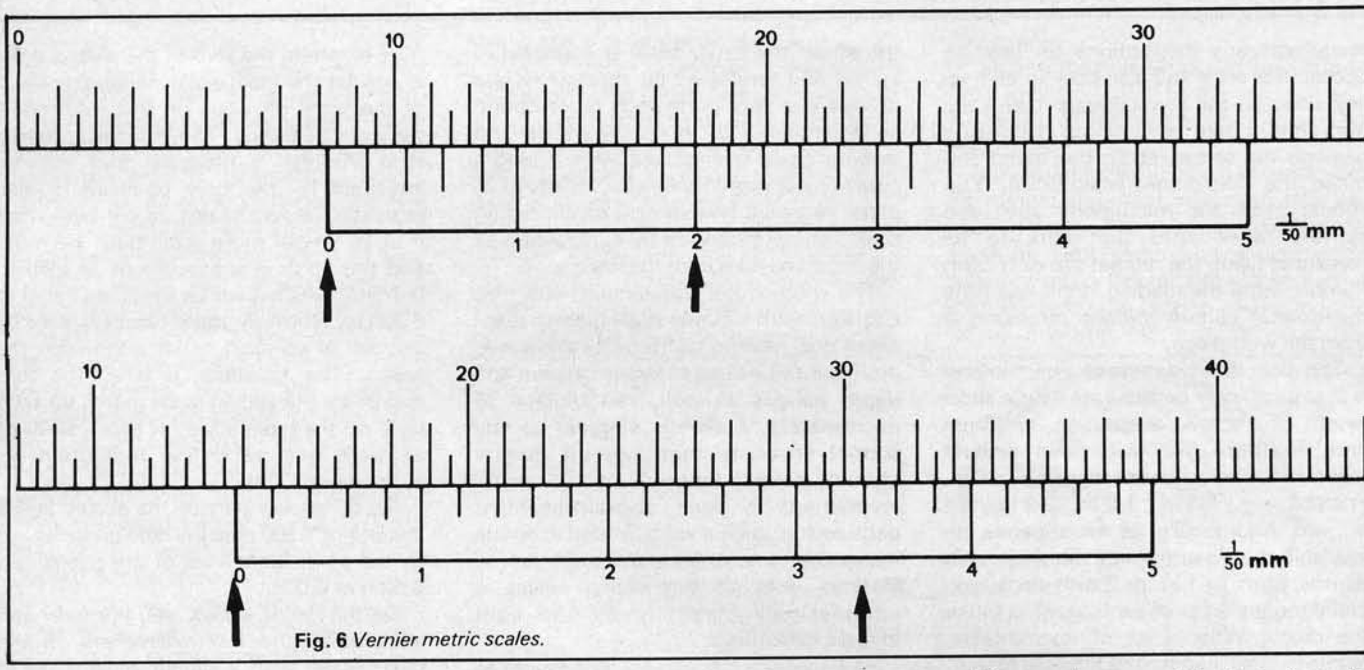


Fig. 6 *Vernier metric scales.*

zero mark of sliding scale.

(b) Find co-incident line position, add to previous reading.

Try Fig 6—answers again at the end of this article.

Dial Gauge Fig 7

Another accurate measuring device that is very useful on the modeller's workshop is the dial gauage or 'clock', which is really a comparison device rather than a direct length reading instrument.

It indicates in 'thous' or 1/1000mm, the variation between one surface and another, or different parts of the same surface. Any movements of the spring-loaded plunger, which bears on the work surface, are magnified and presented visually using a pointer moving over a circular dial, that is calibrated and can be rotated to match the pointer position with the zero or 'null' position on the dial. It is most important that the plunger moves very freely over its full range, any stickiness here will make the instrument inconsistent. Any measuring instrument to be of value must give repeatable readings. The foot of the plunger can be fitted with various accessories, normally it is supplied fitted with a hardened steel ball, which is adequate for most purposes.

Dial gauges find their greatest use on a lathe, to indicate if a workpiece is truly round or concentric, or when used on a milling or shaper machine to indicate if a machined surface is truly parallel to a known fixed surface of the machine. Any error of concentricity or out of parallel state is immediately shown by the pointer moving around its scale. The difference can be measured in 1/100 in. or 1/100mm by reference to the maximum and minimum positions of the pointer. Dial gauges need to be supported very firmly, using an arm gripped under the toolpost or held by an adjustable clamp fitted with a magnetic base, or some other clamping arrangement devised by the modeller. Beware, however, of clamping too tightly around the plunger housing, as this may restrict its free movement.

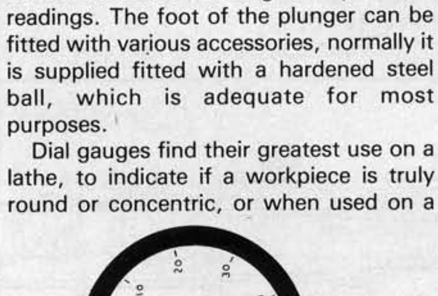


Fig. 7 *Dial gauge.*

Now for those micrometer and vernier gauge readings:

Fig 2 0.215 in., 0.470 in., 0.678 in.
Fig3 3.12mm, 6.81mm, 15.97mm.
Fig 6 8.20mm, 13.8mm.
I hope you were successful.

Mechanic's Workshop

Bench making by Andy Smith

Bench-making details

It seems only right that having dealt in the May issue with the upkeep of simple woodworking tools, we should give some thought to the constructional details of building a workbench, before going on to consider, in a similar manner, some simple metalworking tools.

It would serve no useful purpose to propose and describe in detail a design for a workbench, because such a workshop feature is a very individual and personal thing, that depends on many variables. These comprise, the space available; the situation, i.e. can the bench be built-in or is it to be free-standing: the type of work to be carried out, i.e. "light" or "heavy"; the available material; and last, but probably most important the tools and skill of the builder.

Regardless of the type and size of bench, the chances are that we shall require some form of legs and leg framing, as illustrated in Fig. 1. The height "H" will depend on our physical height and whether woodworking or metalworking is going to predominate. If, as seems likely, it will be a bit of both, then make the bench suitable for woodworking and pack the mechanic's vice up on wooden blocks to raise it to a suitable height for filing; the idea is shown in Fig. 13.

To accurately assess the height "H" to suit YOU, equip an assistant with a tape measure, then, while you hold a woodworking plane in a suitable position for planing, get him to measure the distance from the sole of the plane to the floor. This will give you a custom-built bench at which the planing of wood should be comfortable, bearing in mind that a woodwork vice (Fig. 2) is fitted In rather than ON the bench, see Fig. 3.

If only light metalworking is envisaged, the mechanic's vice can be bolted to a stout timber sub-assembly which is held in the woodwork vice. However, sooner or later, you will want a properly fitted engineer's vice and this should be permanently fitted, blocked up so that the top of the vice jaw is on a level with your elbow. You will find this just about right for effortless filing and hacksawing.

The time you spend in the workshop is supposed to improve your well-being, both mentally and physically. This won't be the case if your bench is uncomfortable to work at, so dont be satisfied until you get it right.

The bench depth, that is the distance from back to front, depends very much on available space, 450 to 600 mm (18 to 24 inches) is about right. Anything wider and it tends to be used as a repository for tools, narrower and it's like working on a shelf.

Referring back to Fig. 1, the general construction of any bench will consist of two or more such frames, joined together by longitudinal members. Hence the making of these frames would seem to be the most important item.

As we have been dealing recently with timber working tools, let us consider bench building in this material.

The simplest way to make up these frames, using plank or board type timber, and no more tools than a handsaw and a small drill, is illustrated in Fig. 4. The timber is simply sawn to length; two legs and two cross-members being needed for each frame. The structure is drilled as shown and bolted together using standard coach-bolts (Fig. 5), obtainable from any ironmonger or DIY establishment. The bolts must be long enough to go through the two thicknesses of wood plus sufficient to take a washer and nut. Bolts of ¼ to $\frac{3}{8}$ inch diameter should be suitable and two at each joint is sufficient. Some glue or old thick paint applied between the timber before final assembly will help to make a firm joint.

If the timber available is of heavier section, something like old door frames, joists or rafters, we can still bolt the assembly together, but the technique is slightly different, as shown in Fig. 6. Here the cross-members are butted against the legs and located by two wooden pegs (dowels). The joints, which may or may not be glued, as desired, is pulled up tight by a bolt, washers, and nut, fitted as shown. The normal coach-bolt is not suitable for this application because a hexagonal head is needed on the outside so that we may apply a spanner to tighten the joint.

In the past, I have used screwed rod with a couple of nuts and washers for this type of joint in various timber structures. Screwed rod, or "studding", may be obtained in various thread sizes from local engineering stockist or by mail order from Whiston, New Mills, Stockport. It is a useful mechanic's workshop material as, by its use, screws of any length can be made up either as studs or as set screws, by brazing a nut on one end to form a head.

Alternatively we can produce a neat frame if the joints are made by "halving" the timbers into each other. This is shown in Fig. 7.

Again coach-bolts and glue or old paint are used to effect the joint. Mark them out carefully and try to ensure that they are a firm, even tight fit. The illustrations, Figs. 8 and 9, show the cutting of this type of joint. Take care that you keep all parts of your anatomy behind the cutting edge of the tool!

If you have a mortise chisel of a suitable size, you may like to do the job in the traditionally correct manner, that is by

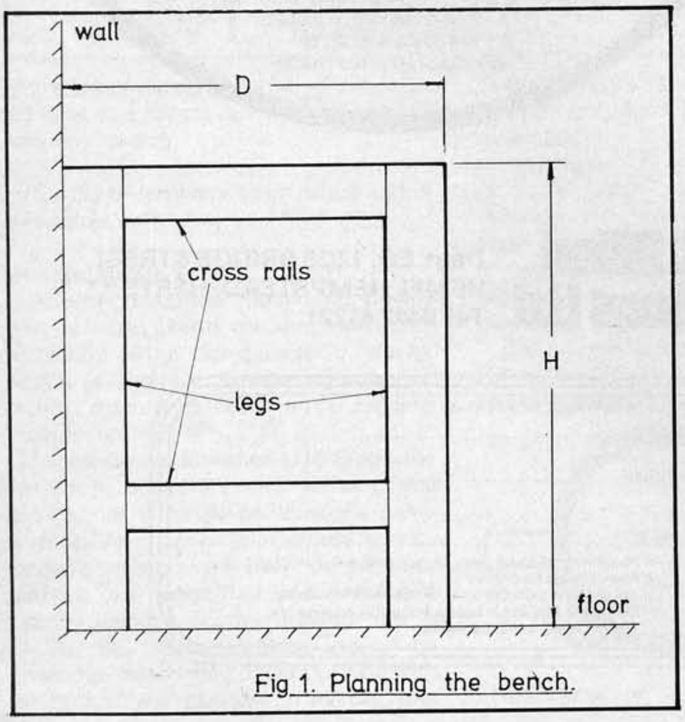
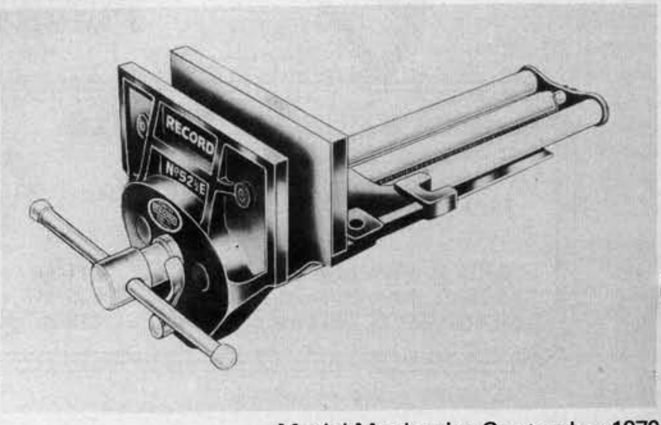
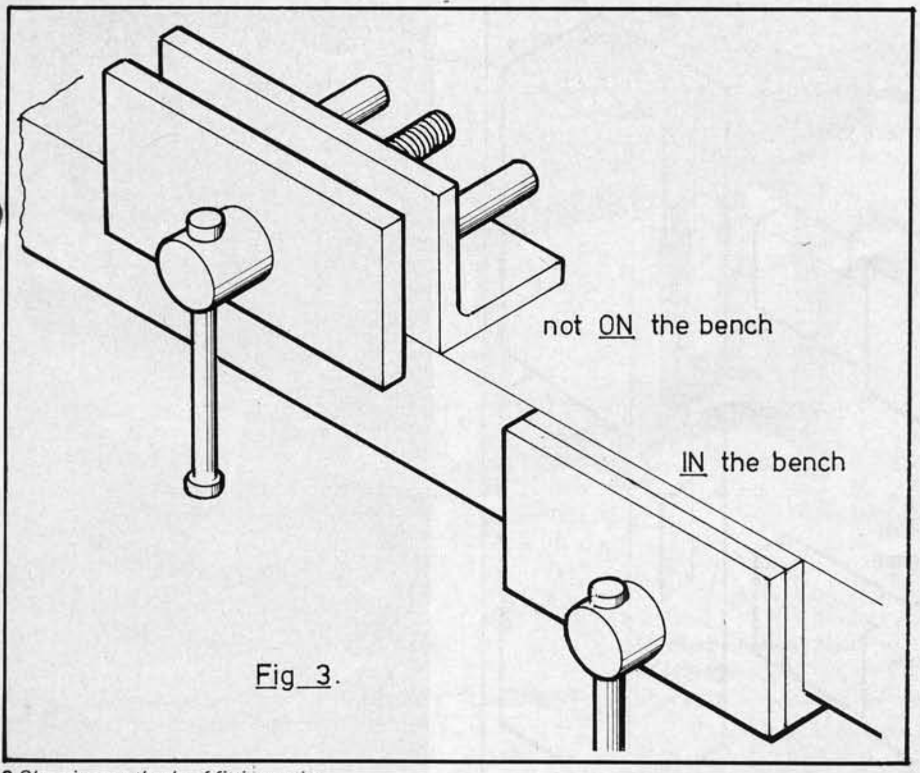


Fig 1. Planning the bench.

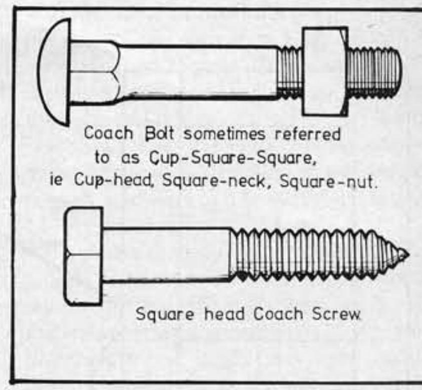
1 *Left planning the bench.*

2 *Below a qoodworking vice with quick adjustment lever.*

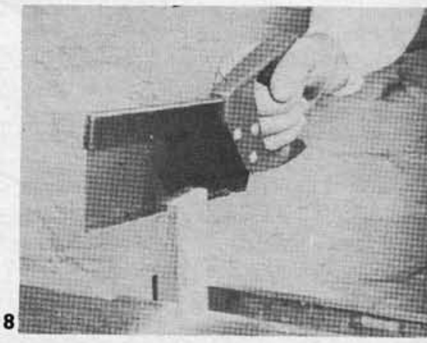




3 *Showing methods of fitting a vice.*



5 *Coach bolts and screws.*



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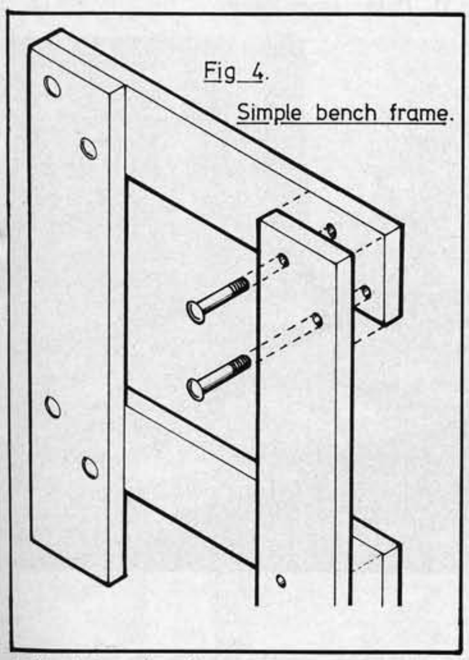
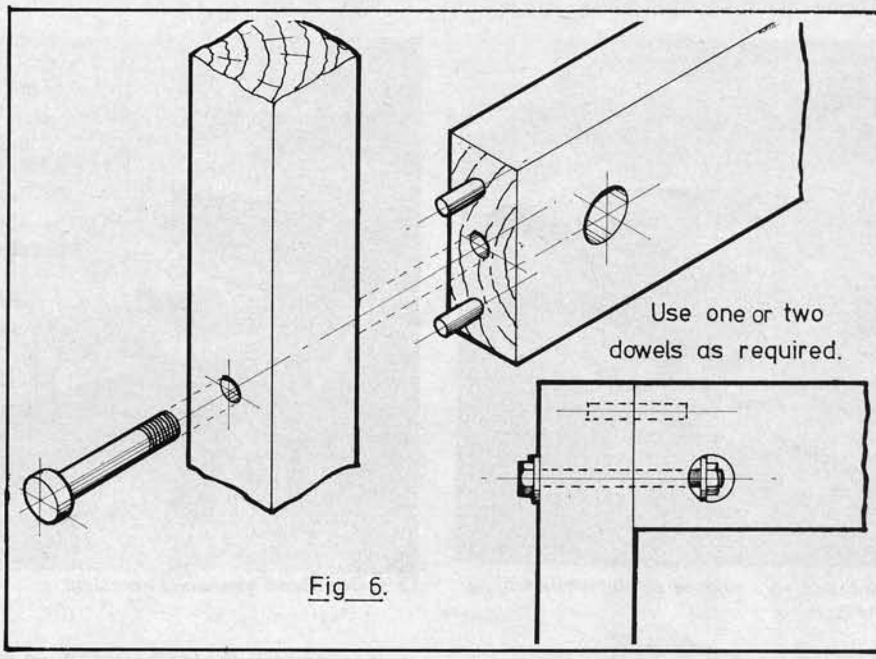
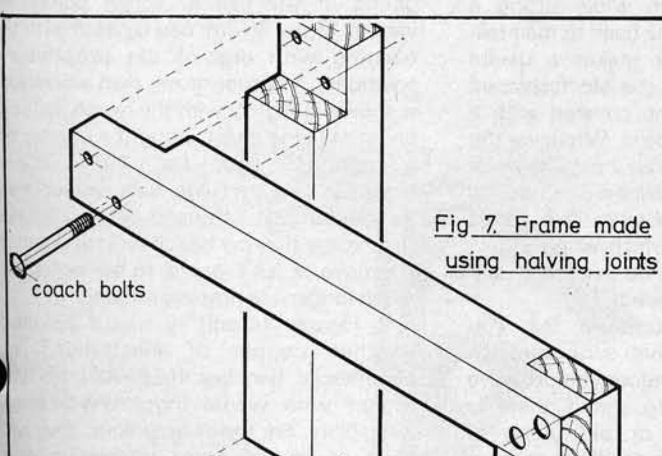


4 *Simple frame bench.*

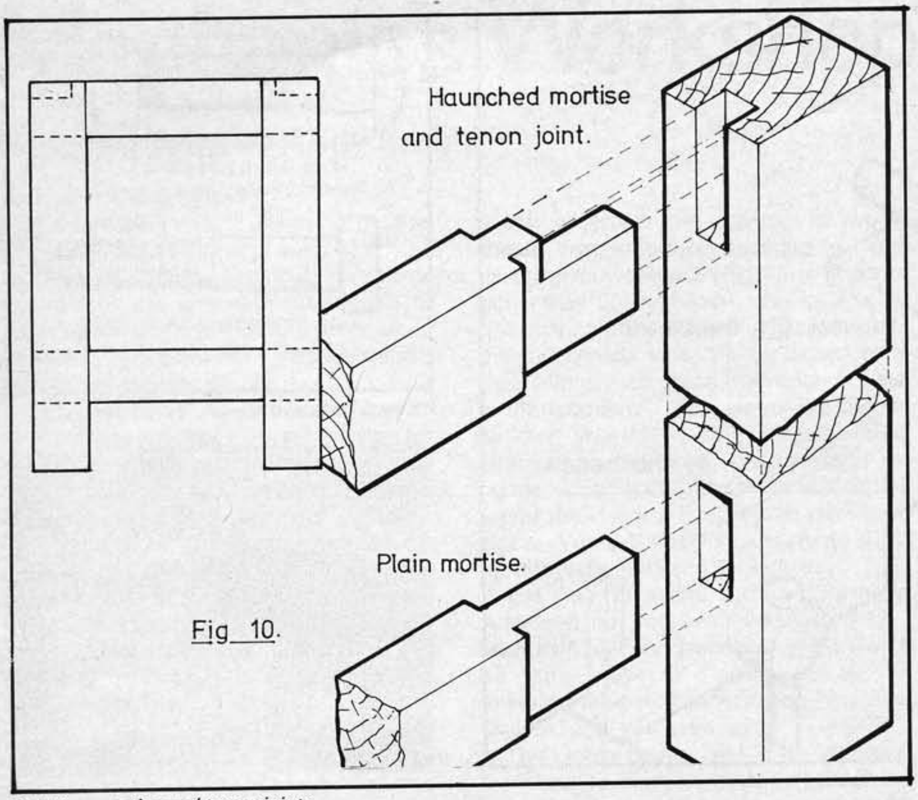


6 *Alternative joint for heavier timbers.*

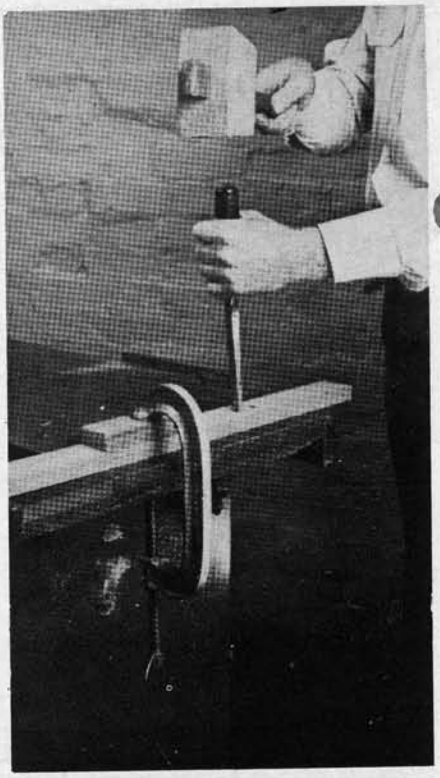


7 *Frame made using halving joints.*

9 *Cutting housings.*



10 *Using mortise and tenon joints.*



11 *Cutting mortise holes.*

12 *For safety's sake be careful where you put the G clamp.*

13 *Inside a Model Mechanics workshop.*

using mortise and tenon joints. The details for this are shown in Fig. 10, with some illustrative details in Figs. 11 and 12.

Normally, the width of the tenon is made about one-third of the thickness of the timber, but if in doubt, or if the leg members are thicker than the cross-rails, the tenon may be made appreciably wider.

Mortise and tenon joints are glued together, but a considerable increase in strength may be obtained by wedging and/or pegging the joints as shown. All these details are glued as well, thus binding the whole joint firmly together.

The longitudinal members that tie these individual leg frames together, may be fitted in a similar manner to that employed for the cross-members. Or we can save on timber by using the top and an under-shelf to seperate the leg-frames. If we do the latter, it is worth while fitting a diagonal strut across the back to maintain stability. An old door makes a useful bench top. Even if of the old fashioned panelled type it can be covered with a sheet of ½-inch chipboard. Whatever the bench top material may be it pays to cover it with a sheet of hardboard, fitted by small nails called panel pins. This makes an excellent surface, which when it gets worse for wear, can be removed and easily and cheaply replaced.

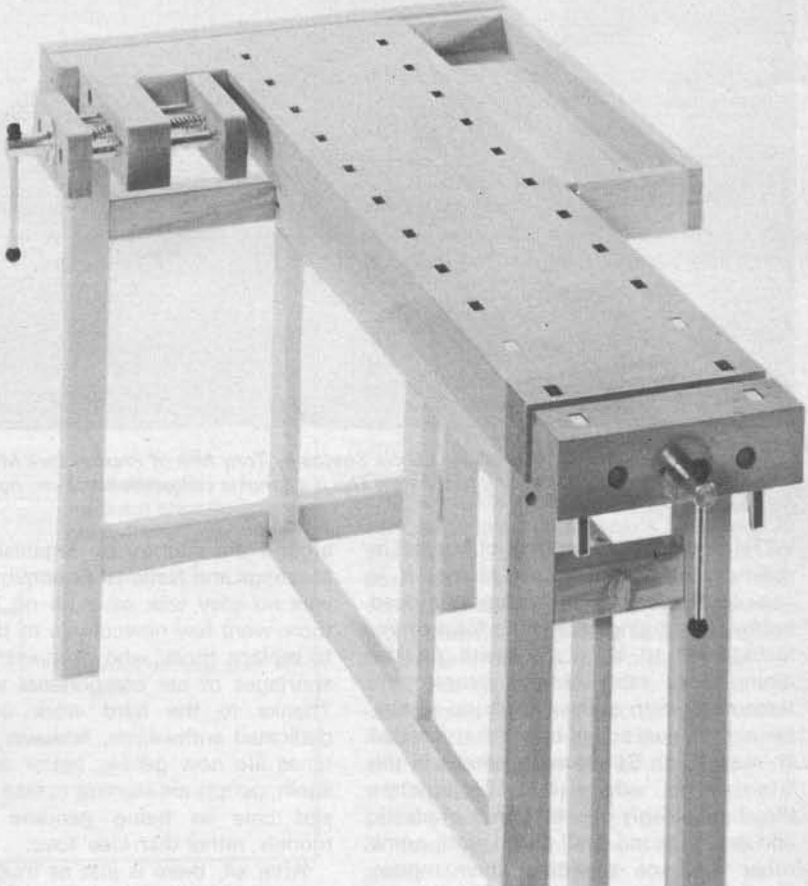
All the above presupposes that you have had to start from scratch when building your bench. Before you do, have a good look round to see if there is perhaps some item or old piece of furniture that might be modified to form the basis. Even if the furniture is damaged, simple repairs are possible by gluing or the use of screw plates of various forms. Worm can be dealt with by treating with one of the proprietory solutions. A corner of my own workshop is shown in Fig. 13 with the bench built up on an old pine chest, bought a quarter of a century ago for 10/- (50p). Unfortunately my wife now appreciates its value in this "stripped pine era", and the excuse that my bench will fall down if I remove it isn't going to be accepted much longer—is nothing sacred!

In Figures 14 and 15 I have included another couple of illustrations of commercial benches (LERVAD) for the reader who wants instant workshop availability. For the impecunious, they will be a source of some interesting and unusual ideas.

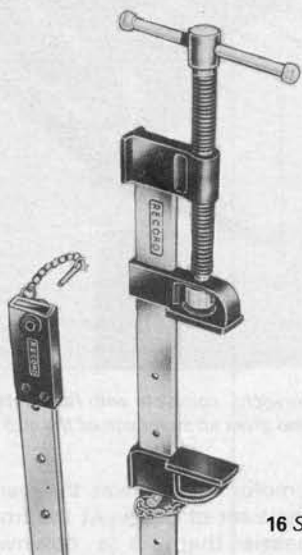
What can be described as "tools of necessity" are shown in Figs. 16 and 17, especially the former, i.e. try-square. This is needed for marking lines square across the face and edges of the timber. The one illustrated has the added advantage of being adjustable, doubling as a mitre (45°) square, and having a blade which is also a 12-inch steel rule.

The sash cramp (Fig. 17), although not strictly necessary is a most useful piece of equipment for clamping woodwork while the glue in the joints is setting, and, believe it or not, it can be equally useful in many metalworking situations—holding 7¼ inch gauge locomotive mainframes and buffer beams together for example!

That, I promise, is the end of wood-bashing for the time being. Next month we will consider some simple metalworking tools and their care and maintenance.



14, 15 *Benches produced BY Lervad.*

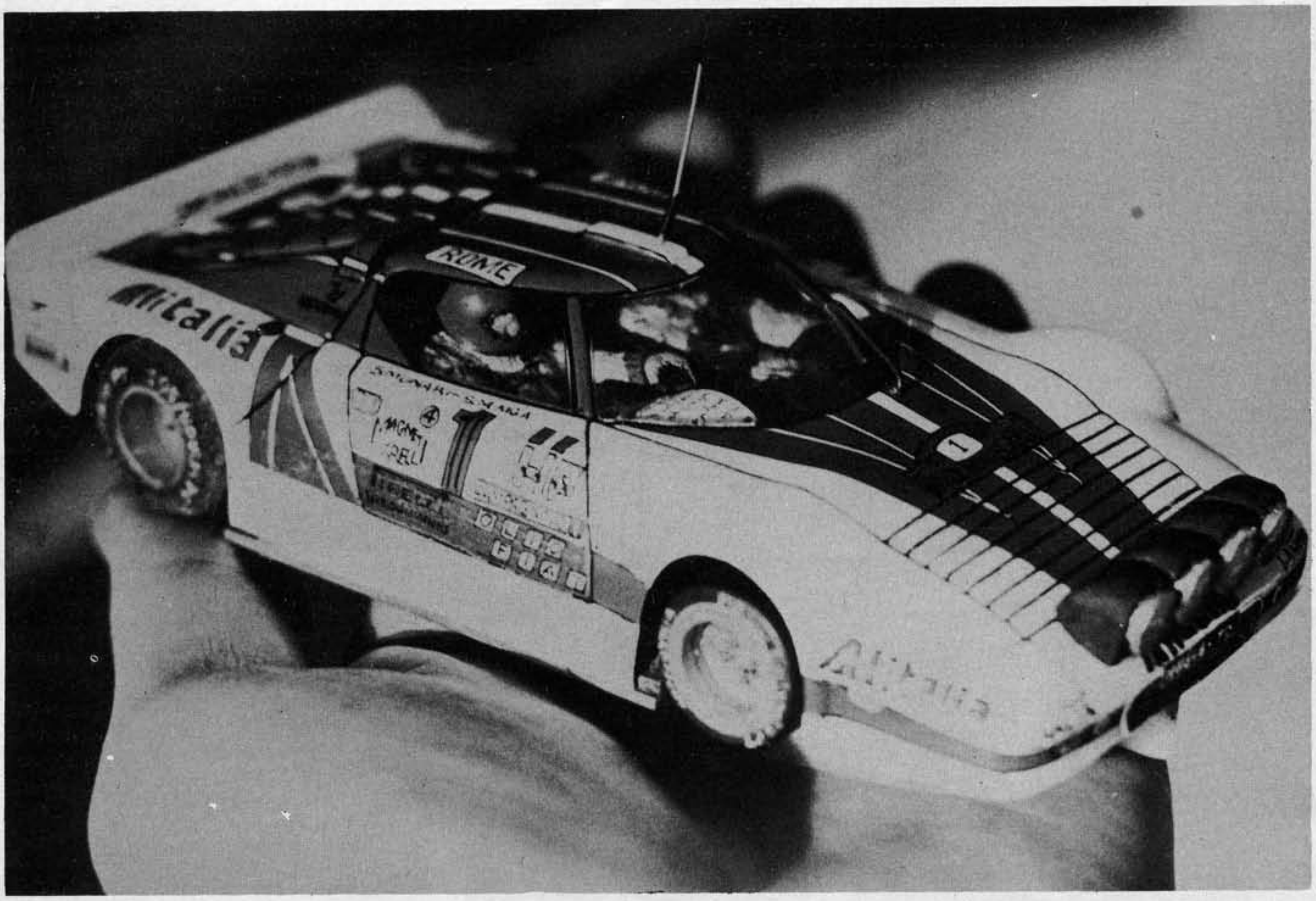


16 *Sash cramps.*

17 *Adjustable try-square.*

Slot-car-racing

By Ian Jensen



Concours—winning model of a rallying Lancia Stratos by Tony Milk of Preston Park Model Racing Car Club (Norwich), complete with fully detailed interior, including co-driver reading race notes! This is a genuine competition slot-car, not just a show car. The hand gives an indication of the size of a $\frac{1}{32}$ in. scale car.

WITH the rapid acceleration of interest in radio-controlled model car racing, it is easy to dismiss slot car racing as a dead hobby, continuing only in the form of toy racing sets to be played with on the dining-room table. Many people will remember, with some distate no doubt, the big, banked speed bowls that invaded so many High Street model shops in the late 'sixties, where noisy youngsters thrashed garishly-painted lumps of plastic and metal round and round until some other way of spending their money caught their fancy. Unfortunately, this brash commercial scene was all the general public ever saw of competitive slot racing and on the whole they were not impressed. Thus, when the businessmen saw profits falling and turned their interests to more lucrative pursuits, slot racing vanished into relative obscurity and few mourned its passing.

However, in England, the Electric Car Racing Association (ECRA), which had been formed long before the appearance of any commercial 'raceway', continued to keep this branch of model car racing alive in the numerous small clubs dotted around the country by organising Open Meetings and National Championships. It was no easy task as, with no publicity, there were few newcomers to the hobby to replace those who dropped out, and shortages of car components were rife. Thanks to the hard work of a few dedicated enthusiasts, however, the bad times are now getting better and, once again, people are starting to take notice of slot cars as being genuine working models, rather than kids' toys.

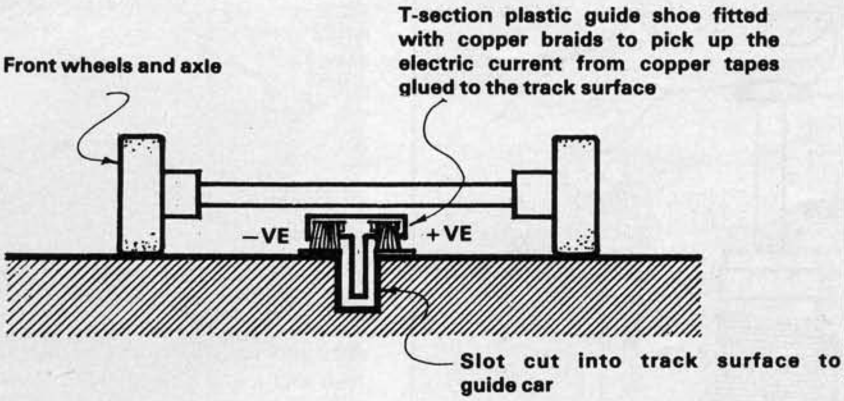
After all, there is just as much skill in building and driving a fast slot car as there is in racing a radio controlled electric car. In fact, they are just as fast (even faster if expressed in terms of scale speed!). The big difference is in expense—you can get started in slot racing for a fraction of the cost of the equipment needed for radio control cars.

What is slot car racing?

I shall try to explain here the basics of how a slot car works and how it is controlled. In its simplest form, the slot car consists of a chassis joining the front and rear axles, onto which is fitted an electric motor which drives the rear axle via a single set of gears. At the front of the chassis there is a downwards projecting pin or blade which locates into a groove or slot in the track surface (hence the name "slot-racing"). This slot guides the car around the track. On each side of the slot, flush with the track surface, there are continuous electrical contacts or "tapes", one positive and the other negative, which are connected to a 12v-16v power supply. Fitted onto the car, one on each side of the downwards projecting "slot guide", are two wire braids which pick up electric current from the "tapes" and transmit it to the motor via flexible leads (see diag. 1).

Several sizes of car are raced, the most popular ones being HO scale, 1/32nd scale ($\frac{3}{8}$ in. to 1 ft.) and $\frac{1}{24}$ th scale (½ in. to 1 ft.). In England, $\frac{1}{32}$ nd scale is almost universal, this being the scale encouraged by ECRA, although many circuits are built large enough to also accept $\frac{1}{24}$th scale cars.

The cars are controlled by feeding different quantities of electricity to the motor—more power to go faster, less



Section through track surface showing car guidance and electrical pick-up system

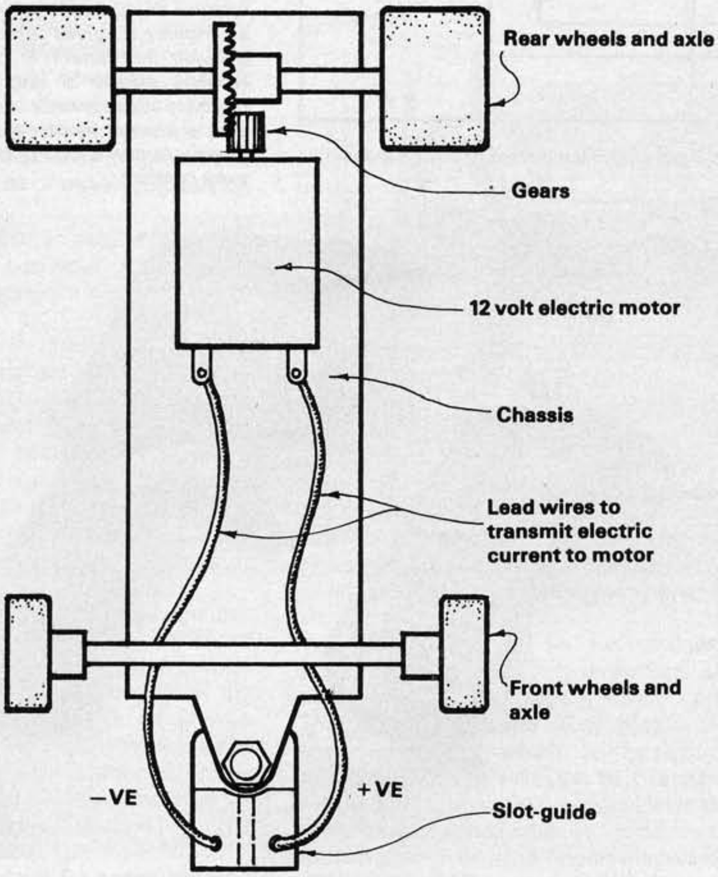


Diagram 1 components of a typical slot car chassis.

power to go slower. This is achieved by means of a hand-held "controller" containing a rheostat operated by a spring-loaded plunger or trigger. To enable the cars to "brake" for corners, the controllers and circuits are wired up to allow for regenerative or "dynamic" braking, where the electric current generated by the motor as it is turned round is used to stop the car. This is worked by cutting off the power to the motor, but still leaving an open electrical circuit through the motor for the regenerated current to flow through. The car is driven as follows: to go fast the driver pushes the plunger on his controller as far down as possible, to drive a little slower he lifts the plunger slightly, whilst to stop or brake for a corner he lifts off completely, thus cutting off all power to the car.

How do I start slot car racing?

Obviously, the easiest way to make a start in slot car racing is to buy one of the excellent home-racing sets that are available in practically any toy shop. These are cheap, easy to use and can provide a great deal of fun for yourself, your family and your friends. If you wish, great improvements can be made to the sets by fixing the track down onto a large sheet of chipboard, so that a very smooth surface is obtained, possibly with slightly banked corners, etc. The object is not to build a circuit that is easy to drive around but to eliminate all bumps and uneveness that can throw a car out of the slot when it is being driven hard. If the circuit is to be permanently installed in this manner, it is a good idea to solder all the electrical connections together in order to achieve a more positive contact than is possible when the track sections are just clipped together.

The standard cars can also be made to run much better if a few minor improvements are made—not necessarily tuning the cars, but just getting the most out of the standard parts. The first step is to ensure that the rear tyres are perfectly true and round as if they are not, the car will bounce around and lose a lot of traction. If the tyres are only slightly out of round it might be possible to true them up on the car with some medium grade emery paper—hold the emery on the track surface and rev the car up with the rear wheels lightly forced down onto the rough surface (you will need somebody to operate the controller for this operation unless you are fortunate enough to be endowed with three hands!). Care must be taken in this operation not to overheat the motor, and it is probably better to take the wheels off the car and true them up on a lathe or even an electric drill. Small amounts of weight can also be added to the cars to provide extra traction or stability—plasticine lends itself well to this application. The braids which pick up the electricity from the track surface should always be well-maintained, as these play a very large part in the car's handling: if they are too stiff, they may well tend to push the front of the car upwards and cause it to de-slot easily, whilst if they are worn they can contribute to bad handling by giving erratic electrical pick-up.

Of course, the components of these cars can be built into a completely home-made chassis, to give better handling characteristics than can be obtained with the standard snap-together construction, but if you are thinking of going to these lengths, you may be more interested in going on to the next stage of slot-racing—joining a club.

This is the way most people are introduced to competitive slot car racing, and it is the only way that you can really learn the complex techniques of building and driving a 'real' slot car. There are very many clubs scattered across Britain, of which about 40 are affiliated to the Electric Car Racing Association. The advantages of joining a club are many, the main ones being that the circuits are generally permanently erected and so do not have any difficulties with joins in the track surface or the necessity of erecting and dismantling it every time you want to

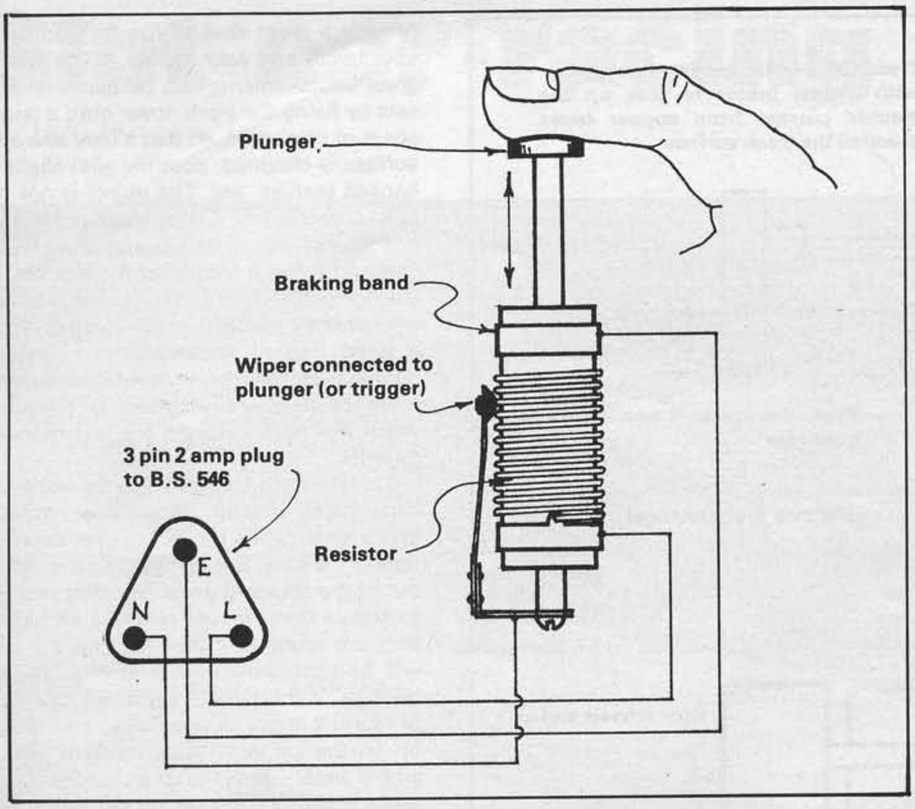
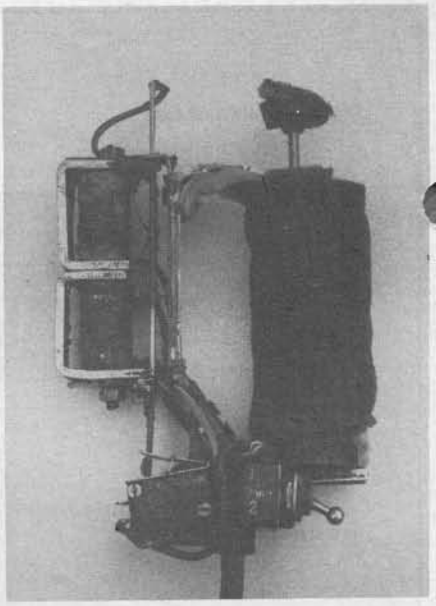


Diagram 2. The wiring of a typical hand controller, the 3-pin plug is connected to a corresponding socket on the circuit.



My own (home-made) controller which features double resistors wired in parallel. This arrangement gives greater reliability by allowing the current to be handled by two resistors instead of only one. Also greater flexibility as one resistor can be switched out to give a change in ohmage. The handle and plunger button is clad in cloth and sponge for extra comfort.

race. The average club circuit also contains more timber, electrical equipment and know-how than most people could afford to incorporate into a home circuit, even if they had the space to fit it. Much advice can be obtained from other club members on building and developing cars, and the regular competition ensures that your driving skills will be used and developed to their utmost. Even if you are not close enough to a club to regularly attend their club nights (and racing) it is certainly worth going to one of the frequent Open Meetings that are held on many weekends of the year in various parts of the country. Details of all these events are published in the ECRA Newsmag, which is distributed to all ECRA members and which can be subscribed to by non-members for a small annual fee.

When starting racing at a club, there are two things that you will need: a car and a controller. You may be fortunate enough that one of the more experienced club members has a car that he can sell you to get started with, otherwise the best way to obtain a reasonably priced car is to purchase a Formula 32 car. This type of car was formulated by ECRA to provide a standard class of racing aimed specifically at the novice driver. The car uses a standard chassis and a standard motor, both chosen for their low cost and reasonable performance.

The photograph shows all the components of a Formula 32 car (except the vacuum-formed bodyshell): the chassis, motor, gears, wheels, axles and axle spacers, slot guide and fixing nut, pick-up braids and lead wires. A similar kit can be obtained for less than £10 from HB Model Products, Fircot, Elm Lane, Earley, Reading, Berks. All that is needed to assemble the car is a soldering iron, pliers, and an Allen key for the grub screws in the wheels and gear. The completed chassis will fit most sports car and short-wheelbase saloon car bodyshells and, as well as being able to race in the special Formula 32 chassis class, the car will enable you to race in both the Sports/GT and Saloon Car racing classes just by changing the bodyshell. Thus you will have three cars in one.

Two of the most popular commercially available controllers. The plunger operated one is by MRRC Ltd. and the trigger version is by Parma International Inc. of America.

As far as hand controllers go, there are two basic types: either the trigger-operated variety or the thumb-operated plunger type. In most parts of the world the former type are universally used, due to their ease of availability and reliability. The best known make is by Parma International of America and prices range from less than £5 up to about £16. However, here in Britain many people prefer the thumb-operated controllers, despite the fact that there are very few available that are really suitable for modern racing conditions, and home-built varieties are common. For a beginner, starting racing with a Formula 32 car, I would recommend a Parma trigger controller of about 2 to 2½ ohms resistance to be about right. The Parma 'Turbo' is undoubtedly the top of the range of parma controllers, but the cheaper versions, such as the 'Pro' or 'Daytona' are also quite adequate.

Once you have become established into slot racing, most people wish to enlarge their stable to include more cars and the next step must be to build or buy a Formula One car, this being the only class of racing which a Formula 32 car will not cover. Basically, ECRA Regulations state that a F1 chassis must not be more than 1¼ in. wide and that the motor must be at 90° to the rear axle (as opposed to all the other classes where the motor is almost parallel to the axles in order to obtain better handling characteristics). Several small manufacturers produce chassis and ready-to-race cars, including Formula Ones and, unless you are familiar with modern slot-car chassis design, it is advisable to purchase one of these rather than attempt to construct your own. I say this because most modern chassis incorporate at least four separate hinges in the design which makes them not only difficult for the newcomer to understand but also quite a feat of model engineering to construct.

There are three basic chassis designs in common use, these days, all of which have some advantage on a particular type of circuit:

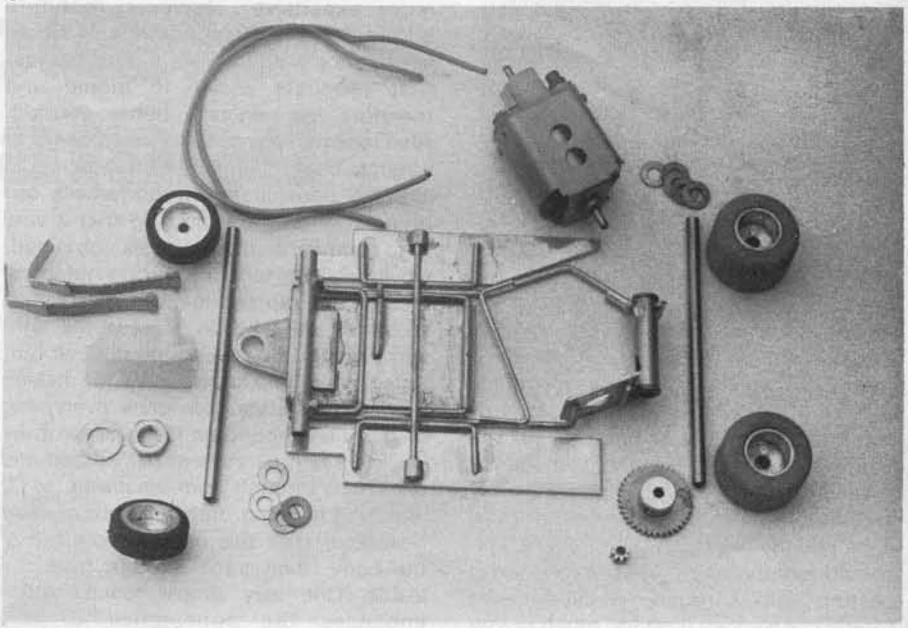
(i) The drop-arm chassis: Formula 32 chassis are constructed along these lines, which consist of rigidly attaching the front and rear axles together, but allowing the slot guide to drop down below the level of the rest of the chassis. This design really comes into its own on bumpy circuits, as it allows the car to bounce about without really affecting the guide or pick-ups.

(2) The Iso fulcrum chassis: On this arrangement the guide is connected directly to the rear axle for more precise handling characteristics. To enable the guide to remain in the slot on uneven track surfaces, the front axle is allowed to move upwards by a small amount. This is probably the most widely used type of chassis as it provides a good all-rounder for any type of circuit.

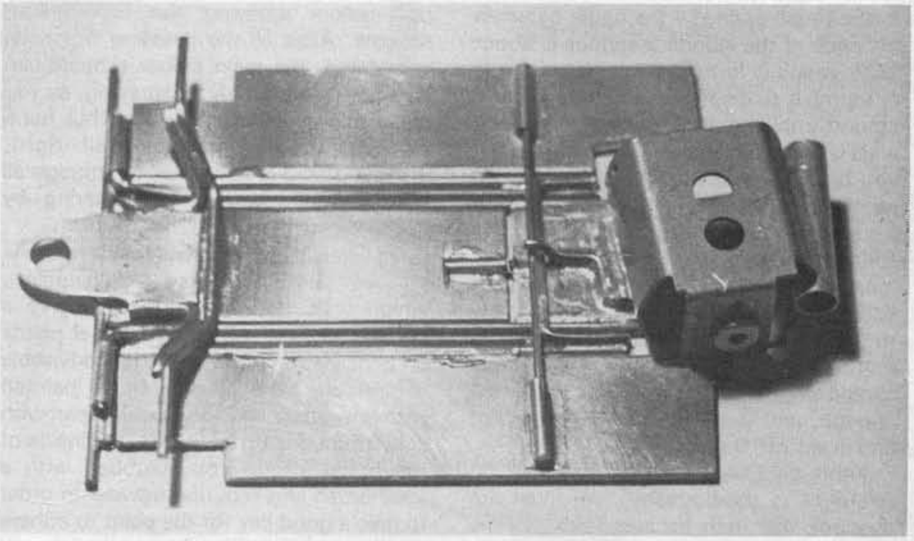
(3) The flexi-board: So-called because the main chassis is basically a flat plank, with method of construction of this 'board' makes for a very flexible chassis, giving excellent handling characteristics on smooth, fast circuits, although due to the fact that there is no play between the front axle and the guide, the chassis has a slight disadvantage on bumpy tracks.

The motors used in modern slot cars are all of the "tin-can" type: i.e. the works' are all enclosed within an open-ended steel casing. Whilst it is quite feasible to purchase a complete motor for as little as £4.50 and use it straight away, one or two minor 'tweaks' will ensure that you are going to get the best possible performance without the possibility of damage due to bad factory assembling. The component parts of a motor are shown in the photograph: on the right is the 'can' together with the two ceramic magnets which are secured inside it by the U-shaped spring clips. In the centre is the armature, the most important part of the motor, which runs in bearings fitted into the back of the can and in the plastic 'endbell', shown on the left of the picture, which fits into the open end of the can and is secured by the two tiny drive-screws (usually called pin-tabs) which are shown on either side of the armature. The armature is spaced between the bearings by brass washers, with a tight fitting plastic washer pushed up against the copper commutator to prevent oil getting onto the surface of the commutator. The oblong shaped carbon 'brushes' slide into housings on the endbell and are pushed against the commutator by the two springs shown alongside them.

To get the best out of a motor, first strip everything down to the basic components (it is not necessary to remove the magnets from the can, however). Start by removing the brush springs and brushes from the endbell. Using a knife blade, remove the two pin tabs securing the endbell into the can and pull the endbell out of the can. Carefully remove the armature, taking care not to lose any of the washers. Now that we



Component parts of a typical Formula 32 racing car.



Typical slot car chassis. A Flexi-board design by Old Pekuliar Products, 201 High St., Old Woking, Surrey. Chassis are made mostly from piano wire, brass or stainless steel sheet and brass tube.

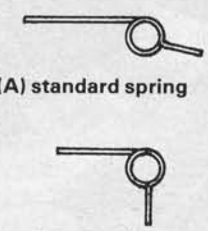
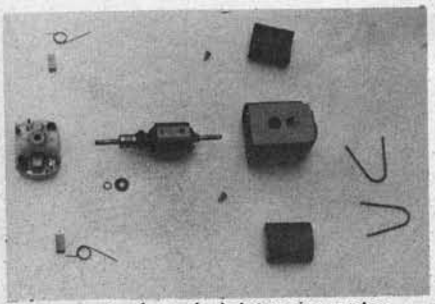


Diagram 3. Modifying the motor brush springs



Components of a typical slot-racing motor.

have everything apart, we can check that the bearings are not tight—the armature should be a slide fit between them, without there being any sideways play. If the armature is tight in one or both the bearings, first check that the bearings are pushed fully home into their housings and that they are lined up together. If this is all right, and the bearing is still a tight fit, you should gently open up the offending bearing with a round needle file—be careful not to open it up too much or you will give it a loose fit, which is no good at all. With this done, we turn our attention to the brush springs—the angle between the ends of the standard springs is about 150°, which is far too much. A good rule of thumb is to carefully bend the long arm around until the angle between the two ends is about 90° (see diag. 3) although, if you have a 6 volt power supply coupled up to an ammeter, it is possible, after assembling the motor, to tweak the springs to the exact position which gives maximum revs with minimum consumption. There are many other ways to wring even more power from the motor, but, for the beginner, the above should ensure that the motor runs well enough, and it can now be reassembled and fitted into the chassis.

Although I have only made a passing reference to the bodyshell, we must not overlook this item because, next to the chassis and motor, this is the most important part of the car and the only item that identifies the car as a model at all. Most shells, these days are one-piece vacuum-formed mouldings of clear plastic, either butyrate or polycarbonate, the latter usually known under the trade name of 'Lexan'. The lexan variety tend to be lighter and more flexible, so they last much longer than the more brittle butyrate bodies and are thus better for general racing purposes, despite being more expensive. However, butyrate bodies do have some advantages where appearance is concerned, due to the fact that they are easier to mould and therefore are generally better detailed. Also enamel paints tend to adhere to butyrate better than they do to lexan.

Being transparent the bodyshells can be painted on the inside, so that a very high standard of finish is obtained. Obviously, any lettering, racing numbers, etc., must be applied in reverse fashion so that from the outside it reads the right way round. This may sound difficult but, in fact, there are several ways of making this easier: (1) you can draw everything the right way round on the outside of the shell in a non-permanent felt tip pen and then trace through from the inside, or (2) draw the lettering onto a length of clear Sellotape, stick this onto the outside of the body, then trace through from the inside. One very simple touch, which enhances the appearance of any bodyshell, is to line in all the door and window surrounds, etc., with a drafting pen before applying the final colour scheme. After all the detailing has been completed, the main colour scheme can be applied, preferably by spraying, as you get a thin even coat this way, but hand painting is also perfectly all right, providing care is taken not to smudge all your carefully carried out lettering by painting over it.

On lexan bodies, the best paint to use is the specially formulated 'lexan paint', which bites into the surface to give a permanent finish. If using enamel paints on either type of bodyshell, it is advisable to carefully sand all area to be painted with fine emery and thoroughly clean with lighter fuel. As an alternative, the inside of the bodyshell can be scrubbed with a toothbrush and scouring powder in order to give a good key for the paint to adhere to. Remember that, when using enamel paints, the thinner the paint film the more flexible it will be and the longer it will adhere to the plastic. It should, therefore, be well brushed into the surface and spread as far as possible before reloading the brush. One point to remember is never to use cellulose paints or lacquer, as these invariably attack the plastic and cause the edges of the bodyshell to curl inwards. With a little care and occasional retouching, you should be able to keep your car looking smart for many months of racing.

Two of the vast range of slot-car body shells, available from: Betta Bodies, 61 Larkfield Lane, Southport, Merseyside.

The final item in this section must be concerned with the care and repair of your cars, because as with full-size cars, models do not go for ever without a certain amount of routine maintenance, such as cleaning, oiling, adjusting, and the replacement of worn-out parts. For this reason a slot-racer without tools is like a car without petrol—he won't go very far! As well as tools, a certain number of inexpensive spares must be carried in order to keep the car running properly and to cater for the odd mishap that can occur at any time during racing. The following items should cope with most routine maintenance and repair jobs, although most slot-racers tend to carry a much more comprehensive kit to cater for *any* eventuality:

Tools, lubricants, etc.

Long-nosed pliers (reasonably heavy duty)
Small screwdrivers.
Allen wrench for 6BA or 4/40 UNC grub screws.
Small pair of scissors.
Modelling knife.
Fine tweezers.
Small files.
Syringe or similar fine oiler.
Tube of Evo-Stik.
Tin of lighter fuel (petrol).
Tyre dressing (usually called goop).
Roll of Sellotape.
Clean rag.

Spare parts:

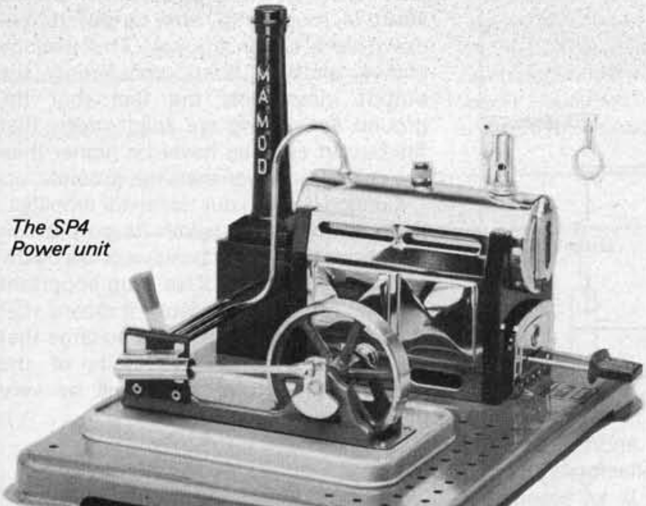
Wheel and gear grub screws (6BA or 4/40 UNC Allen grubs).
Spare Allen wrench for above.
Pick-up braids.
Lead wires.
Rear wheels and tyres.
Set of gears.
Motor brushes and springs.
Axle washers ($\frac{1}{8}$ in. or $\frac{3}{32}$ in. i.d.).
Sheet lead (for ballast).

Obviously a soldering iron is essential for use at home, but most clubs own their own which can be used for trackside repairs. It is often advisable to carry your own solder and flux around, however.

I hope that in this article I have given some readers an insight into a little of what is involved in modern slot-racing, without blinding them with all the technicalities that can only really be learnt by experience. Anybody who does decide to start up in this great, but inexpensive hobby, could do worse than begin by joining the Electric Car Racing Association, as this excellent organisation will provide practically all the information you need to know on clubs, trends, regulations, where to get equipment, etc., through its very comprehensive Handbook and bi-monthly Newsmagazine. Anybody requiring information on the Association should contact the Hon. Secretary: C. M. Frost, 22 Phillips Road, Marnhull, Sturminster Newton, Dorset, DT10 1LF.

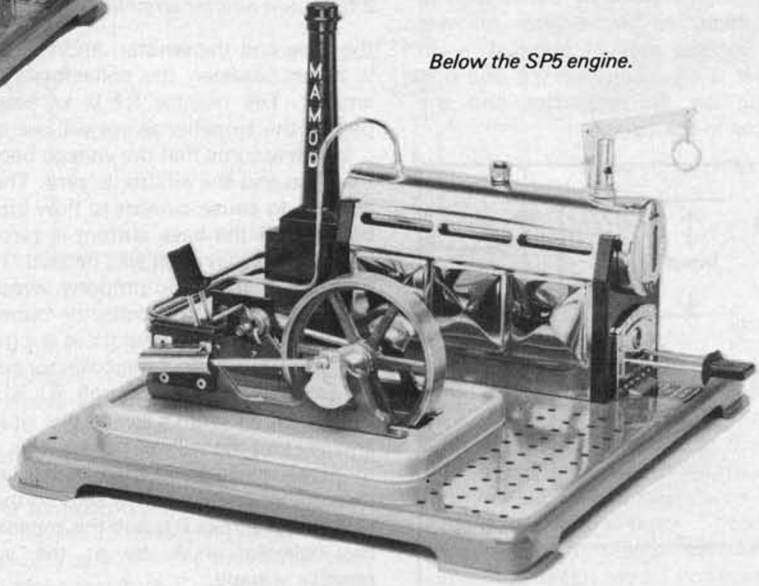
New models from Mamod

by Basil Harley



The SP4 Power unit

Above the SP2 engine.



Below the SP5 engine.

I know that any developments in the steam toy field are of great interest to many of our readers and a new range of engines from as well-known a company as Mamod is particularly welcome. Malins (Mamod) Ltd was established well over 40 years ago (I have told the story of its growth in my book **Toyshop Steam**) and is a lively forward looking company specialising in all manner of steam driven models. Their range of stationary engines, many of which had changed little since they were re-introduced after the war, has now been technically up-dated as well as being made much more colourful and attractive.

English toy steam engines have tended to be somewhat unconventional looking but nevertheless effective workhorses often bearing little resemblance to full sized prototypes. On the other hand the Germans have usually contrived to make their engines very reminiscent of real practice with such things as imitation brick chimneys and boiler casings. Now Stephen Malins, who is responsible for the new models, has been looking out of his office windows and has captured something of the spirit of Midlands industry of the past with a splendid range of black chimneys each with the name Mamod spelled out vertically down the stack. Countless firms in the Black Country had (and many still have) their names in white brickwork on the sooty works chimneys in just the same way.

Even the smallest in the range, the old Minor I, has had a facelift with a cast chimney and a heavier flywheel. The other overtype engine, now the SP2, also has a chimney, a new sight glass for checking the water level in the boiler, a newly styled casing for the boiler most attractively carried out in chrome plated steel together with a nice 'firedoor' baffle on the solid fuel tray.

The only casualty is the old SE Ia, the single cylinder non-reversing engine first made in 1936. This has been replaced by a modernised version of what was the Meccano engine which has always been made by Mamod but not until now marketed by them. It now has a water gauge and the standard lever operated whistle has been included.

Of the two largest engines the SP 4, which is the single cylinder replacement of the earlier SE2a, has a forward and reverse lever and exhaust up the chimney stack. And the biggest, the SP 5 twin cylinder engine with its large boiler can now also be reversed. Both have re-designed boiler casings and base plates and, of course, water gauges and whistles. A nice detail is a pressed channel from the chimney base to let condensed water from the exhaust pipe run away easily.

The engine units themselves are more colourfully painted and now appropriately mounted on new sub-bases which not only look more realistic but also help to contain the usual minor water leaks and oil splashes which are part of the fascination of any live steam engine. It is a pity that all the engines still have oscillating cylinders — fixed slide or piston valve types would increase the realism but perhaps they would add a disproportionate amount to the cost.

The Mamod range of accessories has been tidied up and all the workshop tools and overhead shafting are now available newly painted in blue both separately and mounted on a single baseplate all ready to be driven by one of the larger engines.

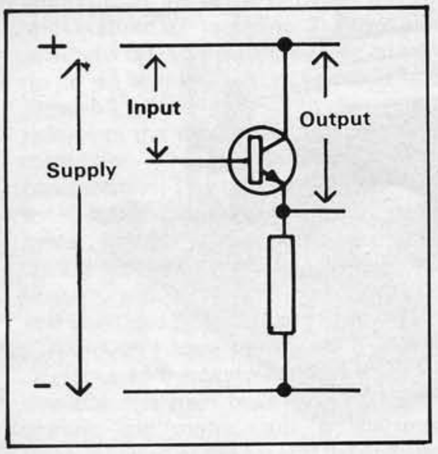
And a new miniature oilcan has been added — just right for lubricating the shafts and bearings, not only of Mamod engines, but any models or small mechanisms. We are told that there are other new products in the pipeline and we look forward to future developments with the greatest interest.

Electronics

Transistor amplifiers and switches
by Roger Barrett

In the past few months I have discussed the use of the transistor as a current amplifier, and shown a practical application. To recap very breifly the basic circuit of the emitter follower is given in Fig 1. The important points about this type of circuit are: 1. The maximum output current is equal to the input (base) current times the transistor gain; 2. The output (emitter) voltage is equal to the input (base) voltage minus about 0.6v.

The emitter follower gives a useful current gain but does not give any voltage gain. That is to say, if the input voltage changes by 1V, the output voltage changes by slightly less than 1v. Now the voltage gain is defined as the change in output voltage divided by the change in input voltage, so the emitter follower gives a voltage gain of about 1 — in practice it will be between 0.8 and 0.99 depending on the transistor and the resistances in the circuit.

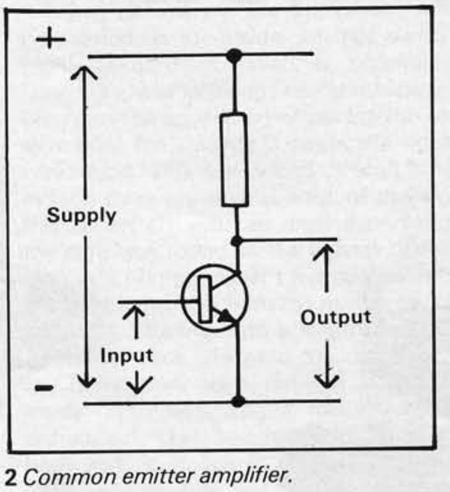


1 *Emitter follower.*

This type of amplifier is obviously very useful in certain applications that need current amplification without voltage amplification. The motor speed controller was a typical example of such an application. It is equally obvious that the emitter follower would be quite useless in many other applications. For example the voltage appearing on the serial of a radio receiver is likely to be in the region of 100µV, or 0.0001V. If we want a signal to drive a loudspeaker or a servo we need maybe as much as 10V. This means a voltage gain of 10÷0.0001 = 100,000.

Common Emitter Amplifier

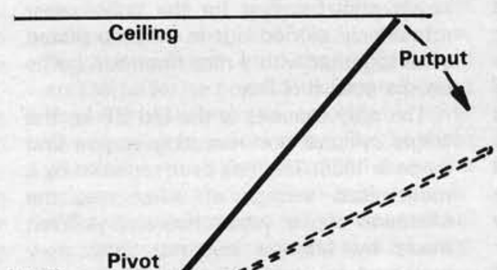
In order to produce voltage gain we must obviously use the transistor in a different way. There are in fact two other ways in which the transistor can be used but I will only deal with the more common one which is shown in Fig 2. This is called the common emitter amplifier because the emitter is common to the input and output. The input is now applied between



2 *Common emitter amplifier.*

the base and the emitter, and the output is taken between the collector and the emitter. The resistor R1 is an essential part of the amplifier as we will see later.

Let us assume that the voltage between the base and the emitter is zero. There is nothing to cause current to flow into the base and if the base current is zero, the collector current must also be zero. This is because of the basic property which we saw earlier that the collector current is equal to the base current times the gain of the transistor. Now if the collector current is zero, the current through R1 is zero. We can apply Ohm's law to this situation and say that the voltage across R1 is equal to its resistance times the current flowing through it. The current is zero so there is no voltage across R1, and this means that the collector must be at the supply positive voltage.



3 *Simple lever.*

If the base voltage is now made slightly positive, a current will flow into the base and this will cause a current to flow in the collector. The collector current flows through R1 and causes a voltage to appear across it which makes the voltage at the collector move down from the supply positive towards the supply negative. The output voltage in this type of amplifier is measured between the collector and the emitter, so the output voltage actually falls as the input rises. We say that the amplifier inverts the signal and the voltage gain is given a negative sign to indicate this inversion.

It may help to visualise this if you think of a simple lever as shown in Fig 3. The lever is bent so that when the input end is at ground level (zero volts) the output end is at ceiling level (supply positive). As the input is moved up, the output moves down by a larger amount. This analogy shows another point concerning the output movement; the fact that the ground and ceiling are solid means that the output end can never be higher than the ceiling or lower than the ground.

Coming back to our transistor amplifier, there is no way in which its output can rise above the supply positive or fall below the supply negative. This is an important point to remember because it means that if the input to an amplifier is so large that the output reaches the limits of the supply, the output signal will be very distorted.

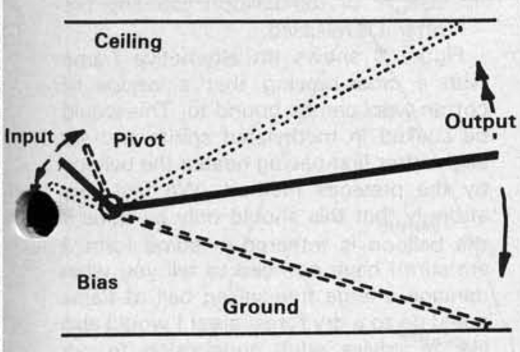
Biasing

In practice the circuit of a common emitter amplifier is more complicated than that shown in Fig 2 and extra components are used to set the collector voltage about halfway between the positive and negative supply limits. In this way the output can move up or down from its normal or quiescent position. The lever system that corresponds with this is shown in Fig 4. The only difference between this and Fig 3 is that the pivot has been raised above ground level to allow both the output and the input to move up or down from their normal positions.

For the transistor this means lifting the base slightly off the ground, or supply negative. This is done by putting a small voltage between the base and emitter to cause a base current to flow. This is called biasing the transistor and is achieved using circuits like the ones shown in Fig 5.

To see how the circuit gives voltage gain imagine that we have used one of the bias methods shown in Fig 5 to set the collector current at some convenient value. If we now change the voltage between the base and the emitter the collector current will change in sympathy. As the base is made more positive (remember that I am using NPN transistors) the collector current will increase. The increased current will cause an increase in the voltage drop across R1 and the collector voltage will fall. For an average transistor set to a collector current of say, 10mA, the collector current will change by 1mA if the base-emitter voltage is changed by about 25mV. Now if R1 is 1k ohm the voltage across it will be given by Ohms Law as follows:

(i) when collector current = 10mA,
Voltage = current × resistance
V = 0.01 × 1000 = 10 Volts
(ii) when collector current = 11mA
V = 0.01 × 1000 = 11 Volts.



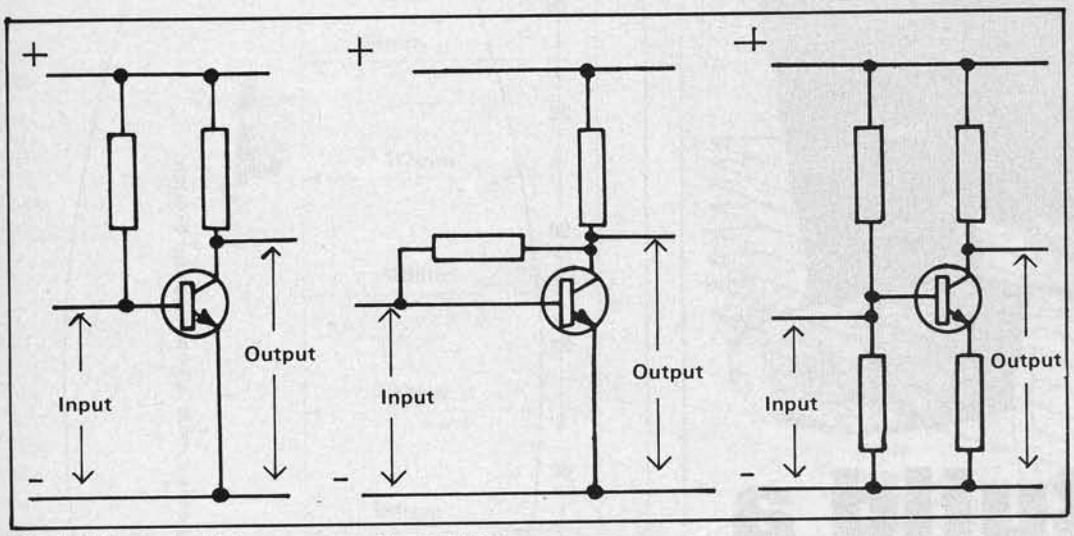
4 *Simple lever with bias.*

fabricated on a tiny piece of pure silicon. the techniques used to do this are the same as those used for making discrete transistors and yet a typical I.C. amplifier may contain the equivalent of twenty or thirty transistors and the same number of resistors.

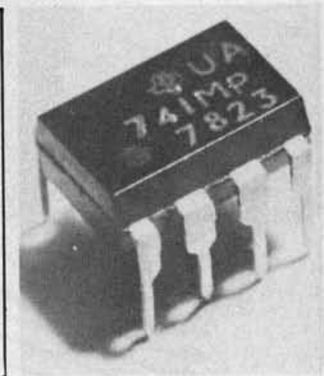
One of the most popular I.C. amplifiers is the "741" which is made by most of the semiconductor manufacturers. The equivalent circuit of this device is shown in Fig 6. This is fairly complex but is made up of individual stages, some of which are easily recognisable. This I.C. costs little more than a couple of transistors and yet

switch. The basic difference is that whereas an amplifier's output varies continuously between its maximum and minimum values, a switch is either on or off, with no intermediate state.

If we go back to the simple common emitter amplifier of Fig 2 it is clear that the transistor is "on" when there is base current flowing and "off" when there is no base current. It is normal in designing switches to make sure, by a suitable choice of resistor value in the collector circuit, that when the transistor is on its collector voltage is very near to the negative supply.



5 *Typical biasing circuits for common emitter amplifiers.*



741 I.C. amplifier.

The change in collector voltage is therefore −1 volt, which was caused by a change in base voltage of 25mV or 0.025V. This means that the voltage gain is −1÷0.025 −40. If you repeat my arithmetic with a value of 500 ohms for R1 you will find that the gain becomes −20. Similarly, if R1 is 2000 ohms the gain would be −80.

In practice the design is not as simple as I have suggested, although it is true that the voltage gain depends very much on the value of R1.

Common emitter amplifiers, like emitter followers, can be cascaded to obtain higher gain. The voltage gains of cascaded amplifier stages are multiplied together and this is where the idea of positive and negative gain becomes useful. If for example we cascade two amplifiers each having a gain of −10, the resulting gain is (−10) × (−10) which is of course +100. This indicates that the combined gain is positive and that if the input rises, the output rises by an amount which is 100 times greater.

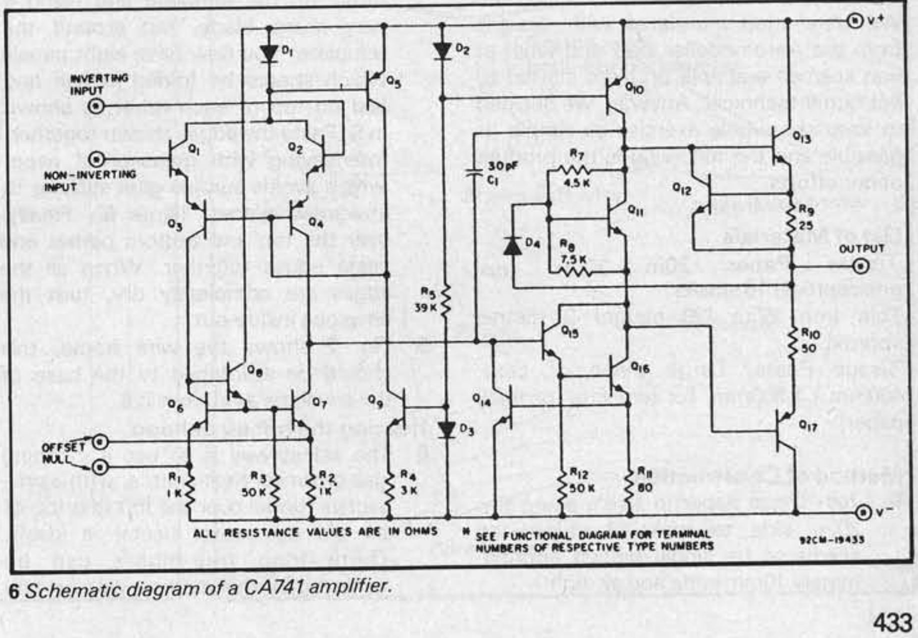
Practical amplifiers are often very complex in design, using common emitter stages with emitter followers where extra current gain is needed. There are available nowadays many types of integrated circuit, or I.C., amplifiers. These are based on the same principles as those using separate (discrete) components but their construction is very different. All of the transistors and diodes and many of the resistors needed for the amplifier are

offers a voltage gain of 200,000 as well as other features which are hard to match using discrete transistors. By the way, don't be fooled by the number of transistors in an I.C. — the method of manufacture means that transistors are cheaper to incorporate than resistors. So, an I.C. having 20 transistors may only do the job of 3 or 4 ordinary transistors plus half a dozen resistors.

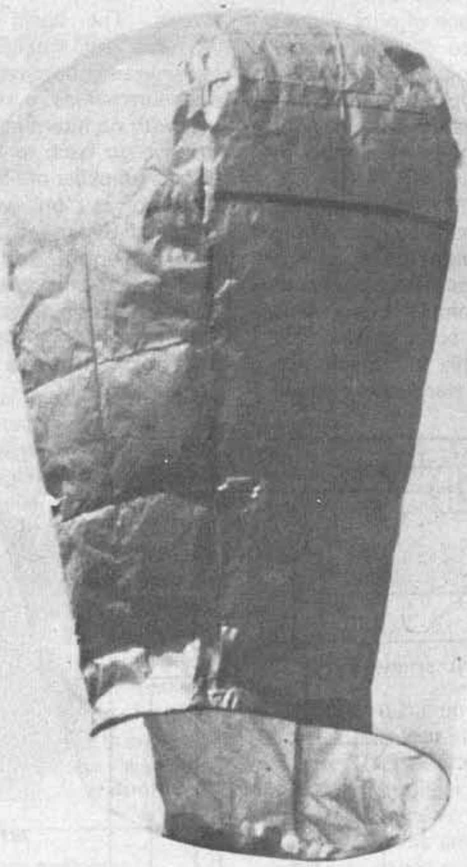
Transistor Switches

Another type of circuit which is really a special form of amplifier is the transistor

The main advantage of this type of switch over mechanical ones is the speed at which it can operate. The best mechanical switches can switch on or off in about one millisecond (one thousandth of a second). In the same length of time a good transistor can switch on and off about ten thousand times. These circuits made possible the digital calculators and computers which are so common today.



6 *Schematic diagram of a CA741 amplifier.*



Build a Hot air balloon

THE idea of a hot air balloon was put to me by Mr. E: D. Stott, who is arranging a demonstration of a full size hot air balloon and also a competition for model balloons at the Alveston and District Summer Flower Show (to be held on the 8th September 1979).

With great enthusiasm, Claire (my secretary) and I set to work to build one. We were soon inundated with designs from the Aeromodeller staff and what at first seemed a simple problem started to get rather technical. Anyway, we decided to keep the whole exercise as simple as possible and the following is the product of our efforts.

List of Materials

Tissue Paper 20in. × 30in. (not greaseproof) 16 sheets.

Thin Iron Wire (20 gauge) 3 metres approx.

Tissue Paste. Large piece of card, 400mm × 1,500mm, for template (or thick paper).

Method of Construction

1 Join tissue paper in two's along the 20in. side to make 8 strips—the seams to be single lapped approximately 10mm wide and air-tight.

2,3 The shape of the panel template is shown in diagram **2**, (it is suggested that thin card or thick paper is used to make the template). Fold along centre line to obtain identical shaped panels.

4 Lay the eight sheets of tissue on top of each other as shown in **4**, with the card template on top. Press down firmly on the template and using a very sharp blade, cut around the template. You now have eight panels which should be folded in half and laid on top of each other as shown in **5**. Paste the edges shown together, interleaving with greaseproof paper which avoids surplus glue sticking to unwanted places. (Note **6**). Finally, over the top and bottom panels and paste edges together. When all the edges are completely dry, turn the envelope inside-out.

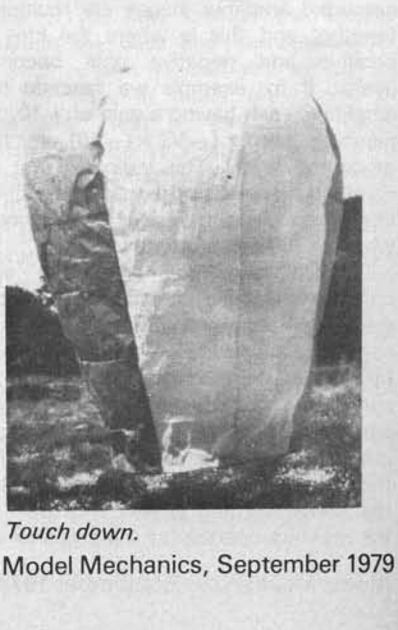
5 Fig. **7** shows the wire frame, this should be sellotaped to the base of the envelope as shown in **9**.

Heating the hot air balloon

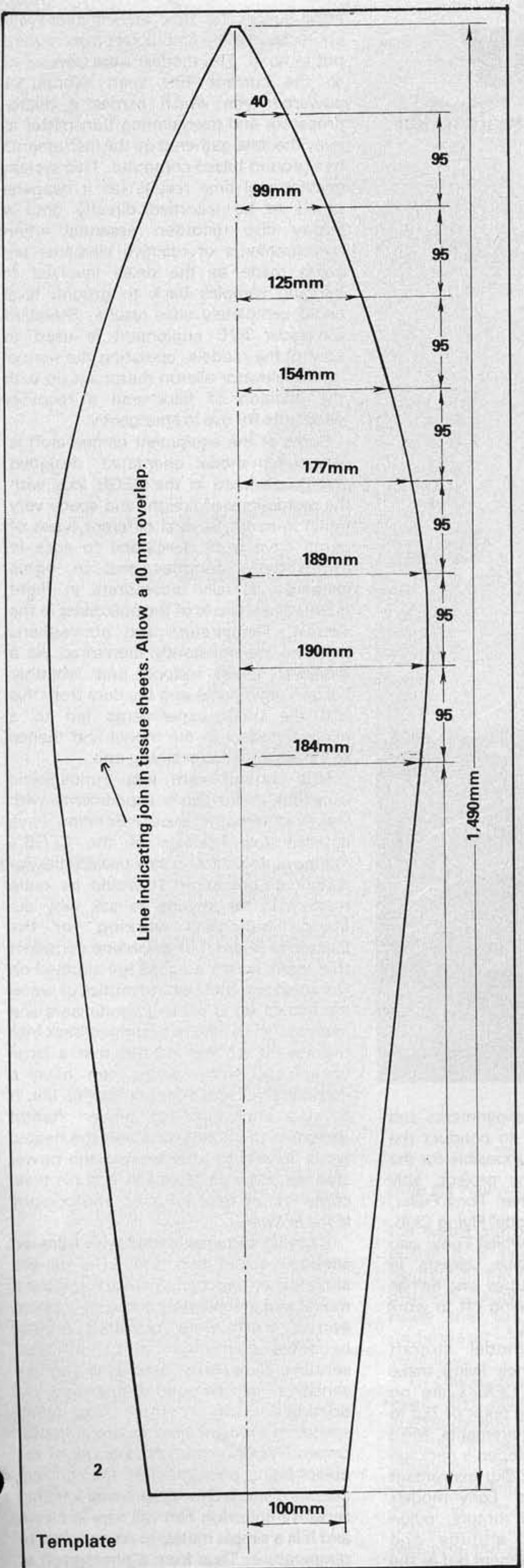
6 The safest way is to use a camping gaz or similar heat source, with a protective funnel over the top (the top of an old gas water heater is ideal). Quite long free-flights can be achieved by this method without any danger of the balloon catching fire after it is released.

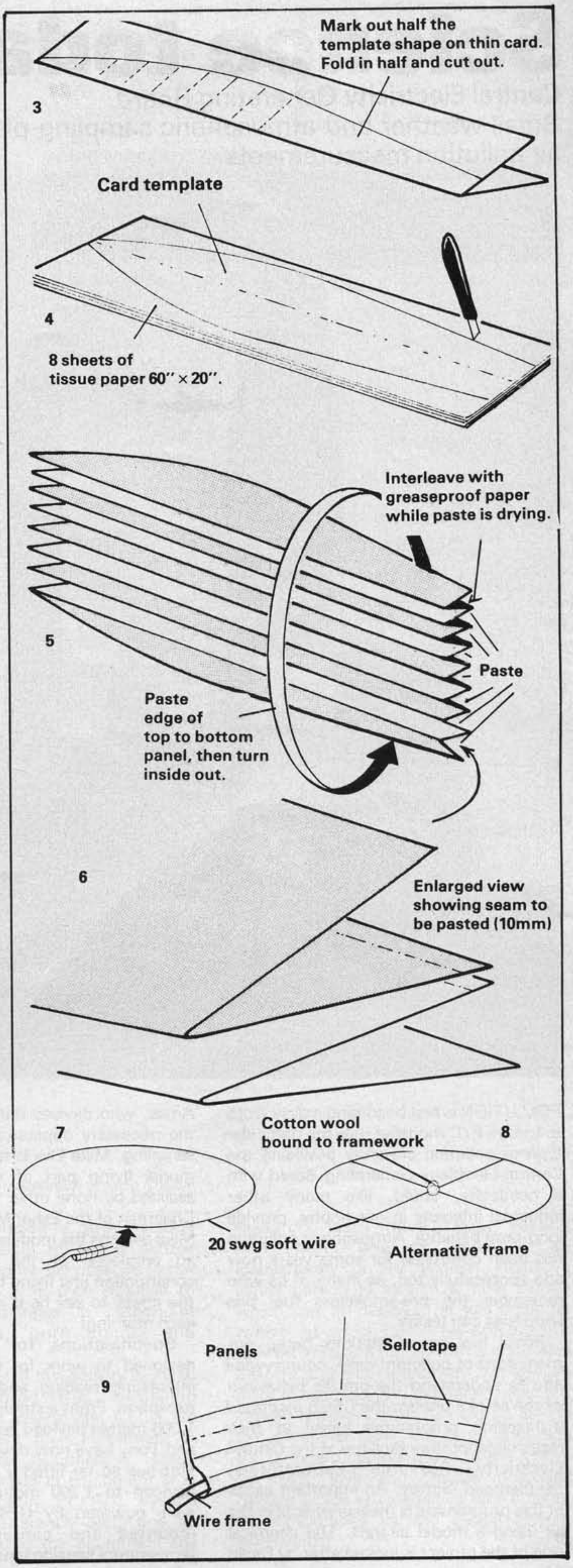
Figure **8** shows an alternative frame with a cross-bracing that a wadge of cotton wool can be bound to. This would be soaked in methylated spirits and set alight after first having heated the balloon by the previous method. We feel very strongly that this should only be done if the balloon is tethered in some form. I am sure I have no need to tell you what damage a large free-sailing ball of flame could do to a dry forest area! I would also like to advise adult supervision to our younger readers.

One of the early flights made from the garden of the Marchmont Arms. (Cost a small fortune buying rounds of drinks every time we had a good flight!)



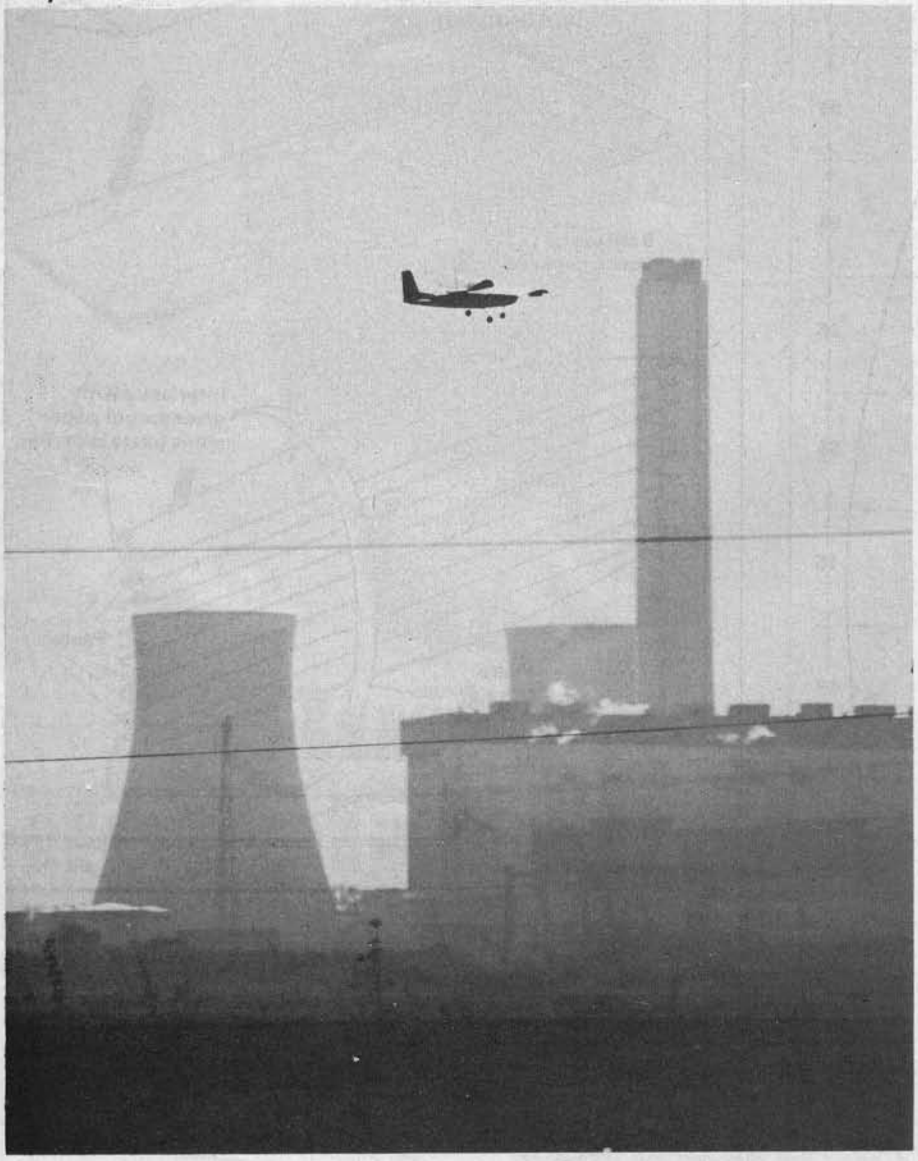
Touch down.


40
95
99mm
95
125mm
95
154mm
95
177mm
95
189mm
95
190mm
95
184mm
1,490mm
Line indicating join in tissue sheets. Allow a 10 mm overlap.
100mm
2
Template


Mark out half the template shape on thin card. Fold in half and cut out.
3
Card template
4
8 sheets of tissue paper 60" × 20".
Interleave with greaseproof paper while paste is drying.
5
Paste
Paste edge of top to bottom panel, then turn inside out.
6
Enlarged view showing seam to be pasted (10mm)
7
Cotton wool bound to framework
8
20 swg soft wire
Alternative frame
Panels
Sellotape
9
Wire frame

Science today

Central Electricity Generating Board.
Small weather and atmospheric sampling platforms for air pollution measurements.



POLLUTION is fast becoming a dirty word to todays R/C modeller, but the particular type of pollution currently providing the Central Electricity Generating Board with a headache, could, like many other industrial interests in our hobby, provide long-term benefits. Atmospheric pollution has been controlled for some years now and successfully too, as many of us who remember the pre-smokeless fuel pea soup fogs can testify.

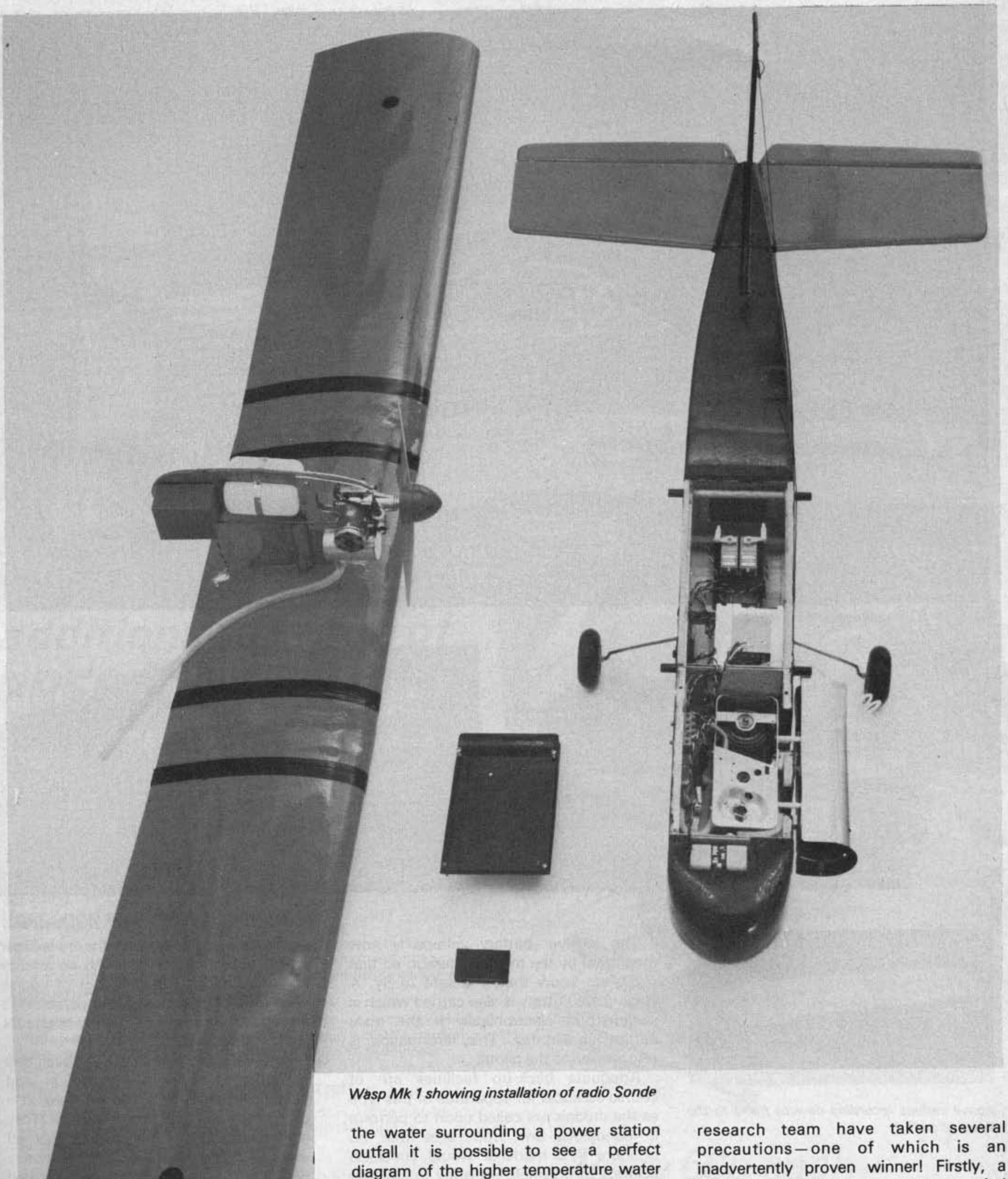
Fossil fuel power stations pump out many tons of pollutant daily, countrywide and to understand the precise behaviour of the smoke plumes the CEGB instituted a research programme based at their research laboratory facilities at the Central Electricity Research Laboratories, Leatherhead, Surrey. An important aspect of this programme is measurements in the air using a model aircraft. The chemical side of the project is looked after by David Ames, who devises the experiments and the necessary apparatus to conduct the sampling. Mike Ellis is responsible for the model flying part of the project, ably assisted by none other than Tony Fuller, Chairman of the Esher Model Flying Club. Mike designs the models whilst Tony, also an employee at the labs, assists in construction and flying duties, and he has the cheek to say he is going off to work each morning!

Specifications for model aircraft designed to work for their living make interesting reading and CERL's are no exception. From a starting point of 1kg to 1,000 metres payload requirements, Mike and Tony have now developed a package that has so far lifted a 2.5kg instrument payload to 1,200 metres. Early models were powered by HP40 motors, pylon mounted and carried altitude and temperature sensing equipment but as the initial success of their experiments were appreciated more ambitious projects were put in hand. The models were developed to the current 10ft span Webra 91 powered type which carries a micro-processor and telemetering transmitter to relay the data gathered by the instruments to a ground-based computer. This system enables real time results (as it happens now!) to be recorded directly onto a floppy disc recorder, essential when measurements of reactive elements are being made as the delay involved in bringing samples back to ground level could completely alter results. Standard Skyleader R/C equipment is used to control the models, operating the normal rudder elevator aileron motor set up with the addition of flaps and a recovery parachute for use in emergency.

Some of the equipment carried aloft is very much model orientated, designed and constructed in the CEGB labs with the restrictions of weight and space very much in mind. Several different types of pump have been developed to suck in atmospheric samples and in some instances actually incorporate in flight quantative analysis of the pollutants in the sample. Temperature and atmospheric pressure are constantly monitored via a modified sönde balloon unit (weather balloon radio pack) and the data from this and the other experiments fed to a microprocessor in the model and thence to the airborne transmitting unit.

Not content with just atmospheric sampling, Mike Ellis's experiments with low cost airborne experimentation have aroused the interests of the CEGB's marine biologists who saw possibilities for further co-operation. It would be quite reasonable for anyone to ask why are marine biologists working for the Electricity Board, but when one considers that many power stations are situated on the coast and that vast quantities of water are heated up in cooling condensors and reactors, all of which is pumped back into the sea, it will be realised that a large volume of warm water can have a considerable local effect on marine life. It is also important for power station designers to know just where the heated water travels to after leaving the power stations. How do Mike Ellis and his team come into all this? Infra-red photography is the answer.

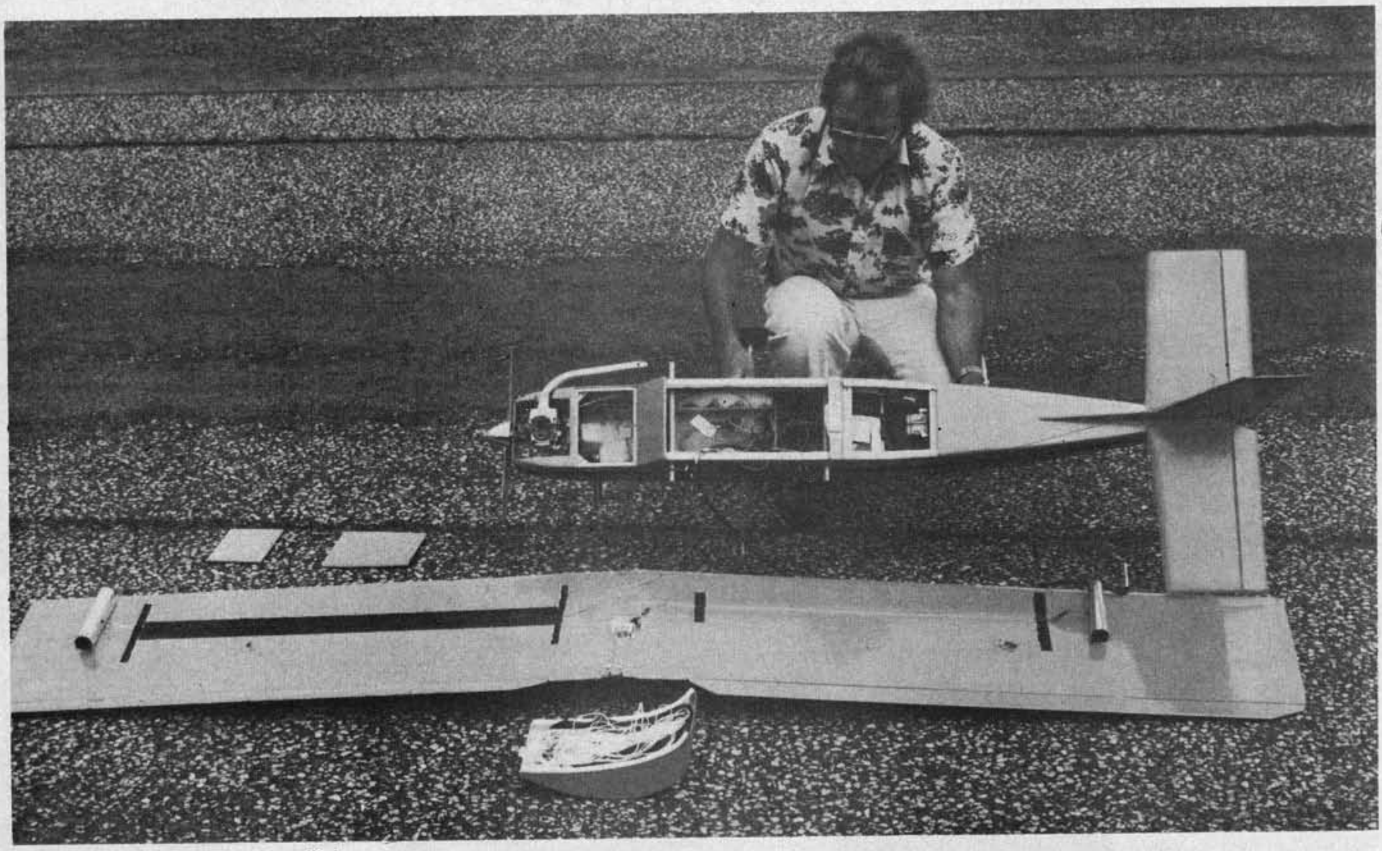
Carrying cameras loaded with Infra-red sensitive colour film aloft in a full-size aircraft is an expensive business but use a model and immediately costs are reduced and a worthwhile research project becomes economic reality. Infra-red sensitive films carry emulsions that are sensitive to the non-visible Infra-red portion of the radiation spectrum—radiant heat in simple terms. Depending upon the temperature of the object being photographed the apparent colours displayed on a processed Infra-red sensitive emulsion film will vary in colour and it is a simple matter to relate colour to temperature. Thus from a photograph of



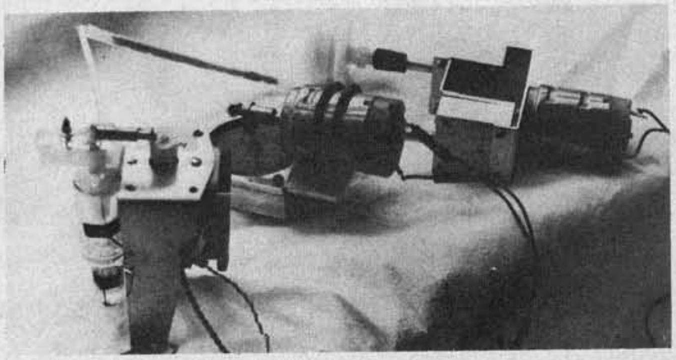
Wasp Mk 1 showing installation of radio Sonde

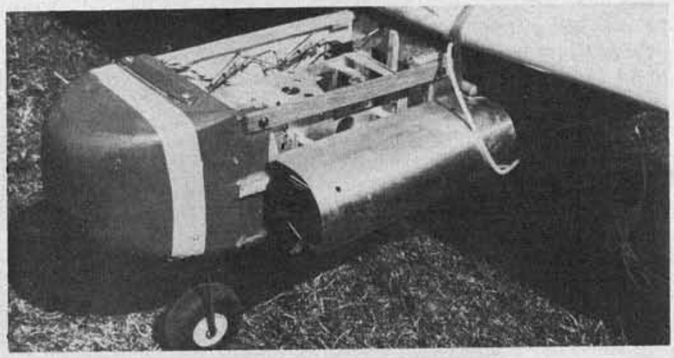
the water surrounding a power station outfall it is possible to see a perfect diagram of the higher temperature water dispersal pattern. It is then possible to relate this to changes in pattern of underwater life, both animal and vegetable.

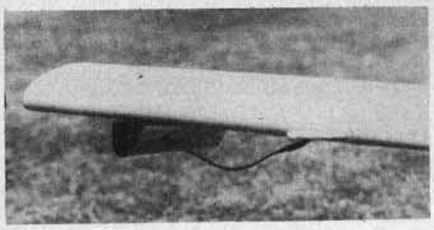
Of course, none of this activity is cheap even by accepted R/C modelling standards and of course the CEGB are anxious to protect their investment in equipment as far as possible. Many pounds sterling value in equipment is at stake at the mercy of R/C system malfunction, interference etc., and to minimise the risk to the equipment the research team have taken several precautions—one of which is an inadvertently proven winner! Firstly, a safety parachute system is now carried which can be deployed at will or under control of an on-board fail-safe device. This provides the model with a controlled descent and a comparatively soft landing if for instance as has happened, the R/C system receiver battery should go flat. In this particular case, the servo operating the on-board camera drove to the end of its travel, switching on the motorised camera which proceeded to take a series of pnotographs as the model floated earthwards!



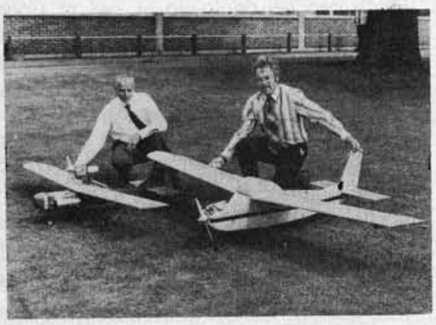
Wasp Mk II being prepared for a flight.







Above various recording devices fitted to the Wasp aircraft.



The receiver battery voltage is now monitored by the microprocessor, so that the pilots know that it is safe to fly. A small spare battery is also carried which is switched in electronically if the main battery should fail. This information is also relayed to the pilots.

Adequate back-up facilities are of course essential for apparatus of this type as the models are called upon to perform in conditions and from sites that no ordinary R/C modeller would consider. Altitude for example—it is fair to say that under normal circumstances, the range of an R/C system is as good as it's operators eyesight but for the CEGB lads, this is not good enough. Their answer is Radar! Track the model with a radar system which can lock onto and follow its target, couple this to a closed circuit TV with zoom lens and immediately the practical range and attitude of operations is more than doubled, for these models have to be flown with precision often from restricted sites some distance from the target area. Hand-overs from one transmitter to another are also used with the transmitter on-off sequence co-ordinated on a voice communication radio-link, not of course on 27Mc. A catapult launching system is a possibility with recovery by parachute for really restricted sites.

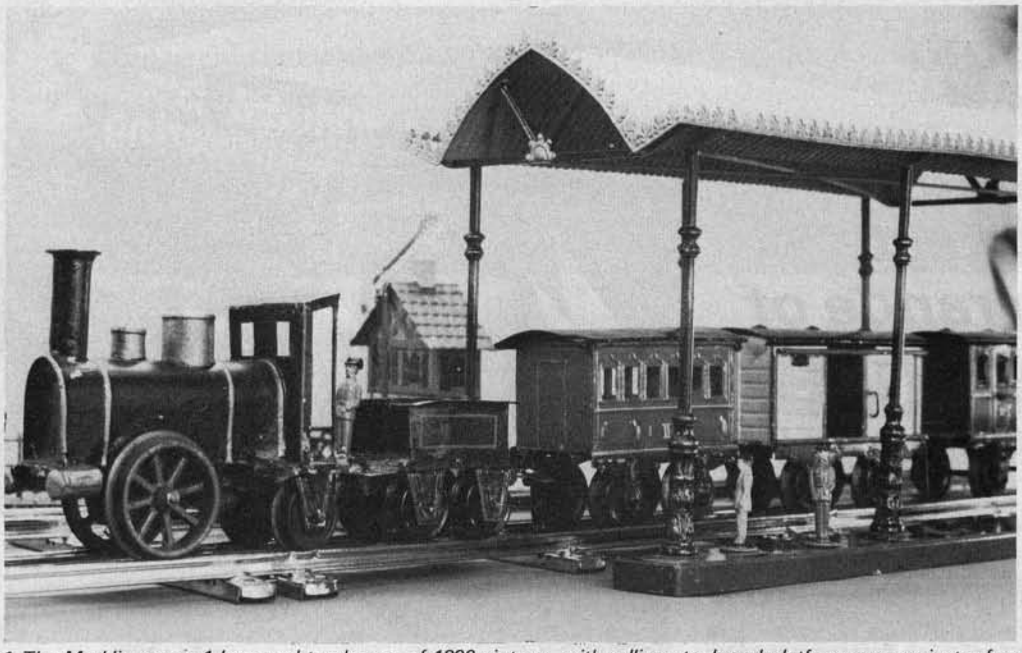
Mike Ellis and his team have been able to develop a highly practical and personally satisfying aid to the research in controlling atmospheric pollution. They have had problems but have approached them with the ingenuity and practicality which is the hall mark of the dedicated researcher just as much as it is the dedicated modeller. Their efforts are significantly helping to cut down the costs of producing electric power, particularly from fossil fuel power stations by helping to understand the nature of pollution propagation and allowing power station designers to evolve more cost effective methods of controlling pollution. This reduction in cost has been further enhanced by their imaginative use of what to them had been just a hobby.

Check and Report by James and Rita Vanderbeek

A wide ranging look at the commercial model scene

About James and Rita Vanderbeek
Professionally, technical and marketing consultants, James and Rita Vanderbeek divide their business into two sections—modern transport and the toy/model industry—and find that the links between these subjects render them particularly satisfying.
James has been a designer, builder and user of models since the early nineteen-thirties, and directly concerned with the toy/model industry since the end of World War II. Rita contributes to the partnership years of specialised commercial experience—gained both in industry and in the City—so that together they are able to deal with the technical and industrial problems of their clients with no little success.

When the Editor invited us to join the group of regular contributors to Model Mechanics by providing news, comment and test reports on commercially produced models and equipment, he emphasised the fact that restrictions on content would be few indeed. Thus it is that we start with a fascinating item of model railway history, given to us at a recent Marklin Seminar by A. M. Richards, the U.K. representative of this pioneer manufacturer.

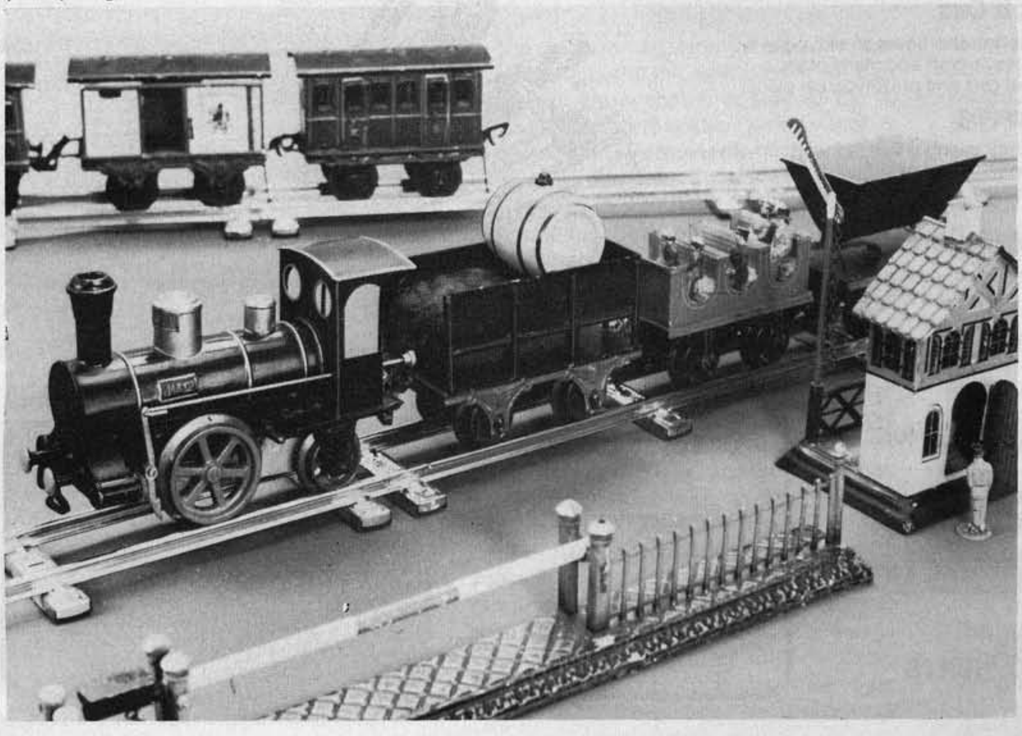


1 *The Marklin gauge 1 loco and tender are of 1890 vintage, with rolling stock and platform canopy just a few years younger.*

The company started making toys in 1859, expanded, and by 1891 was able to offer at a German trade fair a clockwork powered train with 'figure of 8' track, plus turnouts and crossings. A similar gauge 1 train, but of 1895 vintage, is shown in one of the photographs. It was in 1900 that the first Marklin live steam and electrically powered trains appeared—at the famous Leipzig trade fair, with the former described as having "a vertical boiler, spirit heater lamp and fixed single-acting slide valve control".

The first electric models used the domestic 110 or 330 volt lighting circuits as power sources, with carbon lamps to provide resistance for speed control. When the loco was removed from the track the full mains voltage went through the layout! It was not until 1926 that Marklin introduced the 20v AC system, as used today, and operating safety became an essential part of the system.

In 1935 Marklin offered their first HO scale, 16.5mm gauge, models but, for obvious reasons, the full potential of these small trains was not realised until the post-war period. Now these form the premier product range, still AC actuated, with a huge, worldwide following. Gauge 1 trains continue with a European outline range which is as technically advanced as any in the business, but it was in 1972 that Marklin sprang a major surprise with the 6.5mm Z-gauge system. It was one of these diminutive trains which recently set up a new world endurance record—1,219 hours and an actual distance of 720 km. by a locomotive and six cars, taking just over two months on an oval, voltage stabilised track. So much for these modern marvels, but who can resist that glimpse of history in the photographs?



2 *An 1895 clockwork loco with contemporary rolling stock and lineside accessories in well finished tin-plate. The design of the open carriage must surely go back to the days of Der Adler!*

Humbrol Kit for Vacuum Formed Trawler

The new Humbrol kit for the Sea Star deep sea trawler features vacuum formed plastics sheet as its main assembly material. Supplied is a full set of grey and white coloured mouldings for the hull, main deck and superstructure components, liquid cement and injection mouldings for the fine pitch 3-blade screw, life-raft casing, winch, anchor and other detail parts. The engine room equipment consists of a Best Motor HKE1, with on/off switch, leads, battery connectors and a flexible tube link for the direct drive to the prop shaft. There is also a colourfully printed set of transparent backed decals, so that little or no painting is required.

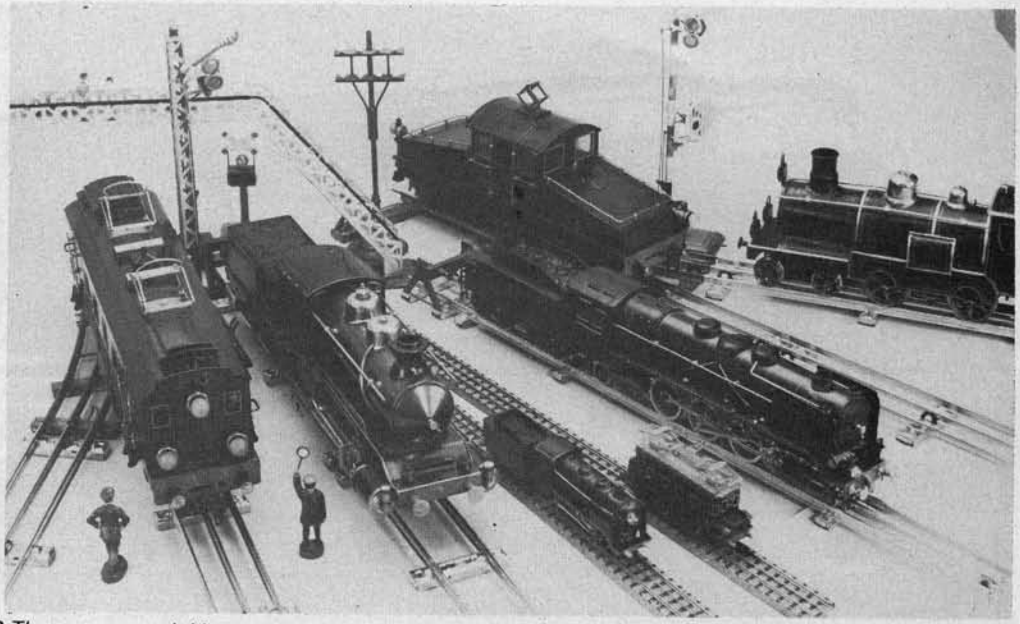
Sea Star is a fairly bulky craft for her length of 18 in. and 5 in. beam, so there is room for simple radio control to be installed—a point which Humbrol mention on the box label although no installation suggestions are provided on the otherwise comprehensive instruction sheet. Humbrol state also that Sea Star will perhaps require additional ballast to achieve satisfactory stability. We think this is essential and would start by altering the battery location to accept two, rather than one, of the specified 4.5v 1,289 cells and so reduce battery load resulting from the direct drive. We would also like to see one or two watertight compartments incorporated to provide emergency buoyancy—especially if expensive radio is fitted.

US Combat Aircraft Kits from Esci

The latest 1/48th scale plastics kits from Esci cover three generations of US combat aircraft in the Lockheed F-104C Starfighter, the Vought A-7E Corsair II and, to bring the line right up-to-date, the McDonnell-Douglas F-18 Hornet which is flying now in prototype form.

Checks of previously released Esci kits have shown that they are of very high quality, with a first-class finish on every moulding. These new aircraft carry on the tradition and are thoroughly to be recommended. In particular the F-18 Hornet is something of a rare bird, for few manufacturers have yet released their versions of this very important fighter of the next decade or so. The new Esci offering has everything which is to be expected of such a modern kit product, from fitted-out cockpit area through optional position undercarriage, opening canopy and, of course, a full selection of underwing tanks, bombs and missiles. As with all Esci kits the waterside transfer sheet is comprehensive and beautifully printed.

A fourth Esci pack covers a similarly scaled set of components for various types of bombs and missiles of American origin. Also included is a special sheet of missile markings, which are not only authentic but put Esci one ahead of their competitors in this important respect. This is the sort of kit which we regard as a real time saver when it comes to finishing off modified or scratch built models.



3 *Three gauges and thiry years are covered in this Marklin photograph. A 4-4-0 of 1904 at top right; Swiss and French outline electrics; a 1906 live steamer in the foreground and a beautiful 1933, gauge 0, 4-6-2 in right foreground. The two HO locos are both from 1935 production.*

4 *The Esci McDonnell-Douglas F/A-18 Hornet Kit in 1/48 in. scale.*

New Western Diesels in OO scale from Lima

The Lima OO-gauge model railway system must rate as being amongst the most improved during the last couple of years. Despite a company policy of maintaining prices at remarkably low levels, Lima are now offering British outline models which are not only noticeably better in every respect than last year's crop, but seem set fair to challenge very much higher priced competitors.

Typical is the BR Class 52 Western diesel hydraulic loco—now in the shops as D1071, Western Renown, in BR blue and D1016, Western Gladiator, in the earlier WR maroon. Constructionally this Co-Co locomotive follows previous Lima diesel design, with simple moulded plastics chassis, a clip-on body shell and a heavy mid-ships mounted steel ballast weight. The two bogies have dull finished all-metal wheels, with two of those on the powered bogie being fitted with traction tyres. The motor is of standard Lima design, with gear train to the outer pair of axles. Auto-couplings are fitted at both ends.

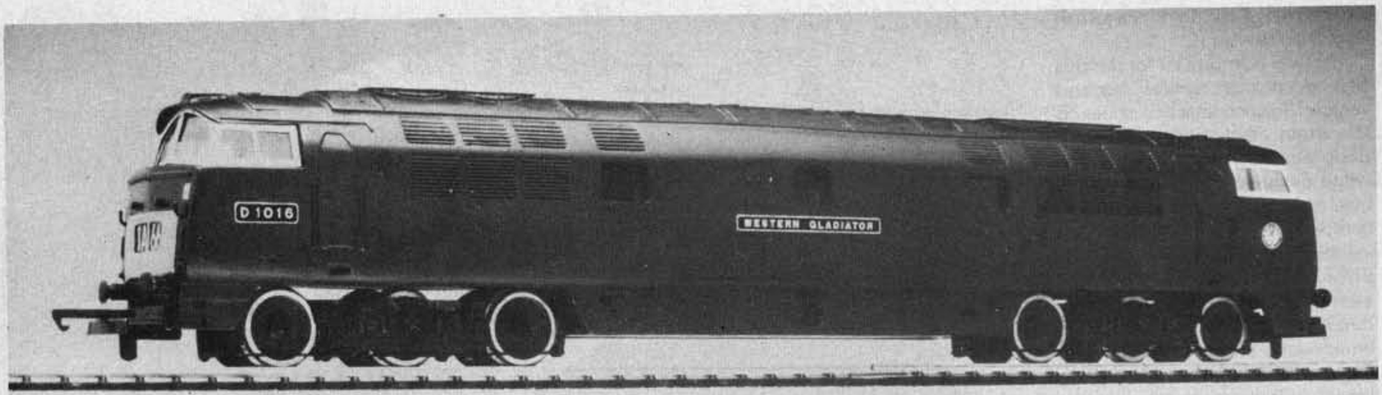
The loco body is a single shell moulding to which are added separate inserts for the cab interiors, glazing panels and frames, whilst a separate transparency glazes the centre pairs of windows. Plated finish handrails are provided at each of the four cab doors and across both ends of the model, whilst other interesting touches include head code panels, oval buffers, neat name and number panels and, of course, appropriate BR insignia. Western Gladiator has its roof panel picked out in grey.

On the test track these locos belied their low prices. Both behaved perfectly at all speeds and at no time did we note even the slightest hesitation in their response to controller movements. A new Lima touch is the provision of a TV interference suppressor across the motor. The matt finish of both our test locos was very attractive and at the head of rakes of BR blue/grey or chocolate/cream MK1 stock the Westerns looked absolutely at home.

The Fire Fighter—an Adaptable new Ship Kit from Revell

Revell has always been a master in choice of interesting marine model prototypes. The Fire Fighter is no exception, for the fire boats of New York have long been one of the most spectacular attractions of that city—being used ceremoniously to welcome new ships or VIPs as well as for their more serious duties in the harbour.

This latest Revell offering is quite large, with an overall length of over 19⅜ in. It is a full-hull model with sufficient detail and equipment on the upper decks to



6 *Lima Western locomotive.*

7 *Harbour fire-boat. Features are 19¼ in. long, two lifeboats, eight pressure nozzles, a high pressure nozzle mounted on a variable position tower, four searchlights, plus two propellers.*

satisfy the most demanding ship modeller. The mouldings are correctly coloured in black and white, with extras including a length of metalised thread and a colour printed sheet of appropriate decals. The scope of this boat can be gauged by the fact that no less than a 16-page instruction leaflet was deemed necessary to provide adequate step-by-step instructions and the resulting model must rate as being unusually good, even by Revell standards.

One extra feature of the Fire Fighter, which is only indirectly referred to on the box lid, is the fact that this is a suitable subject for motorising and conversion from static to a fully seaworthy model. The prototype has twin screws and these are supplied in slightly oversize form in the kit, which renders them about right for electric motor propulsion. To construct suitable motor and battery mountings plus, perhaps, a gearbox utilising wheels of the type available from Proops would not present many difficulties, and the modified model would certainly create something of a sensation on the local pond.

This is a beautifully produced and really interesting kit. It is thoroughly to be recommended.

Interesting Vintage 0-6-0 Tank Heads 1979 Jouef HO Models

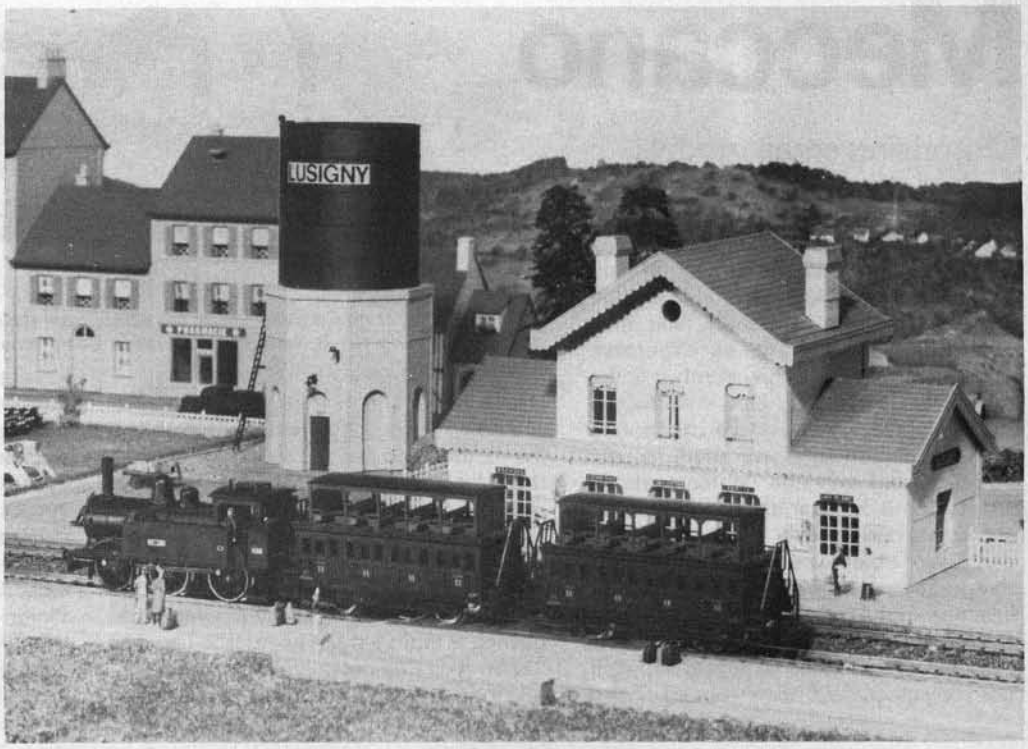
As a change from Jouef's very successful modern image locos, this French manufacturer has placed considerable emphasis on late 19th century models for its 1979 HO scale releases. Heading the list is a Boer 0-6-0 tank locomotive, with 4-wheeled, double-deck coaches to match, besides a selection of plastics construction kits for a country station, water tower and coal bunker.

The loco is classically simple in design and construction and seems assured of a big future, not only in standard form, but also when adapted. In this respect the construction of the lower half of the model is ideal, for the whole body clip-fits onto the running plates. Whatever steam or diesel outline body is required, can, therefore, be very easily added to an undisturbed factory product. A standard Jouef motor is centrally mounted, with worm drive to the rear axle, and other features include moulded-in splashers and buffers, articulated side rods and driving wheels with plated tyres. It is perhaps a pity that the drivers do not have open spokes, but the reason for this is apparent, as part of the overall policy of keeping the price of this "starter" locomotive as low as possible.

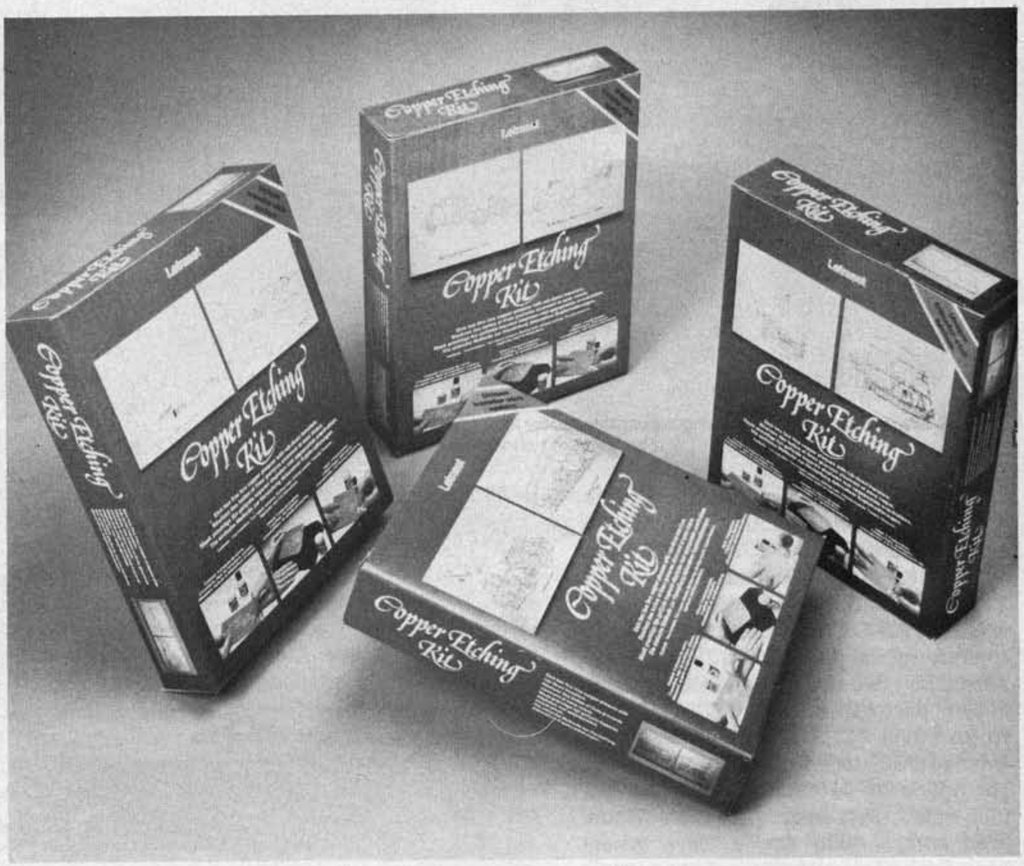
We were equally impressed with the performance of this model. It behaved impeccably on the test track, with load hauling ability enhanced by the friction tyres on one pair of drivers. Smooth, free-running was a feature of the double deck coach. This unusual 2-axled vehicle has steps at both ends, full-length footboards and, of course, the roofed-over benches on which the less fortunate paying customers sat—exposed not only to the elements, but to the Boer's smoke and smuts. In contrast to the black livery of the locomotive, the model has green coachwork, with the top deck structure in dark wood colour, with grey roof. The lettering and numbering is particularly neat and extends to the coach ends as well as the sides.

Although the Jouef building kits are all matched in design and surface finish to the French scene, they offer much in modification potential for British outline layouts. The country station building—Gare de Lusigny—has its mouldings in three colours and comes complete with glazing panel, a set of multi-language notices and ten full-colour printed posters which, although they depict French scenes, would certainly not look out of place in the U.K.

The coal bunker is a low timber framed structure of a type often found in a roundhouse area but it would be quite appropriate near a British shed. The water tower kit would perhaps be more suitable for installation in an industrial area of a U.K. layout, rather than at the trackside but, nevertheless, the kit contains a number of very useful mouldings, besides a further set of name panels. All three of these kits are of very high moulding quality, with the added advantage that because they are part of a system which involves users in all age brackets, they are particularly easy to construct.



8 *A French model railway of 1890, note the open upper deck coaches, and also the water tower on the left of the station.*



Copper Etched Loco Plaques with Letraset Kit

Just as pressure sensitive lettering has transformed commercial art, so has the adaption of similar transfers to copper etching made the whole process easier and, as far as amateur users are concerned, more predictable.

Letraset now offer a number of copper etching kits but our test sample featured two famous locomotives, Rocket and Royal Scot. The kit contents include a vacuum formed etching bath, supplies of etching crystals and transfer remover, an applicator to apply pressure over the transfer surface, two sheets of board mounted copper, each measuring 6×5 in., and the two Letraset reversed transfers of the illustrations.

The process is straightforward through all its stages. The sheet of copper is first thoroughly cleaned, the transfer is removed from its backing sheet and positioned over it and the applicator used to ensure that perfect contact is made over the whole area. The etchant solution must then be mixed and poured into the plastics bath, which has a ribbed bottom surface so as to hold the work clear of the surface. Depending on the strength of the etch mix, the time taken to eat away the unrequired areas of the copper picture will be anything from between one and three hours. The post-etch process involves removing the protective areas of the transfer so that, when clean and dry, the plaque may be treated with ordinary metal polish and given a coat of varnish before mounting on a suitable background or in a frame.

The pressure sensitive transfers simplify the whole operation and, with a kit like this plus reasonable care on the part of the user, a professional looking job may be easily achieved.

Military Figures Kits from Airfix

The scope of the Airfix plastics kits range may be gauged, as far as military figures are concerned, by this manufacturer's simultaneous introduction of packs in three different scales. Waterloo Prussian infantry will be welcomed by wargamers, as these are amongst the most often requested for the 1815 period in OO/HO scale. Similarly, the Multipose kits group will be enhanced by the addition of 1/32nd scale U.S. infantry of late World War II period whilst, representative of earlier years, is a superb 1/12th scale kit of a mounted Bengal Lancer.

The general concept of all these kits is similar to earlier military figure packs, but it must be said that the modelling and tooling seems steadily to improve and that value for money remains quite outstanding.

Meccano

Motorising small models by Bert Love

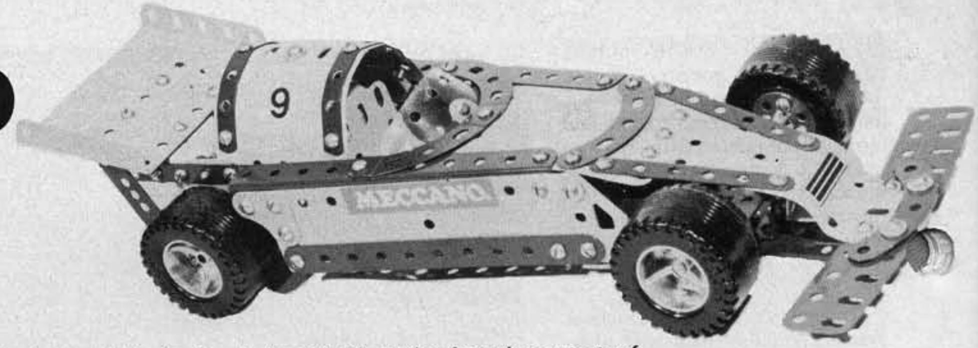


Fig. 1 *Formula Racing Car designed by the author from the contents of the new Meccano No. 3 Set. Note decorative labels provided in the outfit.*

ALTHOUGH advanced and complex Meccano models are to be seen at club exhibitions these days, advanced modellers do not necessarily limit their inventiveness to giant or expensive Meccano structures. This month it is the turn of the younger or less 'wealthy' (in terms of Meccano parts) constructor to see what can be done with more modest outfits. Using only the contents of the latest No. 3 Meccano set, the author shows his design for a Formula 1 racing car. Two objectives were set in this design, (a) to use all of the parts in the set in a meaningful manner and (b) to capture the utmost realism from the limited parts available. The reader is left to judge if both objectives have been realised!

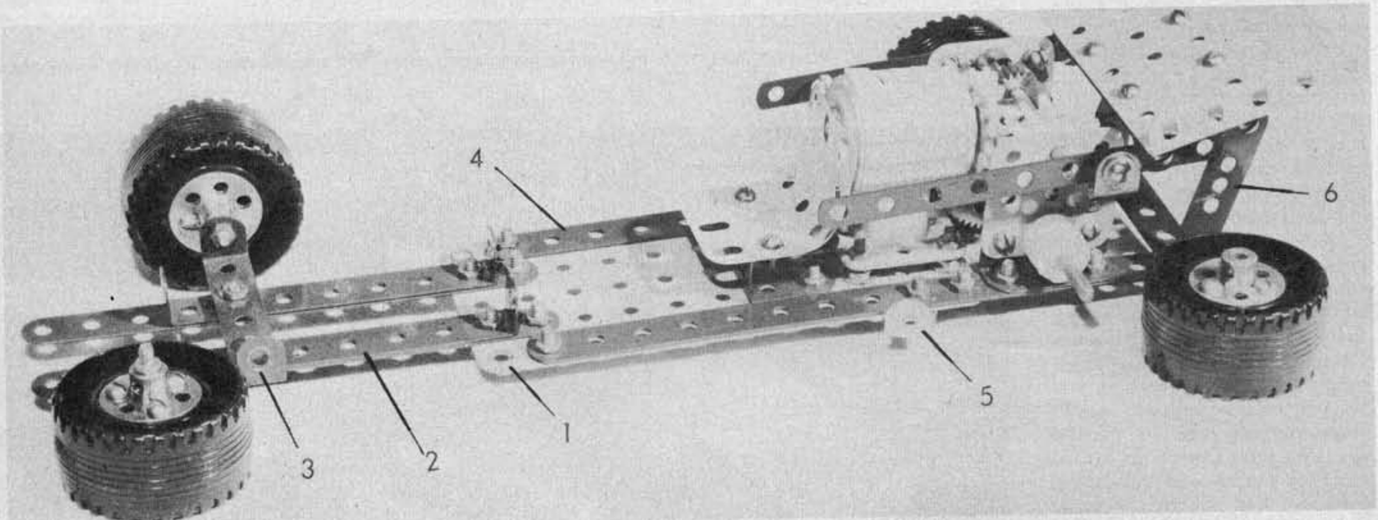


Fig. 2 *Chassis construction showing adjustable motor mounting.*

Formula 1 racing car

Fig. 1 shows the general view of the racing car from which much of the external construction is apparent. Two distinct sections are built as shown in Fig. 2 and Fig. 3 and the chassis is started with a 5½"×2½" Flat Plate (1) extended forward by a pair of 5½" Strips (2) overlapped two holes on the Flat Plate as shown and reinforced by 3½" Double Angle Strips. A 2½" D.A. Strip forms the front axle (3) to which the front wheels are bolted by 1⅛" bolts fitted with two lock-nuts. (See page 205, May *Model Mechanics*, 1979 for a new wheel assembly). Rear extension of the chassis is by a pair of 7½" Strips (4) giving a five-hole overhang at the back. This simple form of assembly gives an overall 'sprung' chassis. On each side of the Flat Plate, one hole in towards the rear, a 1"×½" Angle bracket (5) is bolted on at a slight angle to receive the body shell in due course. Included with the new No. 3 Meccano set is the 3-4.5 volt Meccano electric motor and this should be mounted as shown in Fig. 2 on four ½-in. Bolts, the motor being centralised on the rear of the Flat Plate. Double lock-nuts are placed on each bolt shank clear of the plate so that the motor can be set to critical height when engaging the gear drive to the back axle.

Figs. 4 & 5 show the way in which the gearing is mounted but in order to use the 2½ in. Axle Rod provided in the No. 3 set, one journal plate is set slightly inboard as follows. A 1½ in. Strips but the one shown in Fig. 4 has its lower flange pointing outboard. A second 1½ in. Angle Girder is mounted on the other side of the chassis but its lower flange points inboard. In each case a 1½ in. Square Plate is bolted vertically to the slotted flanges of the small Angle Girders and these plates (20) are adjusted later to give a clean meshing for the gear drive. Through the centre top holes of these small plates, the 2½ in. Axle Rod is fitted (from the left, Fig. 5) with a Washer, then the Plastic Multi-Purpose Gear Wheel locked onto the rod, followed by a 19t Pinion spaced away from the plate by two Washers. Finally, one more Washer and a Spring Clip are placed outboard on the end of the rod to maintain the lateral position of the gears. A rear aerofoil is made from a 3½ in.×2½ in. Flanged Plate (7) fixed to a pair of 2½ in. D.A. Strips and bolted to the vertical sloping 2 in. Strips (6) at the rear of the chassis and to a pair of 4½ in. Narrow Strips as seen in Figs. 2 & 4. The 'offside' Narrow Strip

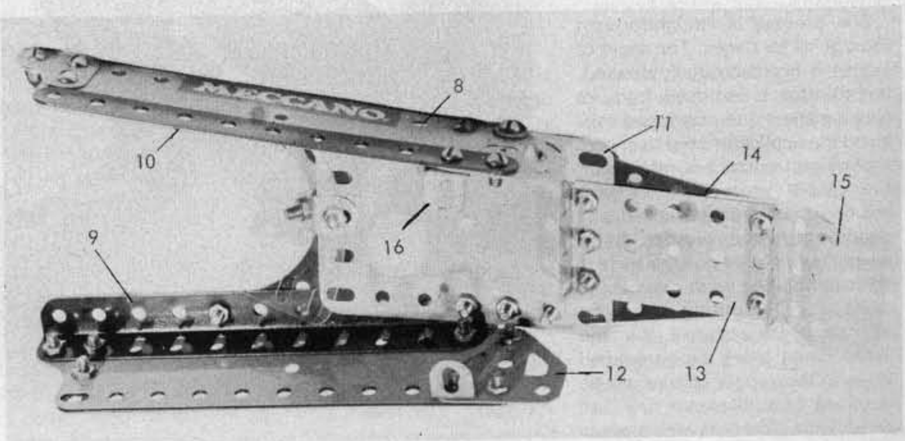


Fig. 3 *Details of separate body shell which is detachable as a single unit.*

bracket fixed to the inner 1½ in. plate as shown in the various illustrations. Both rear wheels are fixed to the rear axle, a 4 in. Rod, by Grub Screws, but Fig. 4 shows three Plastic Pulleys (19) used as stand-off washers on the rear axle (17) to allow for the inboard setting of the 1½ in. Square Plate. On the far side, only one Plastic Pulley is required to complete the spacing.

When the motorised chassis is completed it should be tested on a motor run to ensure that all gears are in clean mesh. The 1½ in. Gear Wheel (21), fixed on the back axle must be set clear of the chassis side members to avoid contact. If the mechanics are satisfactory, the cockpit hood may be fitted, this being made from a pair of 2½ in. Square Plastic Plates formed by 3½ in. Narrow Strips overlaid in a "U" curve as shown and bolted directly to the horizontal 4½ in. Narrow Strips. Fig. 3 shows the separate body shell, the sides of which are 5½ in. × 1½ in. Flexible Plates bolted on to 5½ in. Girders (9) and overlaid with 5½ in. Strips (10). Flat Trunnions (12) are fixed at each side and at the same time, ½ in. Angle brackets (16) are fitted to permit the body shell to be attached to the chassis, the slotted lugs of these brackets being bolted under the leading corners of the chassis base plate on final assembly. Fitted just forward of the cockpit is the 3½ in. × 2½ in. Flexible Plate (11), gently curved downwards at the front and extended by Flanged Plate (13), a pair of 3 in. Narrow Strips (14) and a 2½ in. × 1½ in. Plastic Plate (15) curved in an "S" bend to fit the front aerofoil as shown in Fig. 1. A 2½ in. × 1½ in. Clear Plastic Plate forms the windshield and final and attractive decoration is carried out via the self-adhesive and re-usable label sheet included in the No. 3 Meccano set. The driver's seat is also a plastic plate fixed to a Channel Bearing bent plate bolted to the chassis base. Although a battery box is also supplied with the outfit, average "shelf life" batteries from a shop can give as little as 2 volts (per series pair) instead of the 3 volts really required. The model should still run on a flat table top or smooth sheet of hardboard, but for running greater distances along a corridor, or the floor of an exhibition hall, it should be fitted with a lightweight trailing cable of twin flex and provided with 4 or 5 volts D.C. from suitable batteries.

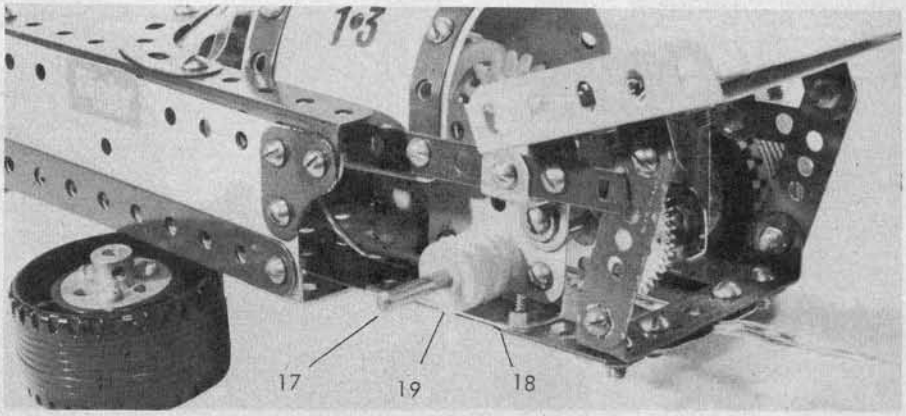


Fig. 4 *Close-up of rear axle mounting showing stand-off spacing pulleys.*

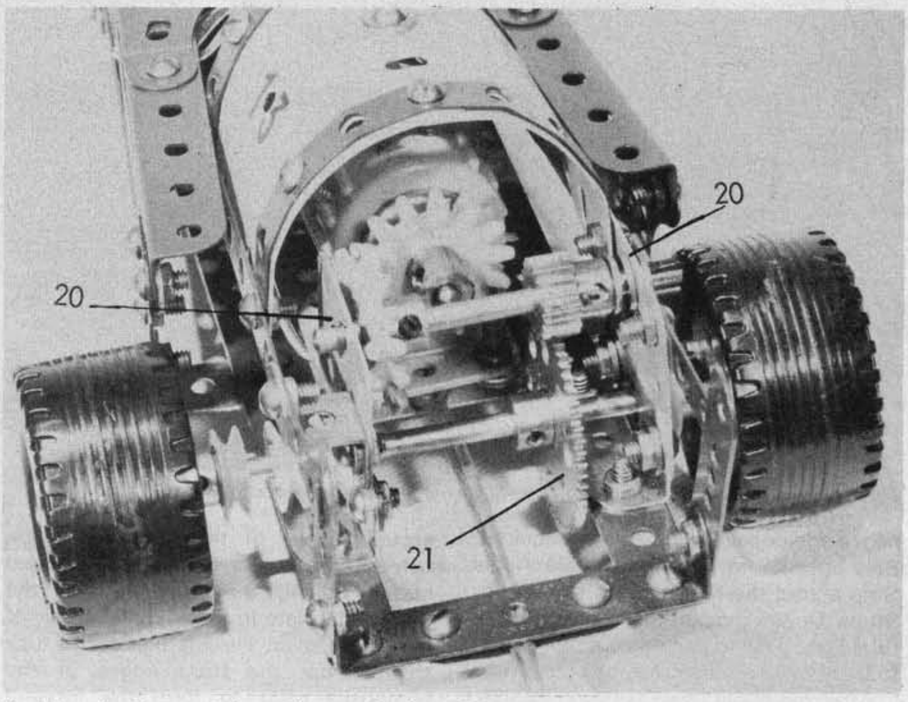


Fig. 5 *Details of transmission and gear reduction to back axle.*

Self-propelled assault gun

Slightly more ambitious than our first model, the Self-propelled Assault Gun shown in Fig. 6 is nevertheless made basically from a junior Meccano outfit and is designed by members of the Society of Advanced Meccano Constructors being a joint effort by Roger Lloyd of Solihull and the author. It uses the Meccano Army Construction Set which already has the necessary caterpillar track but a few extra parts are required, namely four 1 in. Pulleys with bosses and four 1½ in. Axle Rods (commonly found in most constructors' kits) plus two 3½ in. Flat Girders although 3½ in. Strips could be substituted. This model works very well and will climb obstacles with ease thanks to the Meccano Powerdrive Motor (6-12 volts D.C.) which has its own self-contained multi-ratio gearbox.

Chassis construction is quite simple being a 5½ in. × 2½ in. Flanged Plate with its flanges extended downwards 1½ in. by 5½ in. × 1½ in. Flexible Plates bolted to the outside of the flanges. 7½ in. Strips bolted inside the bottom row of holes of the Flexible Plates extend the chassis two holes at either end. Inside again, at the rear, Flat Trunnions reinforce the chassis from the rear holes on the flanges of the main plate and they provide substantial journals for the rear axle of the model. Figs. 7 & 8 show the general construction from below and should be studied carefully. At the forward end, another pair of Flat Trunnions are fixed outside the 5½ in. × 1½ in. Flexible Plates by one bolt each (passing through the third hole back from the front of the 7½ in. side Strips), the "points" of the Trunnions being allowed to swing freely for the moment before completing the upper decking of the assault gun. Each Plastic Track Sprocket is provided with a loose internal bush in the Army Set and drive to the sprockets is obtained from the Grub Screws set in the Collars at each end of front and back axles. These Grub Screws protrude slightly and engage with the castellations moulded in the plastic sprockets. Running gear for the tracks is supported in pairs of 3½ in. Flat Girders (two of which are already in the Army Set) as shown in Fig. 7, pairs of Bent Trunnions supporting the outboard Flat Girder or substitute 3½ in. Strip. Set the 1 in. Pulleys as shown with inside washers. These wheels will be held in place laterally by the tracks themselves,

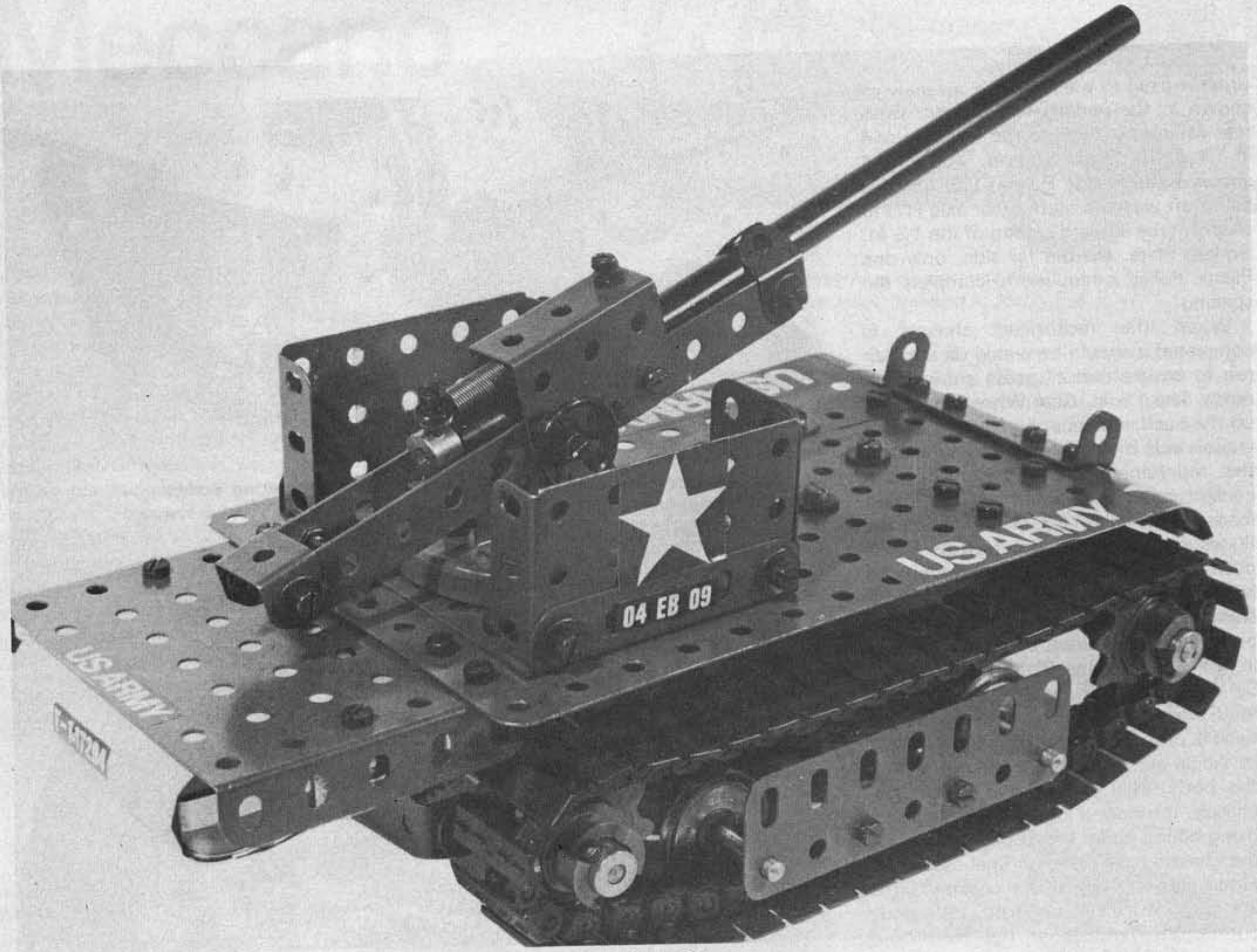


Fig. 6 *General view of self-propelled Assault Gun made from the Meccano Army Set.*

hence additional Collars are not required. Bolt one 2½ in. × ½ in. Double Angle Strip across the rear ends of the 7½ in. Strips. Do the same at the front and use a third D.A. Strip to join the "points" of the forward Flat Trunnions for the time being.

Attention should now be given to Figs. 6 and 9 to add the upper decking. Take both 5½ in. × 2½ in. Flat Plates and overlap them to form a composite plate 5½ in. × 4½ in. Now bolt these to the main Flanged Plate of the chassis, two holes left clear at the front, giving the composite deck plate a two-hole overhang over the rear end of the main Flanged Plate. Certain adjustments are required at this stage as follows; because of the overlap of the composite plate, the "high" side has one 5½ in. Strip tucked underneath as packing while the lower plate has its packing strip placed over the top and this can be clearly seen in Figs. 9 and 10. Both strips are symmetrically disposed and they keep the correct spacing to permit the gun shield and base to be mounted level with the main chassis Flanged Plate. These strips are five holes apart (one "under" and one "over") running from front to back on or under the composite plate. The same illustrations show four bolt-heads with Washers just in front of the gun mounting and this is precisely the location for the securing bolts of the motor baseplate below. One further inclusion is required before bolting the front end of the composite plate in place. Take a pair of 2½ in. × 1½ in. Flexible plates and tuck them under the front edges of the composite plate to form the forward edges of the mudguards over the tracks. Bolt on the composite plate, trapping these small flexible plates in position and reinforce them across the nose of the chassis on top with a 2½ in. Double Angle Strip as shown in Figs. 6, 9 and 10. Before securing the Powerdrive Motor, the gun, mounting and shield should be constructed. Bolt on a 3½ in. × 2½ in. Flanged Plate at the rear of the top decking in the position shown in the illustrations just mentioned. Take the Wheel Flange and mount a pair of Bent Trunnions, back-to-back, as shown in Fig. 10 using a single Bolt for each trunnion which is also used to trap a 1½ in. Strip, Flat Trunnion or similar 3-holed part to give a centralised hole in the open Wheel Flange. Tighten up these bolts to make sure that the Bent Trunnions are firmly fixed, parallel to one another, just under ½ in. apart. Take a ½ in. Bolt with Washer and pass it through the centre of the Wheel Flange, place a Collar and Washer or stacked Washers on the Boltshank and then pass it through the decking to secure it from below with one Washer and double lock-nuts. The Wheel Flange should be just free to turn against some opposition to give a few degrees of left/right traverse to the gun. Mount the Powerdrive motor in place where deft fingers and the aid of a pair of tweezers will be a great help! If serious difficulty is experienced here, the upper decking and motor may be simultaneously put together on the main Flanged Plate before the chassis extensions are carried out.

Make the gun with a cradle of two 5½ in. Strips secured at the front with a ¾ in. Bolt trapping a pair of Obtuse Angle brackets by lock-nuts to clamp the centre of the Meccano Plastic Gun Barrel. Mount a Channel Bearing (bent plate) as shown with further ¾ in. Bolts and use a ½ in. Bolt, adjusted by lock-nuts to bear down on the barrel from the front top of the Channel Bearing. Pivot the cradle on a long Bolt passed through the small Steering Wheel and the top holes of the Bent Trunnions, using lock-nuts on the far side. The firing mechanism is a 2½ in. Rod fixed in a Collar held by a Tension Spring trapped at its forward end by the ½ in. Bolt on the top of the Channel Bearing. A second Bolt is inserted below the Collar to engage (with a slight twist of the fingers) against a standard Bolt lock-nutted into the gun cradle one hole in

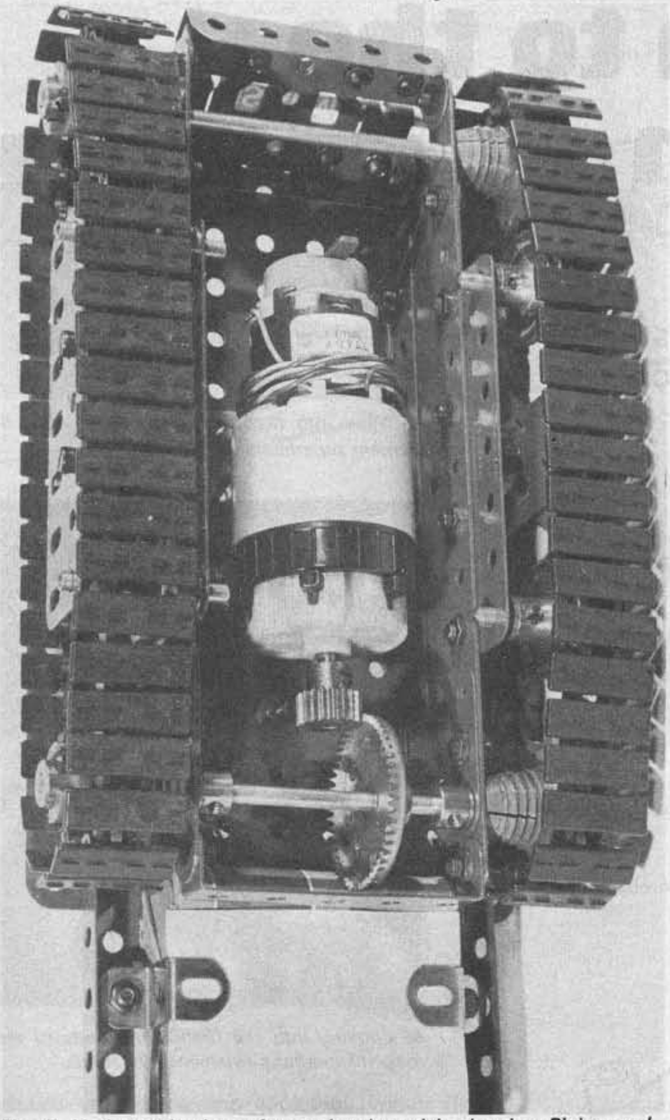


Fig. 7 *Underneath view of completed model, showing Pinion and Contrate drive.*

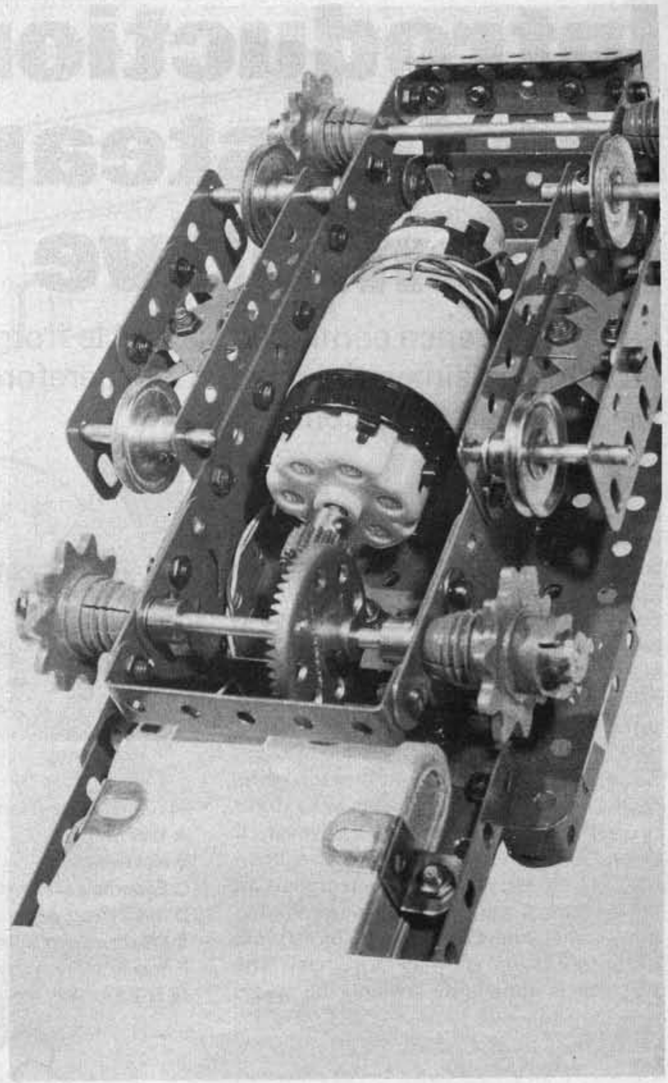


Fig. 8 *General construction of the chassis showing track running gear and sprocket drives.*

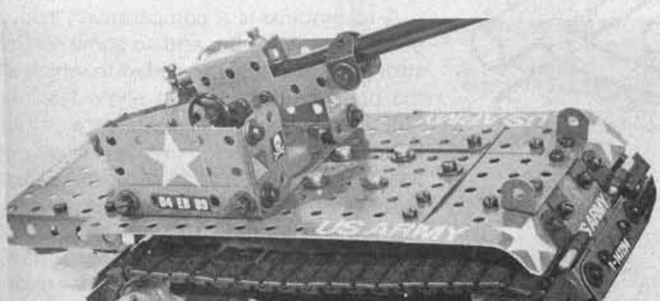


Fig. 9 *Further view of completed Assault Gun showing details of upper decking.*

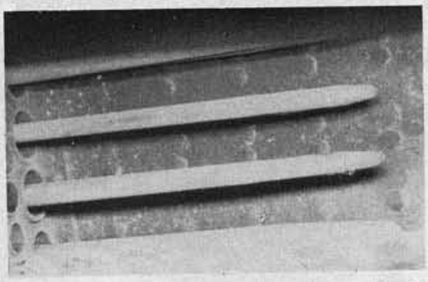
Fig. 10 *Frontal view showing gun mounting swivel and details of front plating. Note use of self-adhesive Vinyl labels to enhance the finished appearance.*

from the rear. This enables the gun to be cocked while plastic "shells" (provided in the Meccano Army Kit) are loaded through the muzzle end.

Complete the front end of the Assault Gun as shown in Fig. 10 suspending a Flat Trunnion by Obtuse Angle brackets from the 2½ in. D.A. Strip, to form the frontal plate of the vehicle. Trap the point of the Trunnion between the D.A. Strip already fitted to the lower forward end of the chassis, by using a 2½ in. Angle Girder as shown. Add the stub axles in the air of Right Angle Rod and Strip Connectors and "fill-in" any frontal holes with symbols and numbers provided with the outfit. Add the sides and fronts to the gun shield and decorate to suit. Bolt on the remaining 3½ in. × 2½ in. Flanged Plate to the rear and fix in it a 4.5 volt pocket flash lamp battery with suitable short leads to the motor. Set the gear box ratio to 60:1 before trials. Check each link of Plastic Track and assemble one by one, checking for absolute flexibility and no binding. Reject track segments which bind or ease them with the finest rat-tail needle file in the link holes. Just a smear of fine sewing machine oil will help. Performance off the dry battery is surprisingly good, but the motor can be run (up to 12 volts D.C.) from a train controller with spectacular climbing performance.

Introduction to the model steam locomotive

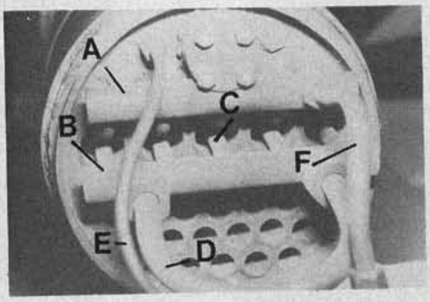
Laurie Lawrence continues his article from last month, explaining the whys and wherefores of the model steam locomotive.



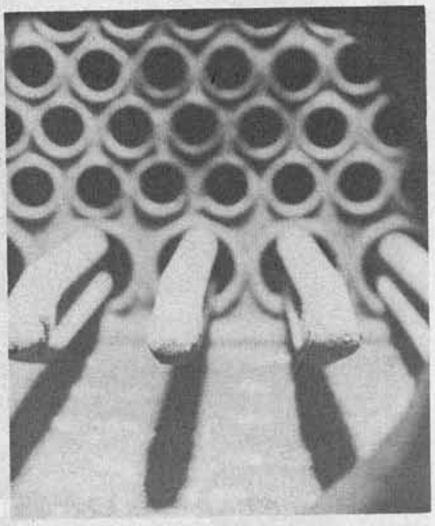
45 *View into firebox showing part of a 5-element superheater.*

Superheaters

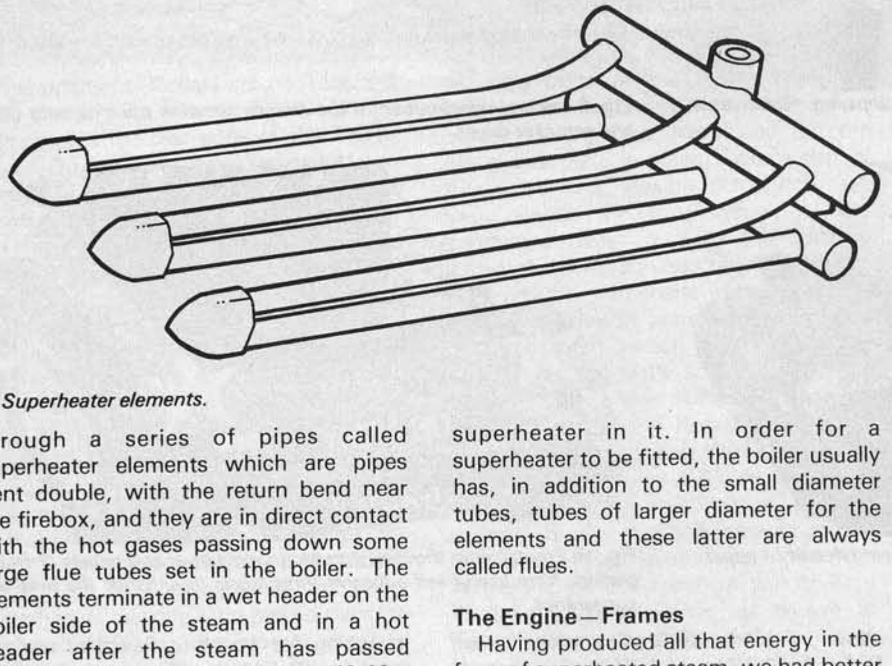
Before we leave the subject of steam and the boiler, there is one other item which should be mentioned and this is the Superheater. Steam which is inside the boiler is called wet, because it is in contact with the water in the boiler and contains lots of water droplets and in that state, it is rather treacly stuff, only relatively so, of course. Locomotives using wet steam only in full size are a good deal less efficient than those using Superheated steam. There are still some model locomotive enthusiasts who don't or won't use superheaters. However, if steam is taken off the boiler and then heated significantly to a temperature above that of the boiler which generated it, then that steam is able to do more work because it is dry and has more heat. The way this is done is by sending the steam



44 *Superheater steam connections.*
A *Wet header.*
B *Hot header.*
C *Superheater elements through flues.*
D *Main steam pipe.*
E *Steam pipe to blower.*
F *Pipe to snifting valve.*
*(**E & F** See later text.)*



46 *Looking into the firebox the ends of the radiant superheater elements are visible.*



43 *Superheater elements.*

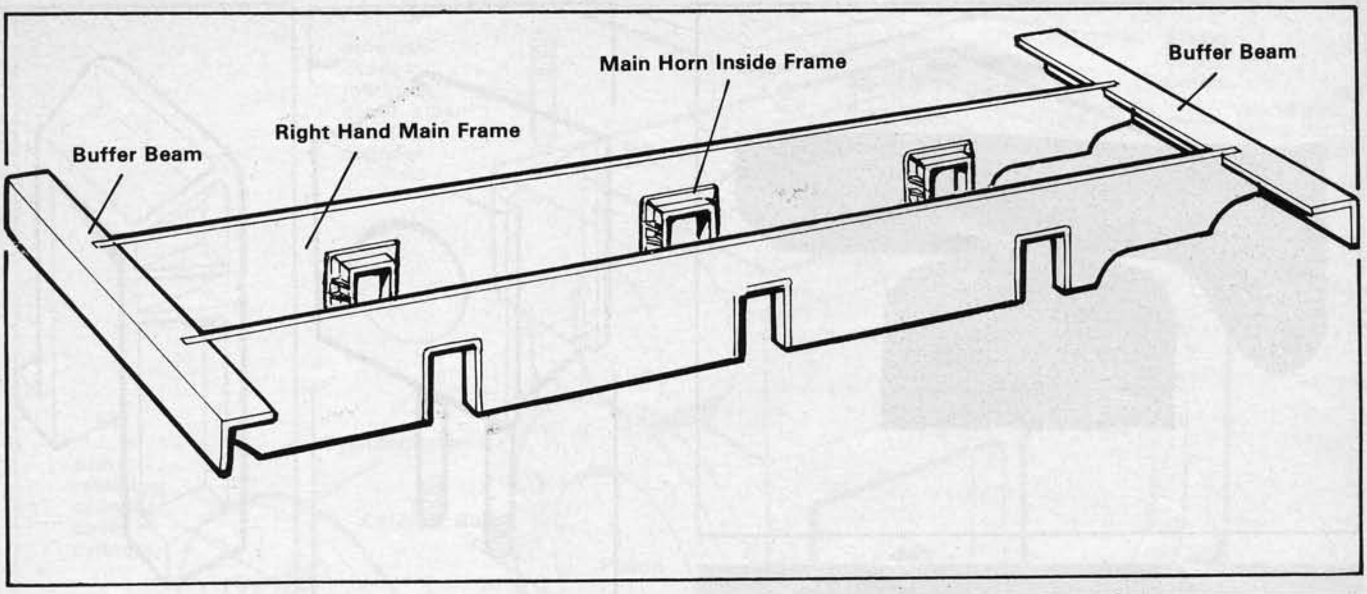
through a series of pipes called superheater elements which are pipes bent double, with the return bend near the firebox, and they are in direct contact with the hot gases passing down some large flue tubes set in the boiler. The elements terminate in a wet header on the boiler side of the steam and in a hot header after the steam has passed through the superheater elements, **43,44**.

Quite a common arrangement nowadays is for these superheater elements to be made of stainless steel tubing and to be extended right through the boiler flues and above the fire, where they get radiant heat from the fire, **45,46**. Such superheaters are called radiant superheaters and they do really hot up the steam. My photo shows the inside of a firebox with the return ends of a 5 element superheater in it. In order for a superheater to be fitted, the boiler usually has, in addition to the small diameter tubes, tubes of larger diameter for the elements and these latter are always called flues.

The Engine—Frames

Having produced all that energy in the form of superheated steam, we had better get on with the bit that converts it into useful work and that is the **Engine.** To the unpractised eye, the engine looks a complicated box of tricks, but in fact, it is a number of related parts all assembled in a straightforward way into a unit which, by long tradition, has been found to be eminently practicable. There have been some weird and wonderful departures from tradition, but generally, however, many variations one sees, they usually conform to the basic Stephenson locomotive concept.

A locomotive is a comparatively heavy thing, it needs to be, and so some sort of strong framework is provided to which all the parts are attached in some fashion. This framework has as its basis a pair of Frames, **47,48**, and these are usually a pair of plates formed to the right shape and they have considerable strong bracing across, holding them at the right distance apart, at various important points, **49**. At each end is a Buffer beam and, in between, are other types of bracing known as stretchers, brackets or plates according to the additional purpose required of them. The Buffer beam needs a little explanation; firmly attached to the beam is a pair of Buffers, **50**, which are sort of spring-loaded shock absorbers provided to withstand buffing shocks on impact when shunting carriages, wagons or on coupling to a train. This type of buffing gear is usually found on British locomotives; there are other types of buffing gear which combine a device for coupling to the train. Stretchers are in the form of rods or bars and their purpose is only to stiffen and distance the frames; brackets and plates will be dealt with when I come to these particular functional items.



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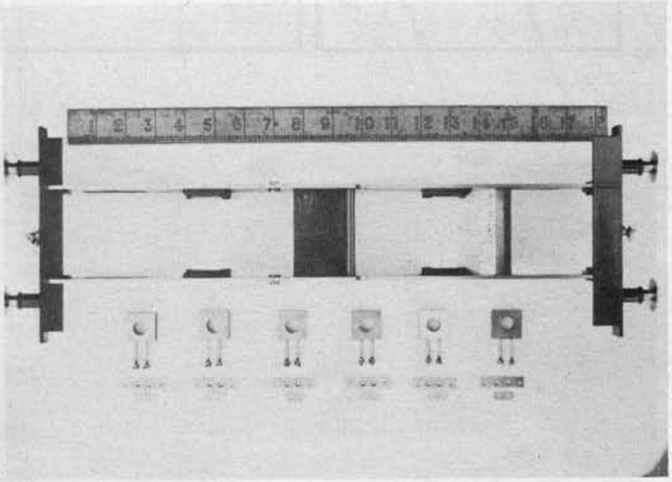

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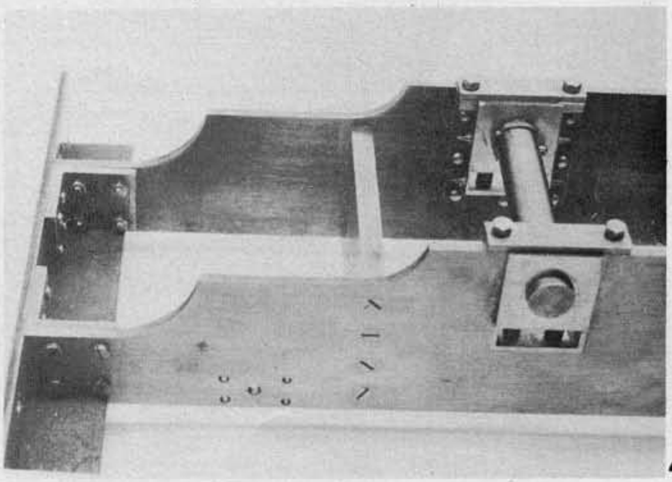

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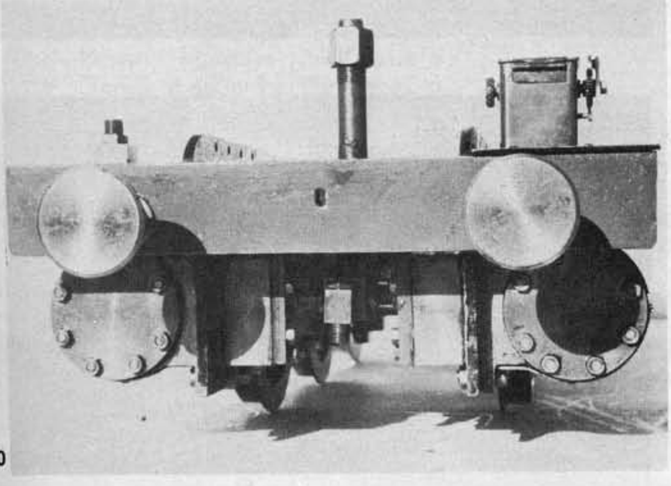

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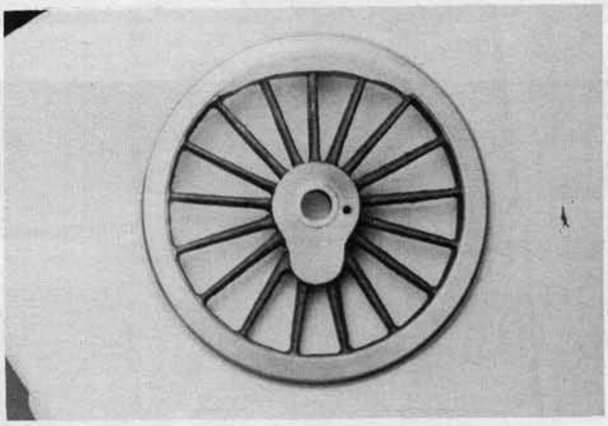

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47 Frames and buffer beams plus main horns erected. (Tank locomotive).

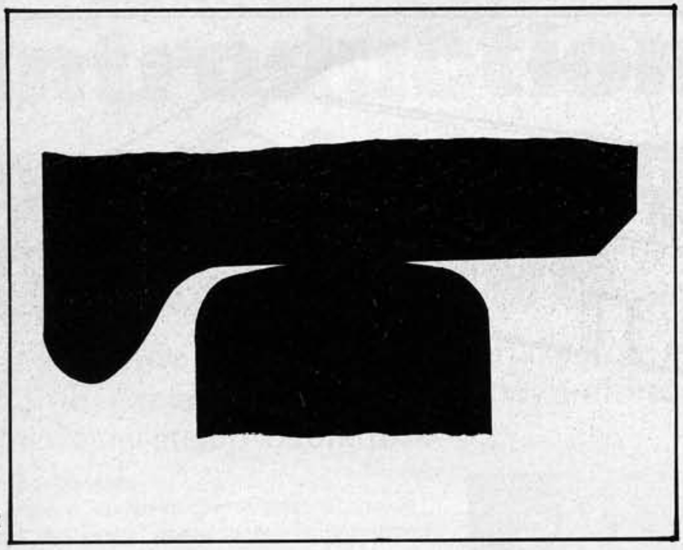
48 Engine frames assembly for a "Rob Roy" (depicted in Fig 2.)

49 Stretcher between the frames and buffer beam at the ends.
50 Buffers on the buffer beam (see also Fig 48).
51 Driving wheel, machined, bored for axle ready for boring for crank pin.

The Engine—Wheels and Axles

The locomotive, of course, has wheels to run on and these are turned (i.e. machined) to a particular profile. A full-size wheel is usually made of 3 separate parts—wheel centre, tyre, and tyre fastening, but in a model they are mostly turned from a one-piece casting, **51**. The profile is important and **52** shows that it has a tread which sits on the rail and a flange which comes below the rail on its inner side and it will be seen there is a radius between tread and flange. This radius is important because the wheel is guided by the radius and not the flange. If there was a corner between tread and flange, the flange would wear rapidly because of great resistance (it would rub) between rail and flange and the locomotive would not run freely especially on curves.

The wheels are carried at the correct distance apart on Axles to suit the gauge (distance apart) of the rails they run on. Axles run in Axle boxes, **53,54,** which slide up and down in horns or Hornblocks, **55,56,** fitted to slots in the frames. Horns are good wearing metal



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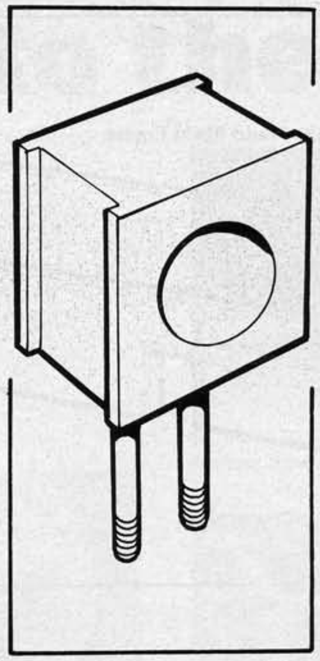

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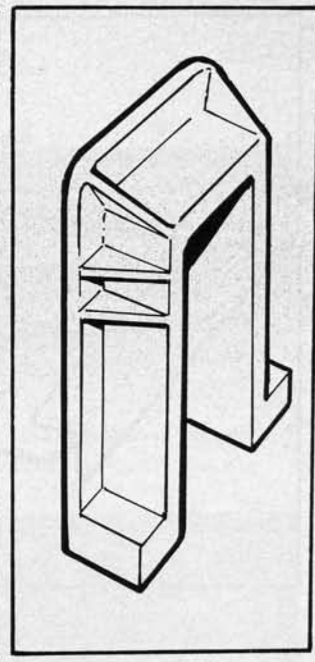

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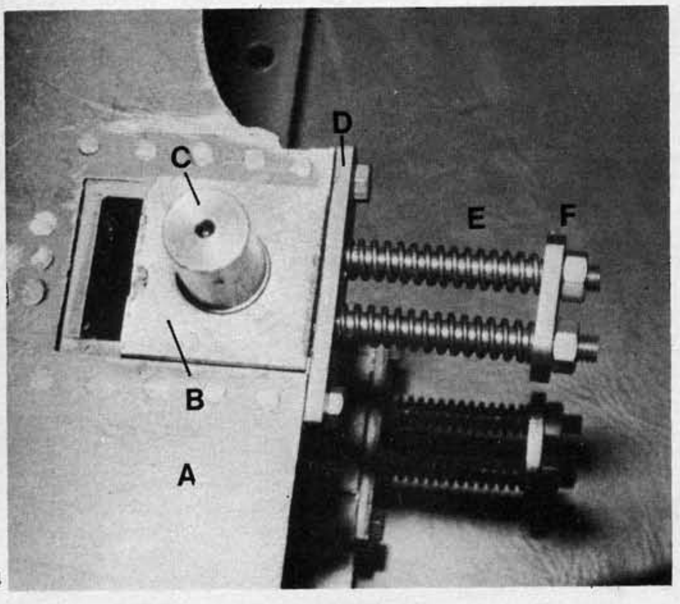

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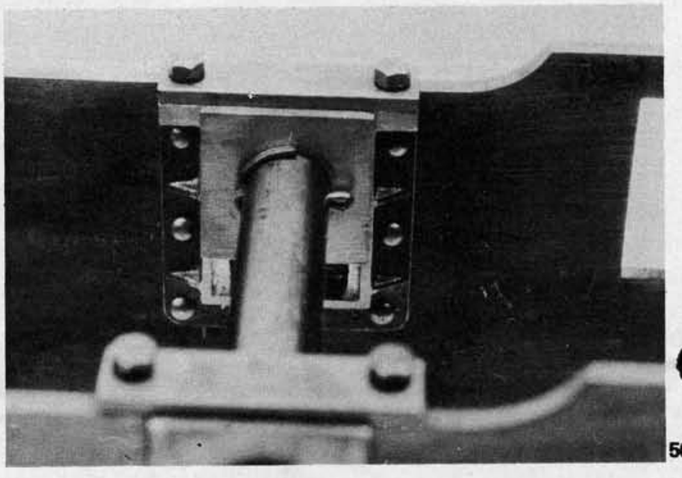

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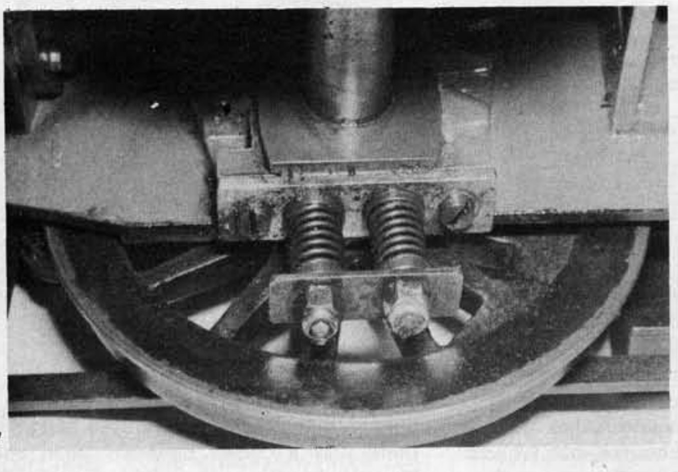

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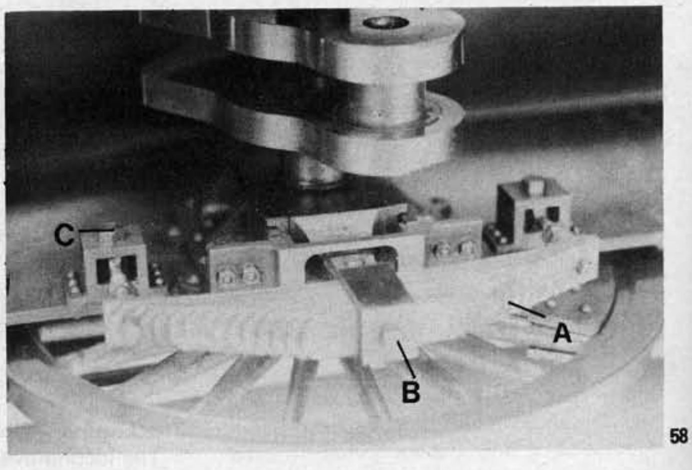

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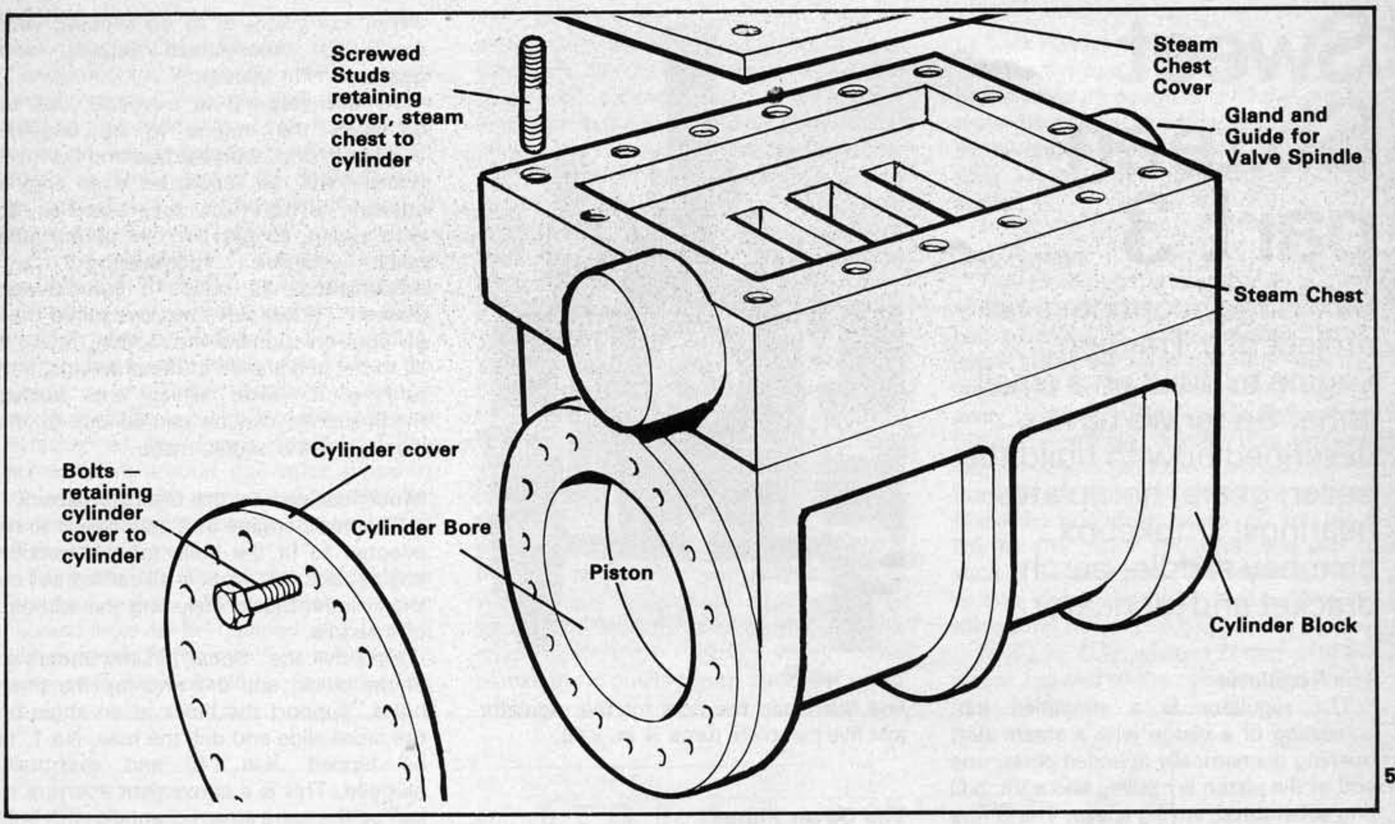
52 *Wheel and rail profile.*
53 *Main axle box with spring pins fitted.*
54 *Axle box assembly.*
A *Engine frames.*
B *Axle box.*
C *Axle.*
D *Horn stay or keep.*
E *Spring and spring pin.*
F *Spring keep.*

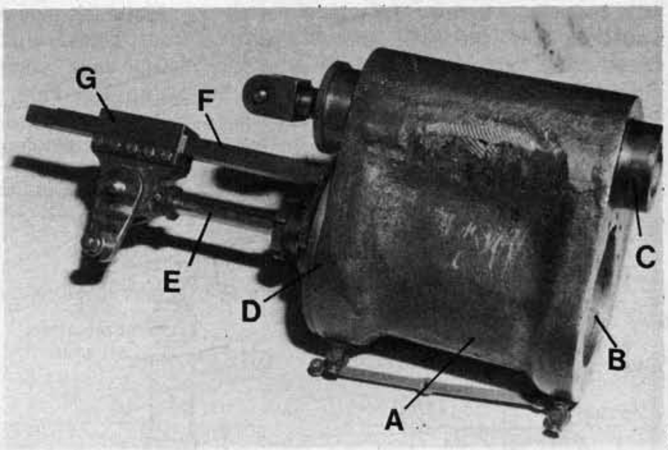
55 *Cast horn blocks.*
56 *The horn block is securely rivetted to the engine frames.*
57 *Axle box and spring assembly for heavy locomotive.*
58 *Fine detail assembly of springing for main axle.*
A *Nest of leaf springs.*
B *Spring buckle.*
C *Spring hanger and bracket.*

60 *Piston valve cylinder with integral piston valve steam chest.*
A *Cylinder block.*
B *Cylinder bore.*
C *Steam chest.*
D *Rear cylinder cover with gland.*
G *Piston Rod.*
F *Crosshead guide bar.*
G *Crosshead.*
H *Piston valve spindle buckle (or clevis).*
*(***G-H** *see later text.)*



parts and their function is to resist the driving force transmitted to them from the engine which is why they are much wider than the frames. If this was a "solid" assembly it would ride on the rails very roughly indeed, so the axle boxes are all sprung, **57,58,** and the springing helps to keep the wheels in contact with the rail and also absorbs shocks from the locomotive's passage along the rails. The axle boxes are prevented from dropping out of the horns by Keeps or, as they are often known, Hornstays which serve a dual purpose of stiffening the frames in the region of the slots for the axle boxes and as pads upon which the springs bear. In our small locomotives, the springing gear is usually a fairly simple arrangement of a couple of spring pins screwed into the underside of each axle box. The pins pass through holes in the hornstays, then coil springs are put on them and finally spring plates are nutted on for the springs to bear at their lower ends. We thus have a nice flexible arrangement which helps to keep a locomotive on the track and ensures all wheels take their proper share of the weight.

59 *Outside cylinder (slide valve omitted).*



The Engine—Cylinders

The driving wheels don't turn round on their own, of course and they have motion work connected to them, but before I talk about that, I'll have to go back to our old friend Steam. When steam leaves the boiler, it is led via the superheater, down through a pipe or pipes to the cylinders, **59, 60.** Cylinders can be mounted outside the frames, in which case it is called outside cylindered, or in between the frames and this is known as inside cylindered. Some locomotives have both inside and outside cylinders and these are known by the number of cylinders they have fitted.

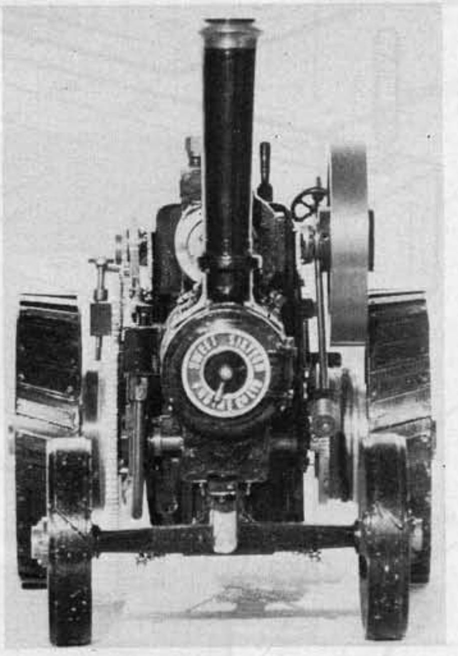
Now to one of the dodgy bits; all conventional steam locomotives have two or more cylinders and they are arranged to operate in a particular way. Firstly, they are what is known as double-acting, that is, every stroke of the piston in the cylinder is a power stroke, which means that the piston is pushed along the cylinder one way and then pushed back again by the steam. Pistons we'll come to in a minute. Secondly, one side of the engine is designed and erected to act at a different time, but in phase, with the other; in a two-cylinder engine, this is simply described as one side of the engine being set at 90° arrangements for three-cylinder engines and also four-cylinder engines can be set differently. I will explain how this 90° arrangement works in due course, but for the moment let us concentrate on one side of the engine only.

The cylinder has in it a piston which is a sort of thick disc of metal machined to a close sliding fit in the bore of the cylinder. When steam is admitted to one end of the cylinder, it cannot escape to atmosphere because the end of the cylinder is closed by a strong cover, it cannot go back because of the pressure of steam behind it, so it pushes the piston and moves it along the cylinder bore. Centrally fixed to the piston is the piston rod, generally extending to the rear only, which passes through a specially designed hole —a gland—in the rear cylinder cover. A gland is a fitting which allows a rod to slide back and forth without leaking steam or water past the rod. The end of the piston rod is connected to the motion work—you'll remember that I mentioned this earlier—which is made up of several bits and pieces; the object here is to convert reciprocating motion, i.e. back and forth movement of the piston, into rotary motion of the wheels.

TO BE CONTINUED

Sweet Sixteen part 3

Rex Tingey continues his project of a Traction Engine to build on a small lathe. So far we have described how to build the boiler, gears, hornplates, bearings, smokebox, chimney saddle, perch bracket and lubricator.

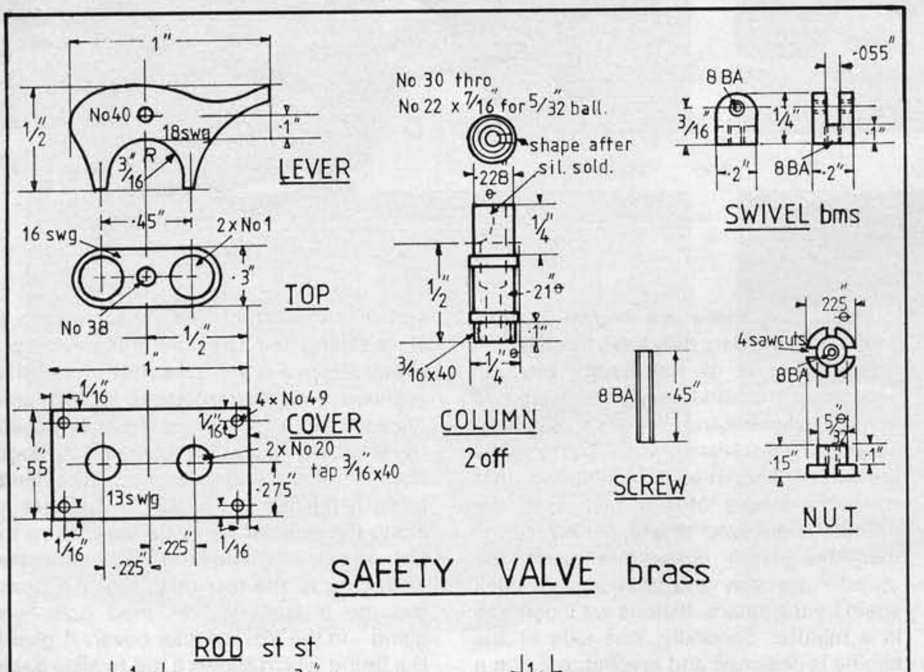


The Regulator

The regulator is a simplified job, consisting of a piston with a steam slot, opening diametrically opposed ports, one end of the piston is missing and a Viton O ring substituted, saving space. The O ring acts as a steam seal for the regulator rod and bore only, the alloy piston in the brass being sufficient to cut off steam. Steam pressure keeps the O ring away from the steam ports when the piston is pushed in. After making the piston, rod and bush, tap the hole for the regulator just five complete turns ¼ in. × 40.

The Cover Plates

Make the side and safety valve covers from brass, and a Ramsbottom type safety valve silver soldered to its cover plate. The side cover is to be silver soldered in place when the saddle and dome are completed, and the safety valve cover, complete, is to be secured with 4 × 10 BA cheesehead screws, and gasketed with Loctite.



At this stage it is a sound idea to complete the engine in its original, complete form, with the bed and flywheel (which will be used on the engine anyway) to run it on compressed air, or with steam, to get the feel of the little beast before completing any modifications to adapt it for "Sweet Sixteen". If this side-step is required then go right on to make the motion, fitting it all to the bed shown in the drawings, and running it, after which the further modifications can be carried out to the block, and the saddle made.

Modifications to the Cylinder Block

The basic engine unit now needs to be adapted to fit the boiler of the traction engine, and this work is all carried out on the cylinder block, including the addition of a saddle.

First mill the "dome" in the underside of the block, and drill and tap the three holes. Support the block at an angle on the cross-slide and drill the hole, No 1, to be tapped ¼ in. × 40 and eventually plugged. This is a convenient aperture to join up the extra steam channels with little risk of cutting into other passages. Drill the short hole from the milled dome into the No 1 hole, which is straight-forward, but take great care when drilling the next hole.

The best way to tackle the main cross hole, which is required to miss both the steam inlet bores and the steam slots, is to clamp the block, underside up on the cross-slide, precisely along the line of the bed, fore and aft. With the vertical head tilted so that the drill will emerge in the inlet bore already made, set the drill as far back in the hole as possible. Before drilling sight the position of the hole to be drilled, from all angles, using the ends of a drill pushed into the various bores to make sure of missing all but the correct hole.

If a mistake is made and the drill appears in the milled steam slot the unwanted hole can be covered with a slip of thin brass, silver soldered in place, and the slot then milled a little wider and less deep. Mill the front of the block for the exhaust pipe.

The Engine Saddle

The engine saddle is made from ⅛ in.brass sheet, starting off with a piece about 1½ in. wide and at least 3 in. long. Anneal the piece and clamp one end in the vice with a suitable diameter to bend around. Relax and check the curve which will certainly be oversize, re-anneal and try again (you will be left with a straight free end) when it should go to diameter. If not, use a 1½ in. diameter former.

Mark out the best part of the curved brass, and cut away and file off the surplus. Hold in the machine vice and mill the flat for the engine base. Mill away the dome part of the saddle and drill the securing holes, turn the work upside down and countersink the three holes. Centre-pop for the saddle securing holes and the water filling hole. Drill these holes angling the saddle for each row, in the machine vice, so that the holes are at right angles to the tangent of the curve. Do not tap the filler hole until the engine unit is finally secured with screws.

Screw the saddle to the engine block and place on the boiler, getting the engine vertically in line with the hornplates. Mark through with the scriber for all the holes, remove the engine block, and replace the saddle on the boiler, positioning on the marks to scribe in the part of the pad to be cutaway as the lower portion of the dome. Mark around the outer shape of the saddle on the pad so that the pad can be filed away a little and make a neater job of the cladding.

Paint the top flat of the saddle with Easyflow paint. Make a plug for the exhaust hole to be covered and for the convenient hole (tapped ¼ in. × 40) and fit these with Easyflow paint. Paint the side panel with the silver solder paint and clamp on. Secure the saddle in place with three brass screws painted with Easyflow and heat up the block adding a little fluxed stick, when the paint runs, to the dome joints and externally on the saddle joint to ensure a surrounding fillet. Pickle, wash and examine, cleaning up where required. Rub the saddle down on a suitable diameter covered with emery cloth.

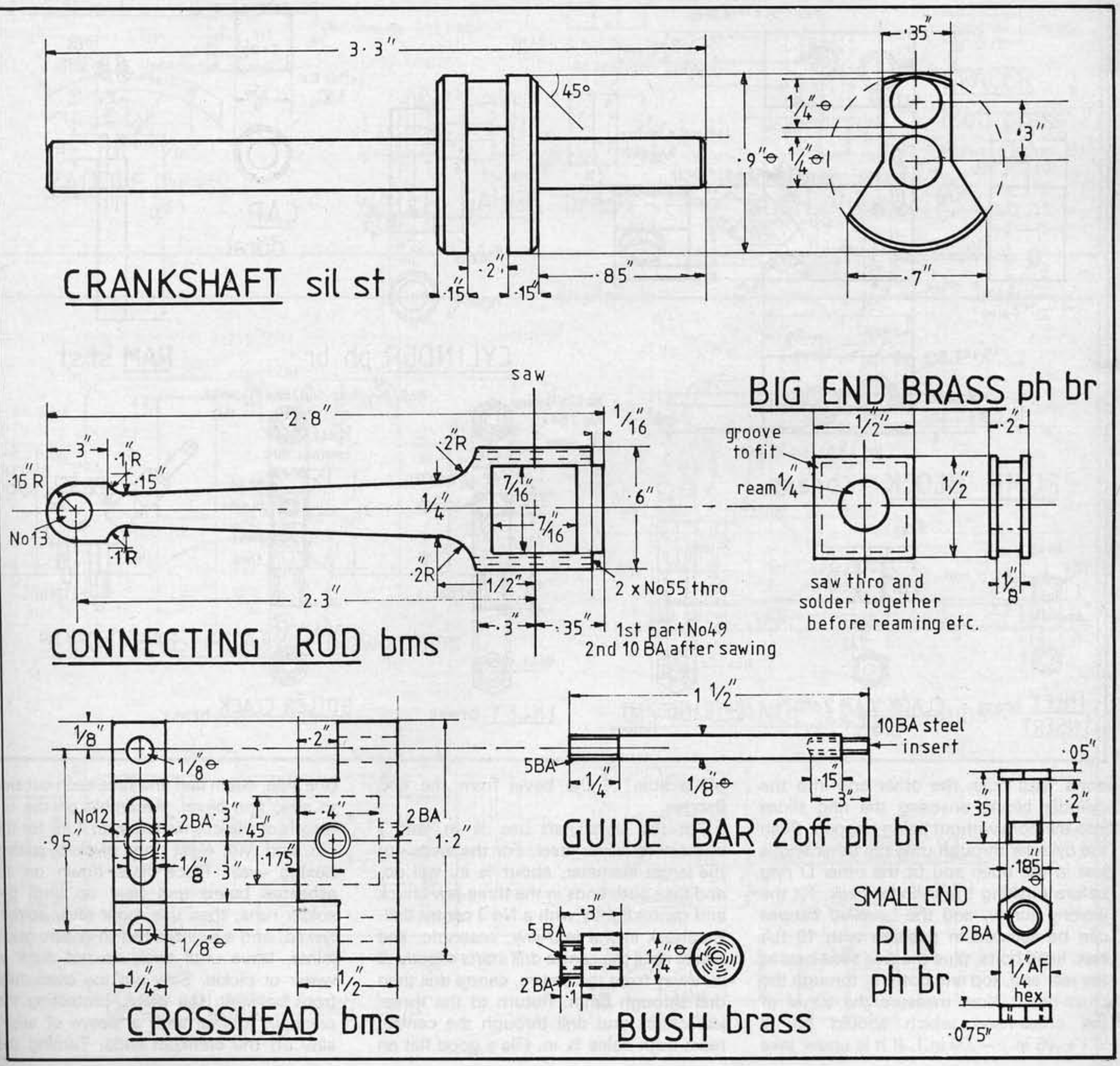
Drill and mill the boiler top, washing out the bits of copper after tapping all the small holes. Mark the front of the boiler with a top centre line for the smokebox, as a guide, and try it in place, complete with chimney, to ensure it will be upright. The motion plate saddle is secured in place with a single screw, and it and the smokebox are soldered with Comsol paint, a high temperature solder, using the appropriate flux and avoiding runs. Alternatively it is quite satisfactory to secure the motion plate saddle and the smokebox with epoxy resin. The smokebox is pushed onto the boiler up to its back row of rivets.

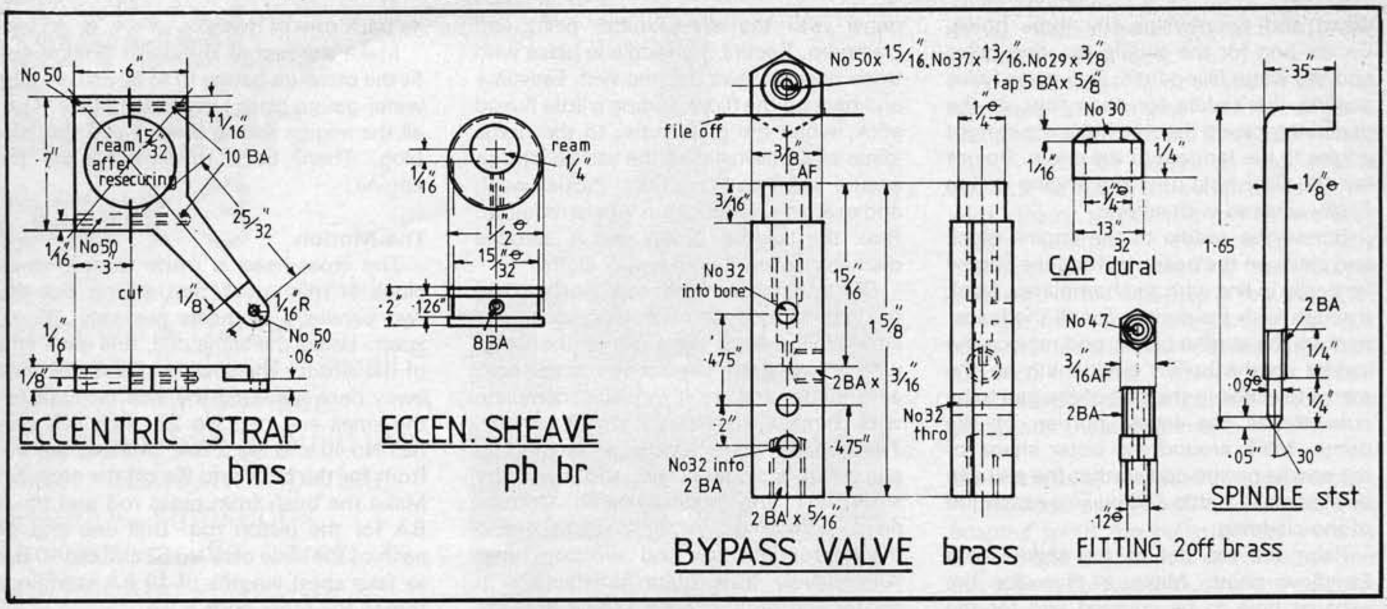
Make the rest of the boiler fittings and fit the pressure gauge (0 to 80 psi) and the water gauge glass Loctited in place. Turn all the engine saddle screws and the filler plug. Then, back to finishing off the engine.

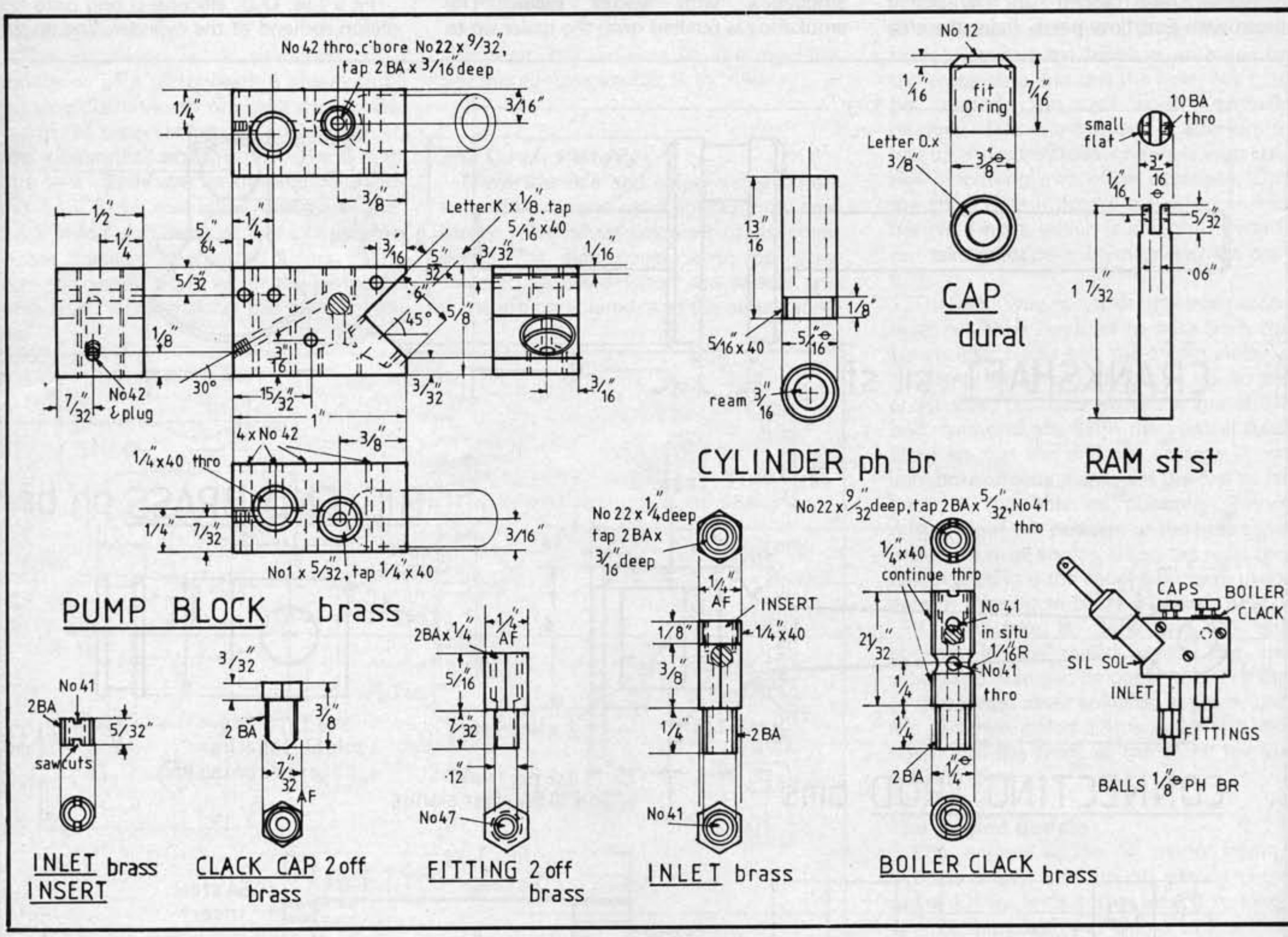
The Motion

The cross-head is made from a small block of mild steel, first drilling out the two parallel $\frac{1}{8}$ in. holes precisely .95 in. apart. Using the same drill, drill each end of the slot for the small end and then mill away between. Drill the side through for the small end pin, No 22, then drill one half No 10 and tap 2 BA. Drill and tap the front for the bush and file off the corners. Make the bush from brass rod and tap 5 BA for the piston rod. Drill one end of each of the slide bars No 53 and tap 10 BA to take short lengths of 10 BA studding; thread the other ends 5 BA.

Fit a $\frac{7}{8}$ in. O.D. silicone O ring onto the piston rod end of the cylinder, line up the

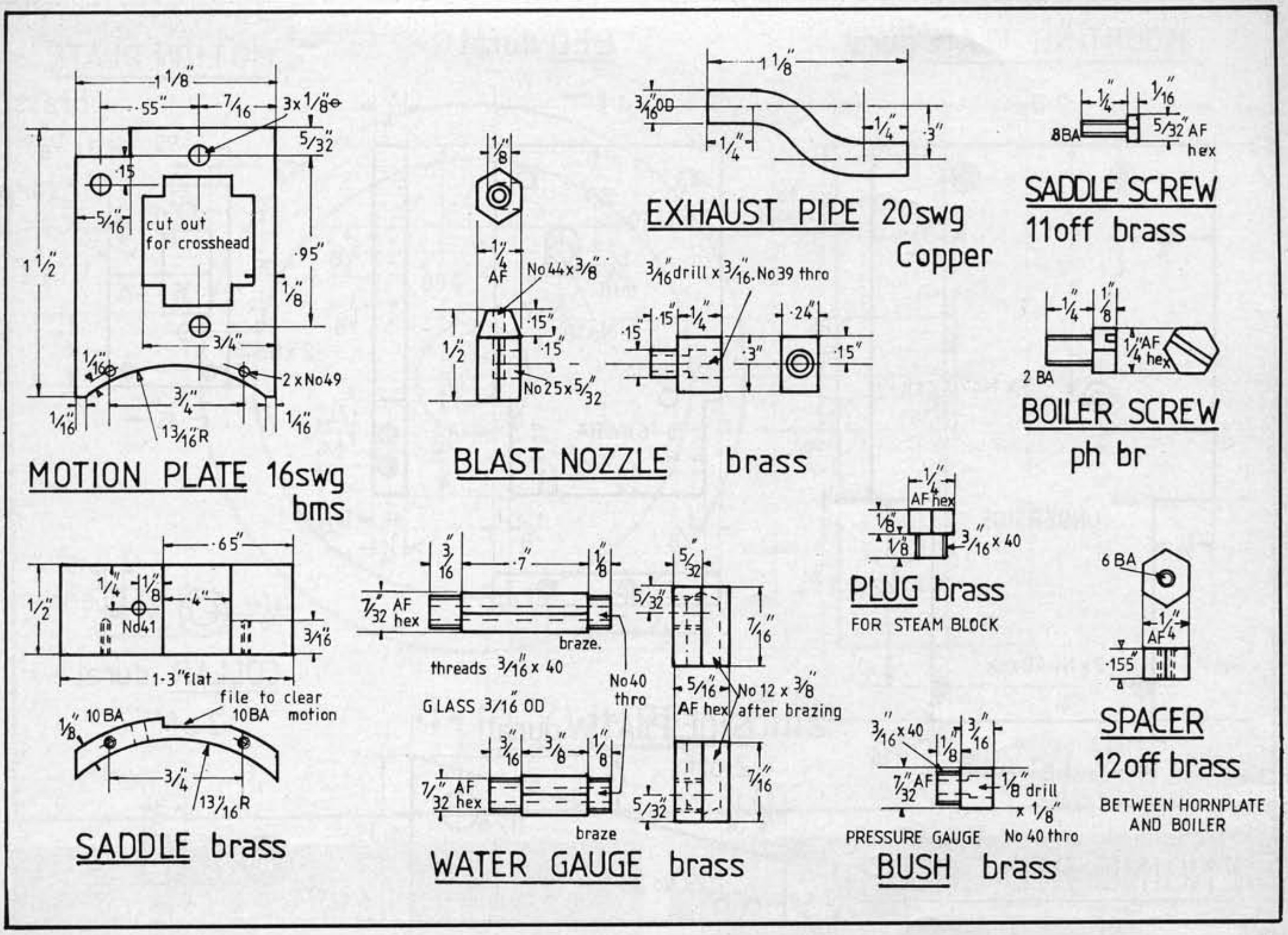


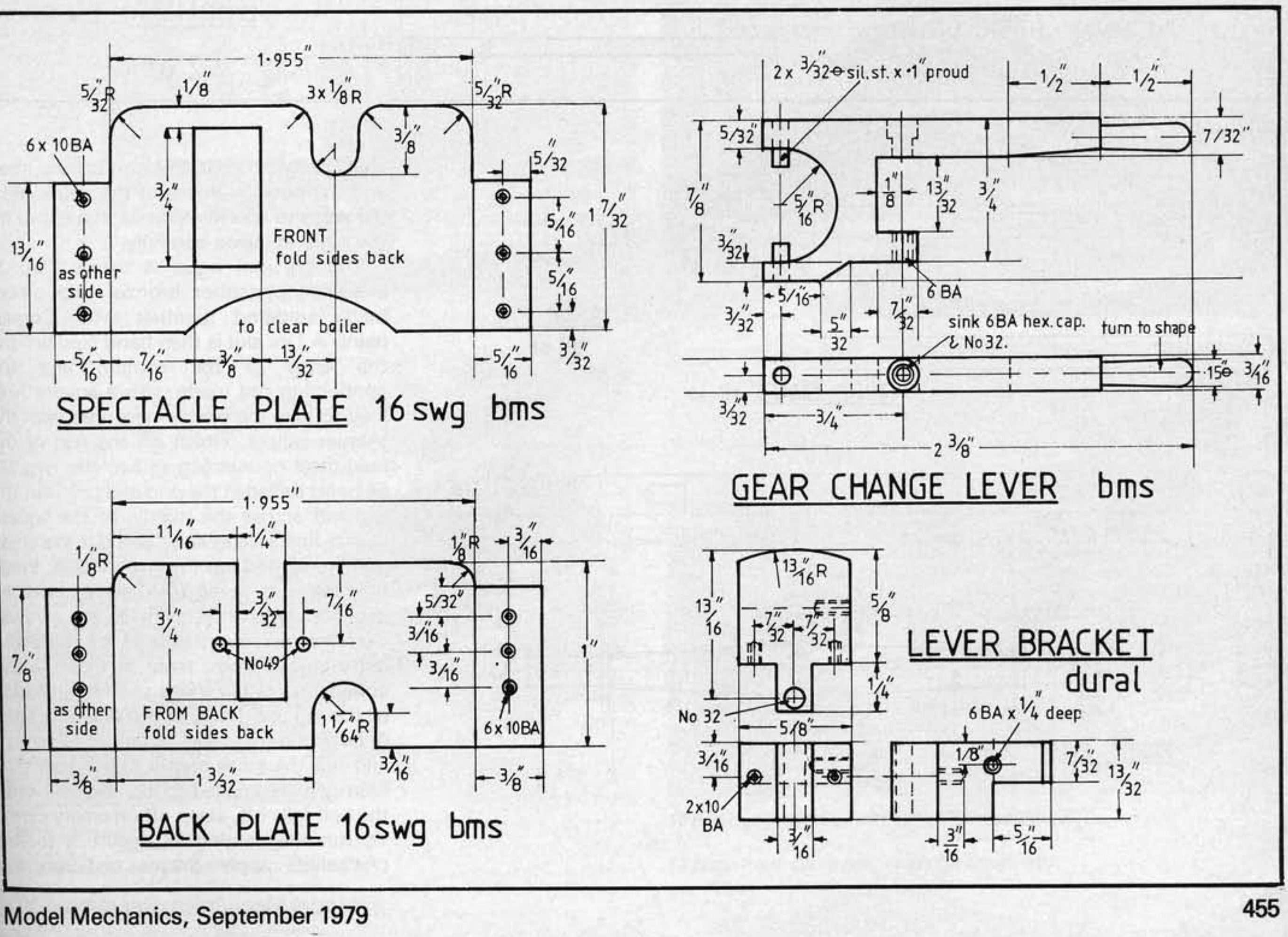


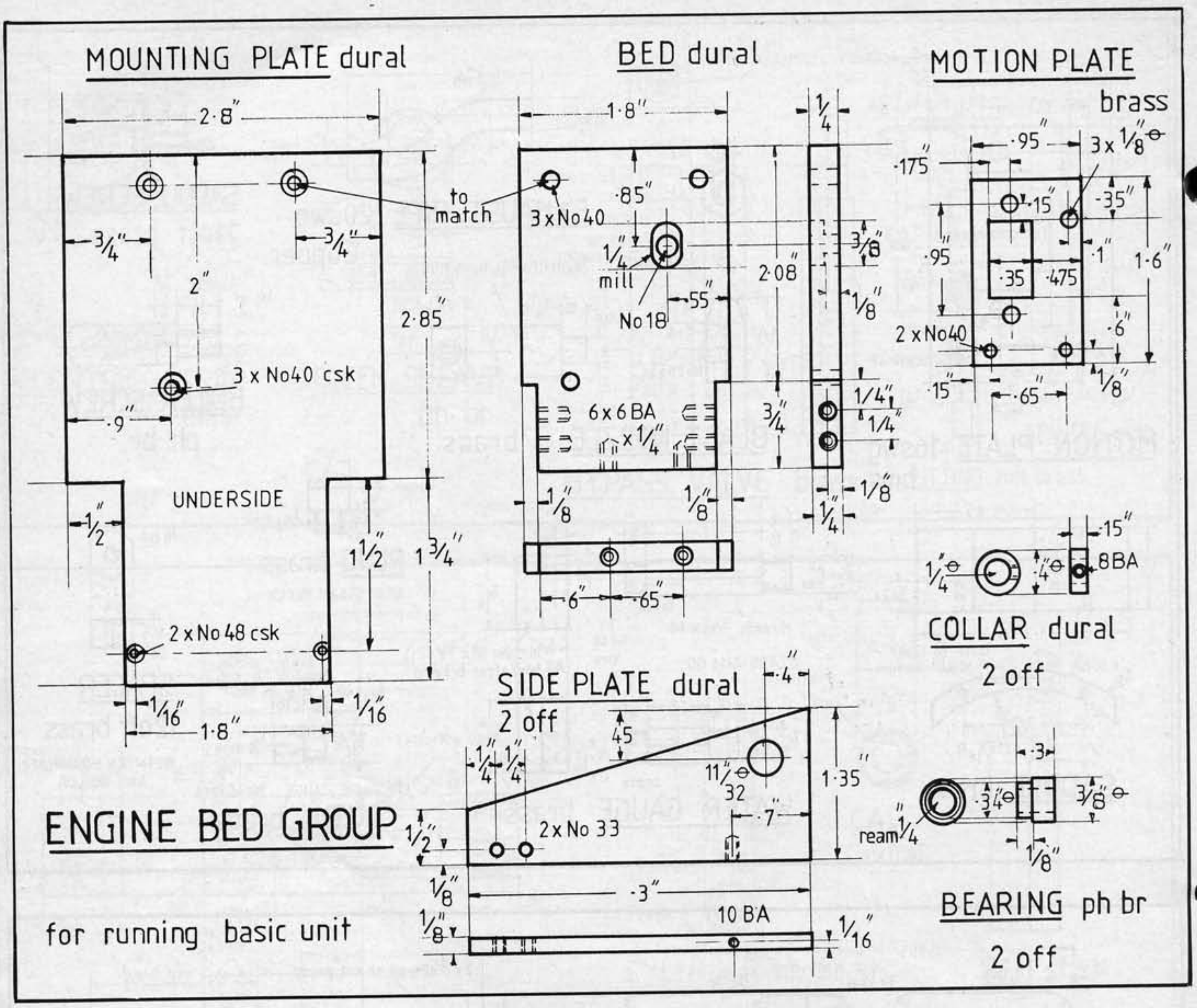


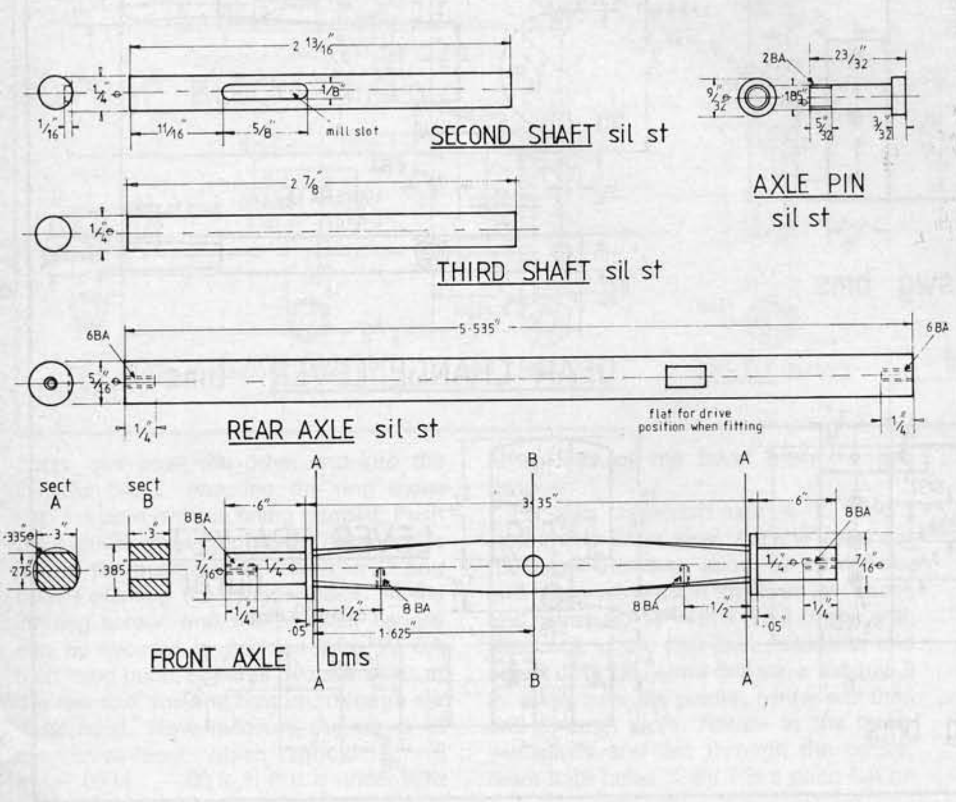
ports, and push the other end into the cylinder block, ensuring the ring slides into the bore without being trapped. Push the cylinder through until the other end is just in the open and fit the other O ring before pushing the cylinder back. Fit the limiting screw, and the bevelled flanges can be secured in position with 10 BA hex. head bolts, plus the two slide bars at the rear end, top and bottom, through the cross-head. Now measure the travel of the cross-head which should be .6 in.(+ .05 in., — .00 in.). If it is under take off a little of the bevel from the end flanges.

For the crankshaft use ¼ in. and ⅞ in.diameter silver steel. For the webs cut the larger diameter, about ½ in. will do, and face both ends in the three-jaw chuck and centre lightly with a No 3 centre drill. Re-chuck in the four-jaw, eccentric, and adjust until the centre drill starts exactly .3 in. away from the centre, centre drill then drill through 6mm. Return to the three-jaw chuck and drill through the centre, ream both holes ¼ in. File a good flat on one side, cut in half and face each cut side to size, and bevel. Assemble on the full length of the crankshaft with 1 in. for the pin, and with eight rings of silver solder, fluxing well. Place flats down on an asbestos board and heat up until the solder runs, then use more silver solder, fluxed, and a pointed rod to ensure good joints, leave until cool, do not dunk in water or pickle. Saw out the crankshaft from between the webs, protecting the crankpin journal with a sleeve of alloy, saw off the crankpin ends. Turning the


MOTION PLATE 16swg bms
cut out for crosshead
2 x No49
BLAST NOZZLE brass
No44 x 3/8
No25 x 5/32
EXHAUST PIPE 20swg Copper
3/16 drill x 3/16. No39 thro
SADDLE SCREW 11off brass
BOILER SCREW ph br
SADDLE brass
1·3" flat
file to clear motion
No41
WATER GAUGE brass
threads 3/16 x 40
braze.
GLASS 3/16 OD
No40 thro
AF hex
No 12 x 3/8 after brazing
braze
PLUG brass
FOR STEAM BLOCK
PRESSURE GAUGE
BUSH brass
1/8 drill x 1/8
No 40 thro
SPACER
12off brass
BETWEEN HORNPLATE AND BOILER

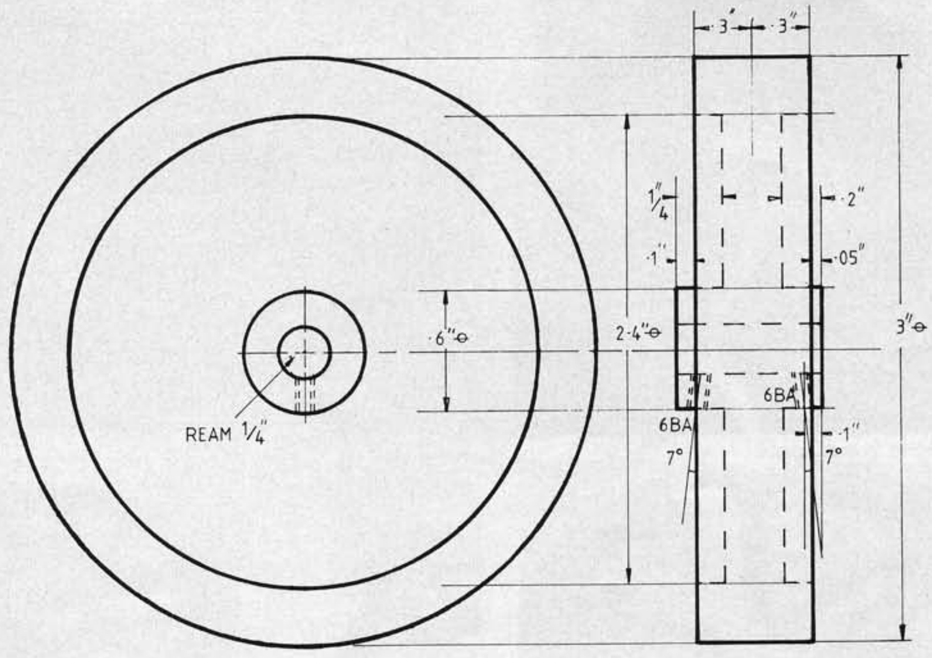

SPECTACLE PLATE 16swg bms
6 x 10BA
as other side
FRONT
fold sides back
to clear boiler
BACK PLATE 16swg bms
FROM BACK
fold sides back
No49
6 x 10BA
GEAR CHANGE LEVER bms
2 x 3/32 sil. st. x ·1" proud
6BA
sink 6BA hex. cap. & No32.
turn to shape
LEVER BRACKET dural
No 32
6BA x 1/4 deep
2x10 BA



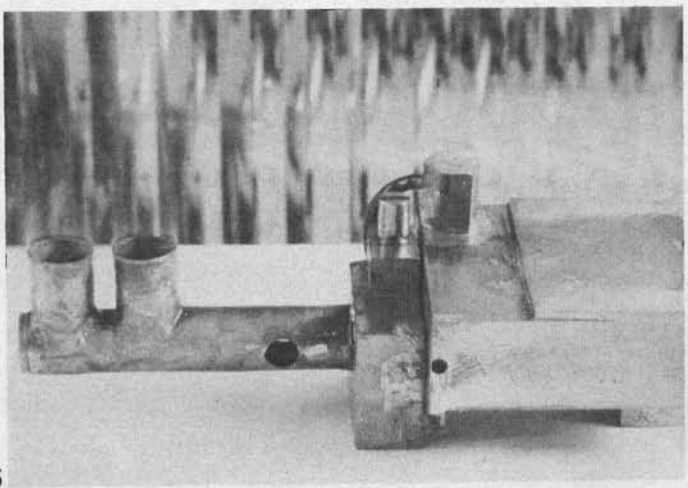


shaft between centres clean up the shaft and the outer surfaces of the webs. Saw the webs to counterbalance shape and file the pin and inside carefully.

The big end brass is made from ¼ in. square phosphor bronze, two pieces being soldered together with Comsol paint. A ⅛ in. slot is then hand filed around the edge of the square, and the connecting rod made with a square hole filed to take the brass, measured with the Vernier caliper. Finish off the rest of the mild steel connecting rod to the two No 64 holes drilled in the end and then cut the big end across the middle of the square with a fine slitting saw; drill out the small part No 49 and tap the large 10 BA. Press the big end brass into place, cuts all aligned, and secure with 10 BA screws. Centre punch the middle of the brass and drill through 6mm, ream ¼ in. Hold the connecting rod in a vice and file each side of the big end brass until it will be a tight fit between the webs. Remove the screws and put the small end in the vice so that heat can be applied to the big end until the half falls off, clean off on emery cloth. To run the bearing in, secure it to the crankshaft apply Brasso and run the



FLYWHEEL bms



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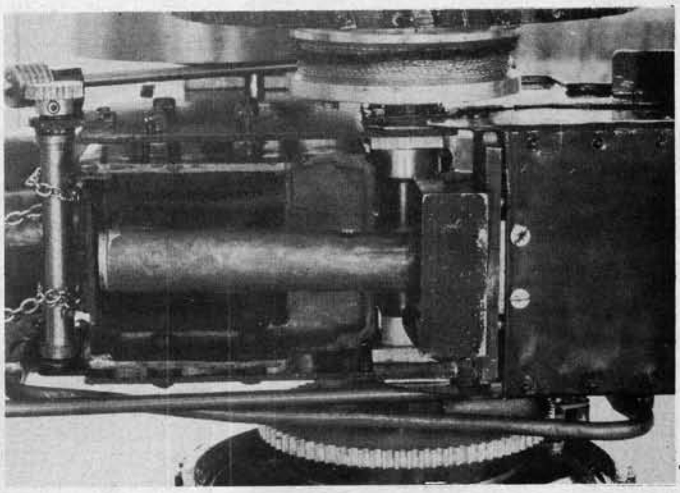

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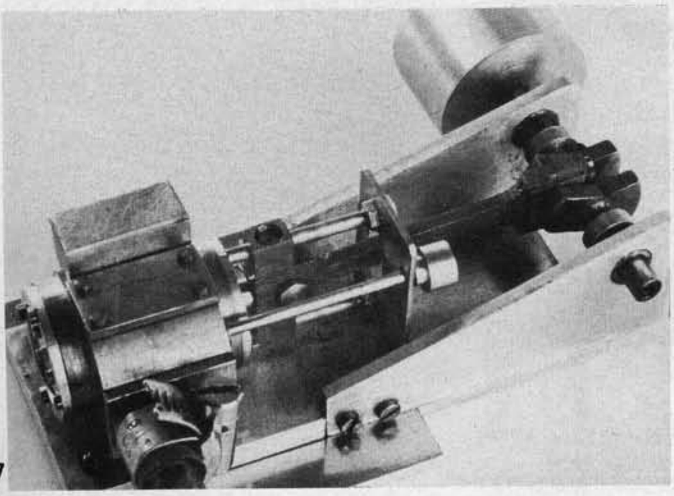

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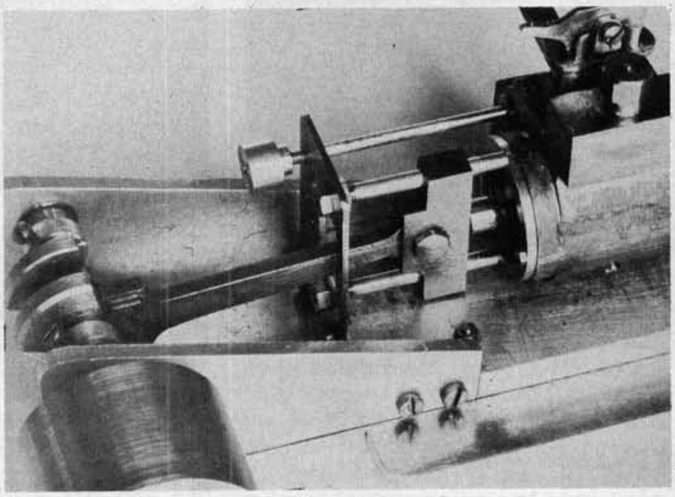

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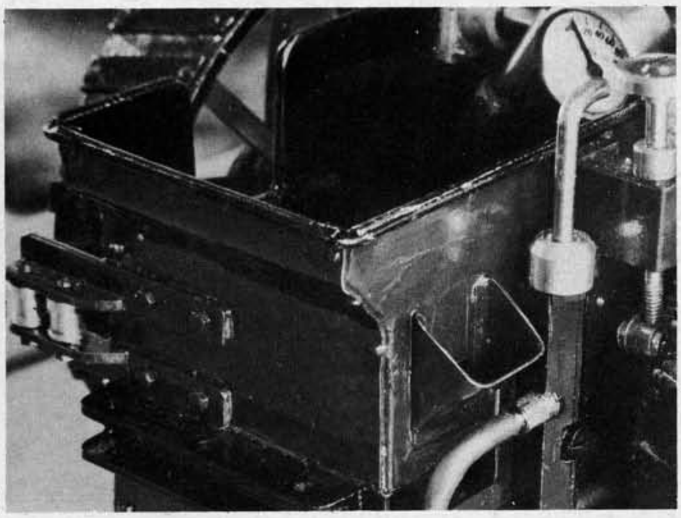
15 *Burner assembly.*

16 *The tender and burner from underneath.*

17 *Basic engine on air test (small flywheel fitted).*

18 *Engine unit on its bed, ready for steam test.*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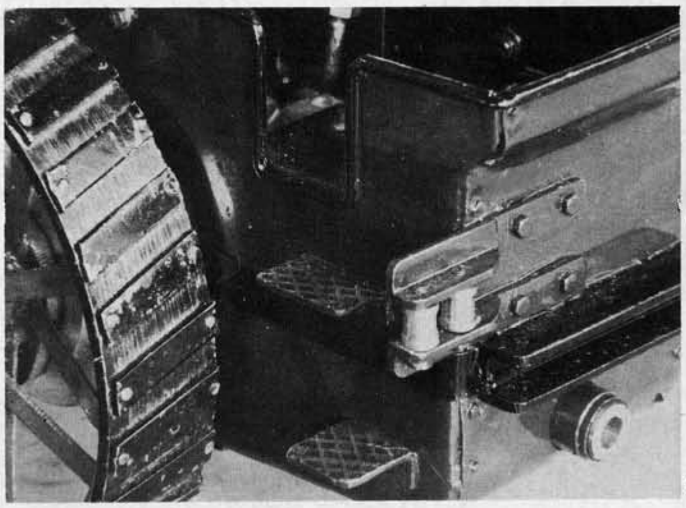
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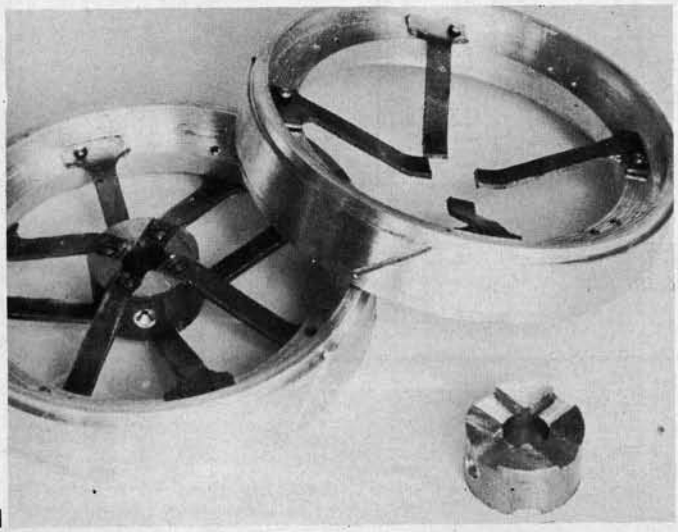
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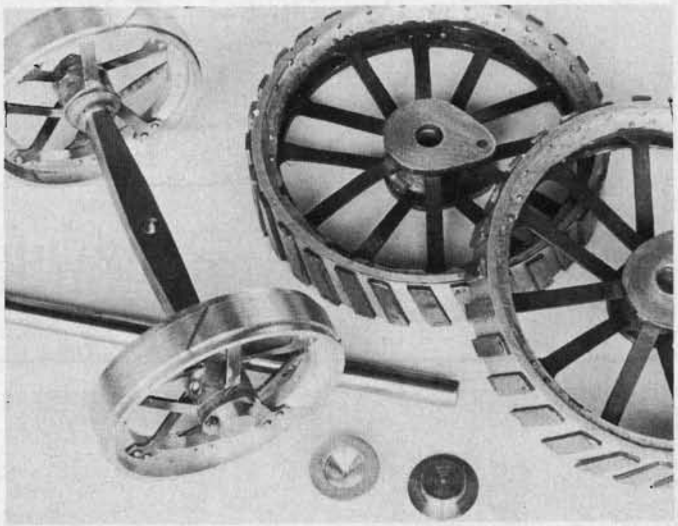
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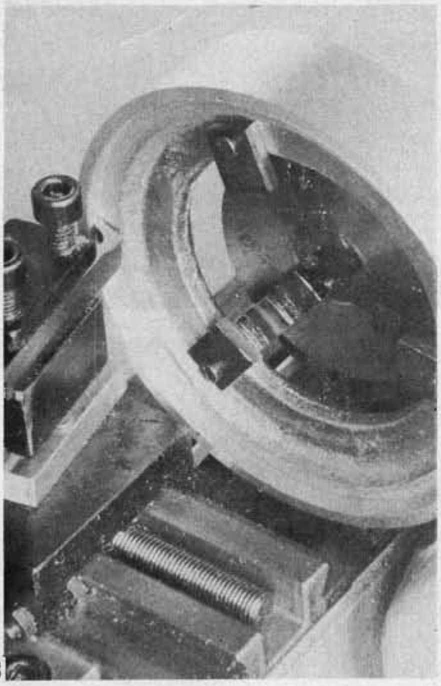
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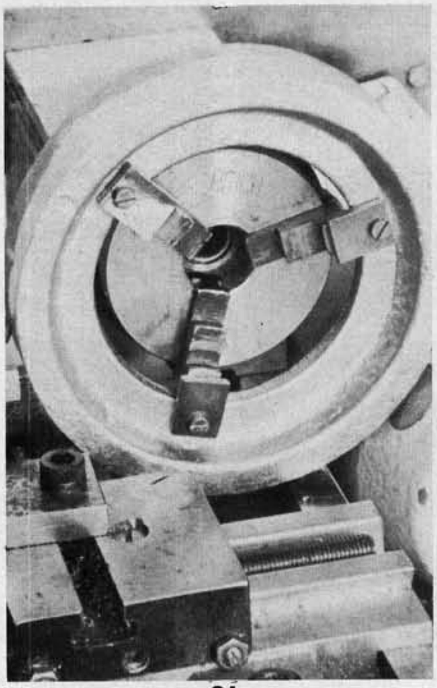
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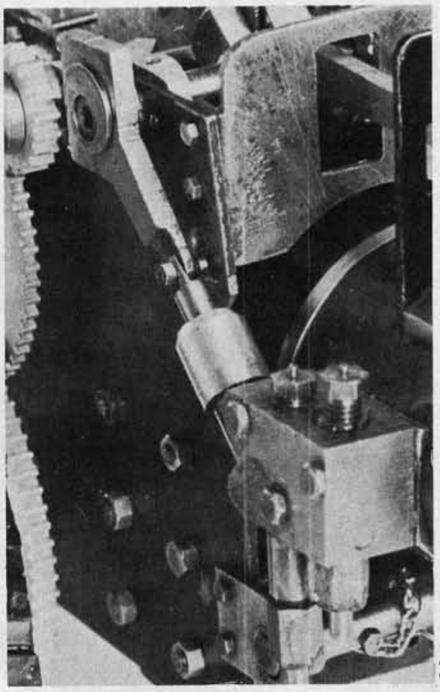
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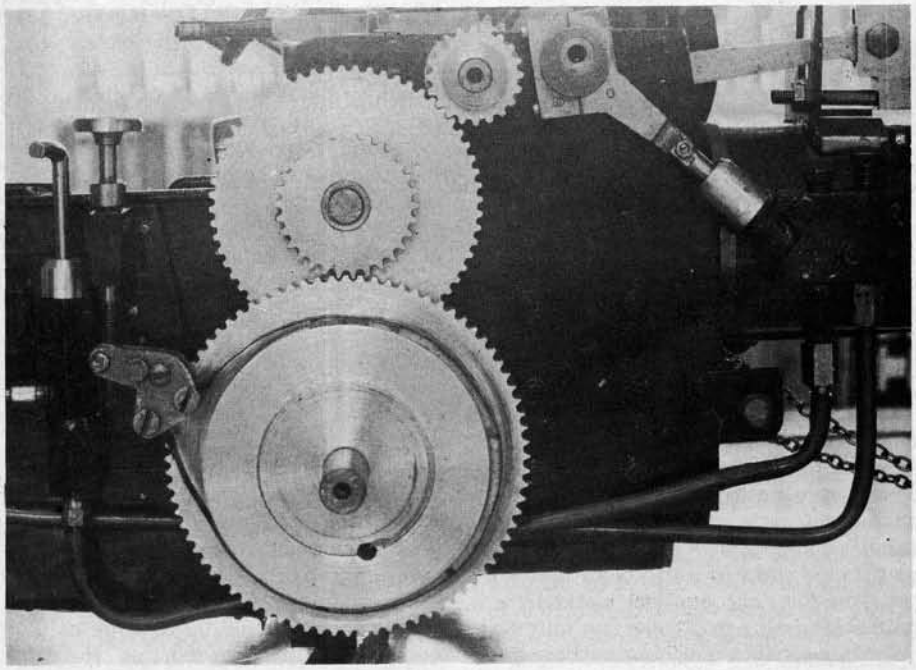
19 *Water pocket by-pass and brake control.*

20 *Steps, cable fair lead and draw bar.*

21 *Front wheels under construction.*

22 *Front and rear wheels.*
23 *Using the double-ended tool on a rear wheel rim.*
24 *Turning the outer diameter of a rear wheel. Unimat 3 in the increased swing mode.*

25 *The boiler feed pump.*



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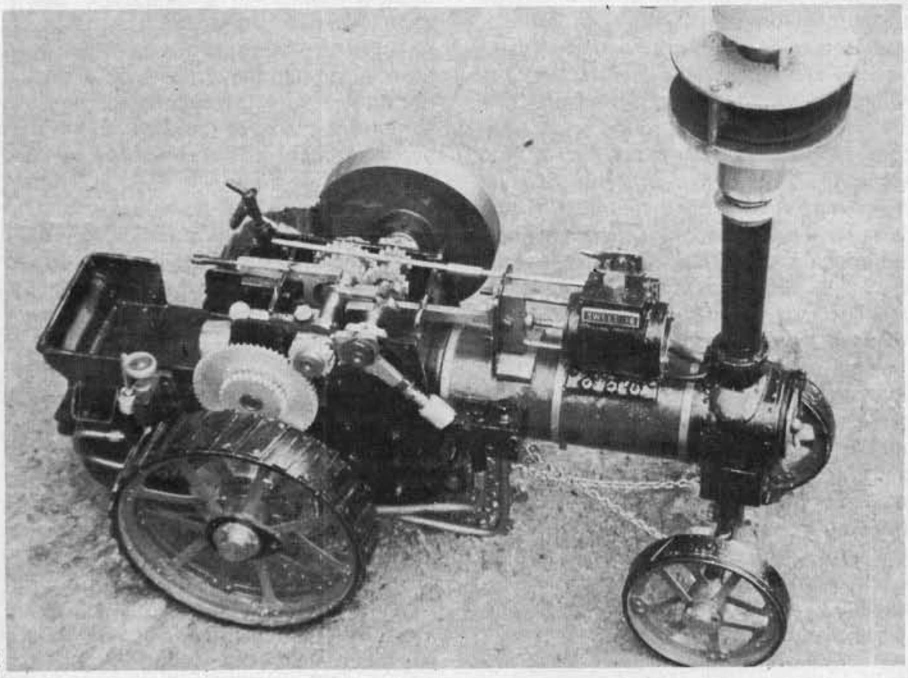

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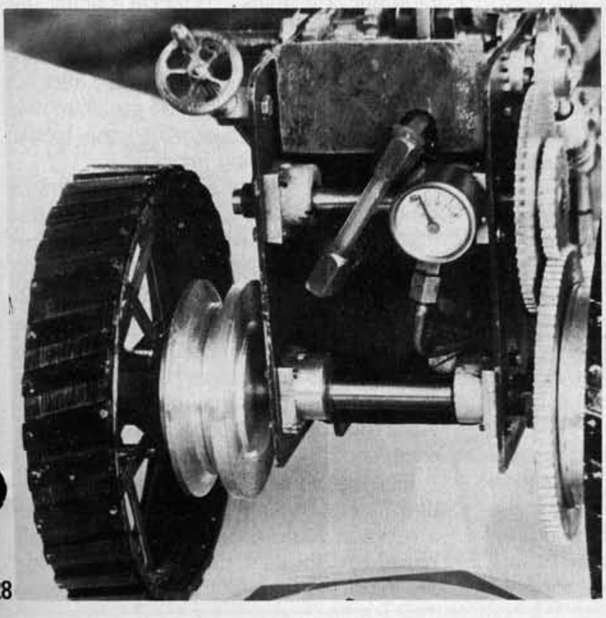


28

Back issues of Model Mechanics containing previous construction articles on Sweet Sixteen are available from:
Model Mechanics, M.A.P. Ltd., P.O. Box 35, Hemel Hempstead, Herts. HP1 1EE.

26 *The drive gears.*
27 *Getting up steam with an electric blower.*
28 *Winding drum and cable.*

crankshaft in the drill chuck, holding the connecting rod against rotation, clean off well and oil.

Make the 3 in. diameter flywheel from mild steel (which may be a difficult job on the SL). Cut out the motion plate from 16 gauge mild steel and secure in position. Fit the engine unit on the boiler and secure the saddle all round. Put the crankshaft in its bearings and screw the bearings to the hornplates, tighten the big end on and fit the flywheel so that the big end stays in line with the motion, use a ¼ in. gear collar, pro tempore, at the other end. Oil the motion and the engine and turn over the flywheel when everything should work in line, but a little tight.

Make the spectacle plate and back plate and fit these; they will need working and filing at the angles for a perfect fit, but they must not distort the hornplates. Undo the small end at the cross head, and the engine saddle screws, and make the exhaust pipe to fit. Secure the safety valve in place, and make a paper gasket to fit over the engine pad using thin good quality writing paper, and, with a little Boss White Jointing smeared on both the saddle and the pad, secure the engine unit, complete with the exhaust pipe, tight enough to extrude the surplus jointing compound. Tap the water filler 2 BA.

Test Run

Clamp the boiler horizontal and fill until the water gauge glass is half full, no more. Screw in the filler screw with a smear of Boss White on the threads. Fill the lubricator with a steam oil, such as Valvata, and secure the cap. Oil the motion. Check that everything turns, that there are no loose nuts and bolts, and no ominous water leaks. If all is well apply heat into the firebox; I used two small spirit lamps, but a small blowtorch is more satisfactory. Too much heat will spill out as yellow flame around the hornplates, but should do no harm.

Check that the regulator is closed, and watch the pressure gauge. When the water starts to boil the level in the water gauge will disappear then fill and go a little mad, but this will settle down as pressure rises. At about 25 psi open the regulator fully and turn the flywheel when the engine should run, gradually gathering speed. Turn the regulator down to allow about 200 rpm. If the engine does not start, close the regulator until the pressure gauge reads 35 psi and try again.

After about two minutes running stop the flywheel and reverse the running for another two minutes, after which the flame should be removed. The water remaining can be checked by tilting the boiler back. Whilst still hot, but no longer above boiling point, check that the engine feels free. If it is still a little stiff remove the lubricator cap and, with an eye-dropper, remove the water and refill with oil. Refill the boiler to level, as before, replace the filler screw and heat up for another run-in. If the flywheel comes off, file flats for the screws.

The 'Eagle'

A simple 2½ in. gauge 4-4-0 locomotive
By Martin Evans

MANY BUILDERS of model steam locomotives seem to have trouble over the operation of valve setting, but where the valve gear is of the slip-eccentric type, as on **Eagle**, even a complete beginner should find it easy. But first we have to assemble the steam chest and cover, with some kind of gasket between cylinder block and steam chest and between steam chest and cover.

At one time, builders were advised to use a regulation steam sheet packing material such as "Hallite". I have never liked this, as the stuff tears very easily unless such a thickness is used that it upsets all our dimensions (the thickness of the gasket between block and steam chest affects the spacing between piston and valve spindle of course).

Recently, I have been using a material called "Walkerite" or "Golden Walkerite", supplied by Messrs. James Walker & Co. Ltd. of Woking, Surrey. This can be obtained in sheets $\frac{1}{64}$ in. thick. It is stronger and harder than "Hallite", and I can recommend it. However, several builders of steam models have been trying a liquid gasket, such as one of the Hermatite range—it must be a type which does not set hard—or Loctite "Gasket Eliminator". From what I have heard, these products are fine for the job and save having to play about with razor blades, scissors, punches, etc.

Having satisfactorily completed the gaskets, and assembled cylinders and valve gear, the first thing to do is to adjust the valves on their spindles until they move an equal amount "fore and aft" over their ports. This can just be checked "visually" by temporarily removing the steam chest cover, but keeping the steam chest in position with the fixing screws.

The valve gear eccentric is of course, with slip-eccentric gear, loose on the driving axle, but the stop collar, which does the driving of the valve gear eccentric is to be held firmly to the axle by a 5 BA grub screw. An Allen-type socket head grub screw is best for this job, but as 5 BA screws are rapidly disappearing from the market, we may have to be content with an ordinary steel one, but on no account use a brass screw as this would not be strong enough. For a start, tighten this grub screw *just enough* to grip the axle, then turn the driving wheels in a forward direction, making sure that the stop collar is engaging the eccentric and watch the valve. A little inspection mirror is a great help here; though there is no reason why the other cylinder or rather steam chest, should not be temporarily removed while the valve setting operation is being carried out as we can always get the valve back in its final position once the stop collar has been correctly set.

All we have to do now is to keep turning the driving wheels in a forward direction, then stop them at the back dead centre position. The valve, at this point in the cycle, should just be starting to open the rear steam port to steam. The port should show as a thin black line. To get it to the right position, slacken the grub screw in the stop collar and turn the collar in a forward direction, pushing the eccentric round in front of it, until the above position is reached. Tighten the grub screw just enough to hold again. Now try things in reverse gear, turning the wheels backwards enough to ensure that the stop collar has gone round enough to come up against the stop pin in the eccentric. Check the opening of the steam port at back dead centre. If all the parts have been made exact to drawing, the opening in reverse should be exactly the same. If not, the cutaway in the stop collar will be at fault. Too much metal removed from the stop collar will give a too late opening of the steam port, too little removed means a too early opening, i.e. the "black line" will be quite a thick one, or even a definite "gap" open to steam in extreme cases.

Important. While valve setting, the driving axle must be in the correct running position, so to ensure this, pack up the axleboxes by putting something of suitable thickness between the bottom of the axle boxes and the hornstay.

The boiler

We can now make a start on the boiler. Boiler-making is a very different "art" from machine work, different techniques are called for, but no beginner should allow himself to be frightened off, as if the instructions are carefully and unhurriedly carried out, success will be assured.

There are two most important points to watch if boiler making is to be successful. The metal must be really clean, and there must be enough heat in the right place to ensure that the solders etc. being used are melted and melted reasonably quickly. But first a few words about the equipment necessary to make the boiler for **Eagle**.

The most important item is of course the blowlamp or blowpipe for the heating of the job. Very few model locomotive builders seem to use the petrol or paraffin blowlamp nowadays— I have used these in the past but always regarded them as rather fearsome things! Few builders, too, will possess Oxy-acetylene equipment, and I certainly would not advice such things for the beginner. In the days of the old "Coal" gas, an air-gas blowpipe was a very good type of heating equipment, and I made several locomotive boilers with one of these in the old Model Engineer Workshops in Noel Street, London. Nowadays, the bottled gas blowpipes are very popular, and those made by the Primus-Sievert people, burning bottled Propane, I find very good indeed for model boiler work. (Usual disclaimer.) To make sure of plenty of heat, I find Sievert burner No. 2943, which has a burner tube of 1¼ in. diameter, and burns about 70 ozs. of gas per hour, just right for locomotive boilers of 2½ in. and 3½ in. gauge. With the burner, we shall require a handle or support with valve and hose, for connection to the gas cylinder. The gas cylinder, obtainable from the local "Calor Gas" people, should be as large as can conveniently be carried, as there is nothing worse than running out of gas in the middle of a brazing job.

These Propane blowpipes are self blowing, that is they require no extra air, but draw in their own air, so all one does to start up is to open the valve slightly and apply a match! It is just as easy as that. The cylinders normally have a control valve on the top, which of course must be opened after the hose and blowpipe have been properly attached. The valve on the blowpipe is then used to control the flame. After use, the cylinder valve is shut first, so as to burn off the small amount of gas left in the hose; finally, the blowpipe valve is closed.

The next most important item for boiler making is some kind of brazing hearth or stand. Now even for one boiler, it is worth making a fairly decent brazing hearth. All we need is a few lengths of black steel angle around 1 in. × 1 in. for the legs, the "hearth" itself being knocked up from sheet steel—the type called C.R.C.A. by metal merchants is best (cold rolled-close annealed). This could be about 18 SWG or about $\frac{3}{64}$ in. thick. To tackle a boiler the size of **Eagle**'s the "hearth" could be about 18 in. long × 9 in. high, with a back about 10 in. high and a front edge about 3 in. high. A little coke can be obtained and piled around the boiler when the bigger brazing jobs are being tackled.

We will also need a couple of pairs of tongs, a large strong pair to grip the hot boiler with, and a smaller pair, which can be quickly home-made from steel strip about $\frac{3}{8}$ in. × $\frac{3}{16}$ in. section. We could also do with a "scratch rod", to break up any flux bubbles that can appear while brazing. This can also be home-made—an 18 in. length of ¼ in. diameter iron or steel rod, one end bent into a ring, the other end filed to a point.

Finally, we need some kind of "pickle bath", into which the boiler is dunked after each brazing operation. For a small boiler like **Eagle**'s there is no need for anything expensive. I use one of those.

rubber buckets supplied by dealers in garden requisites. These are generally made of quite thick rubber and stand a lot of handling, as well as being resistant to acid. Failing this, a plastic bucket could be used, though great care must be exercised with plastic buckets, as if touched by anything very hot, they start to disintegrate! For the "pickle", we need some diluted sulphuric acid. The acid as used in motor-car batteries is just about right without further dilution, so enquiries at the local car battery depot or one of the larger garages will probably solve this problem. Another approach is to order a pint of *commercial* concentrated sulphuric acid from the local chemist. Half fill the bucket with cold water and add the acid to this, carefully and gradually. *Never* add the water to the acid, as this can easily cause an explosion.

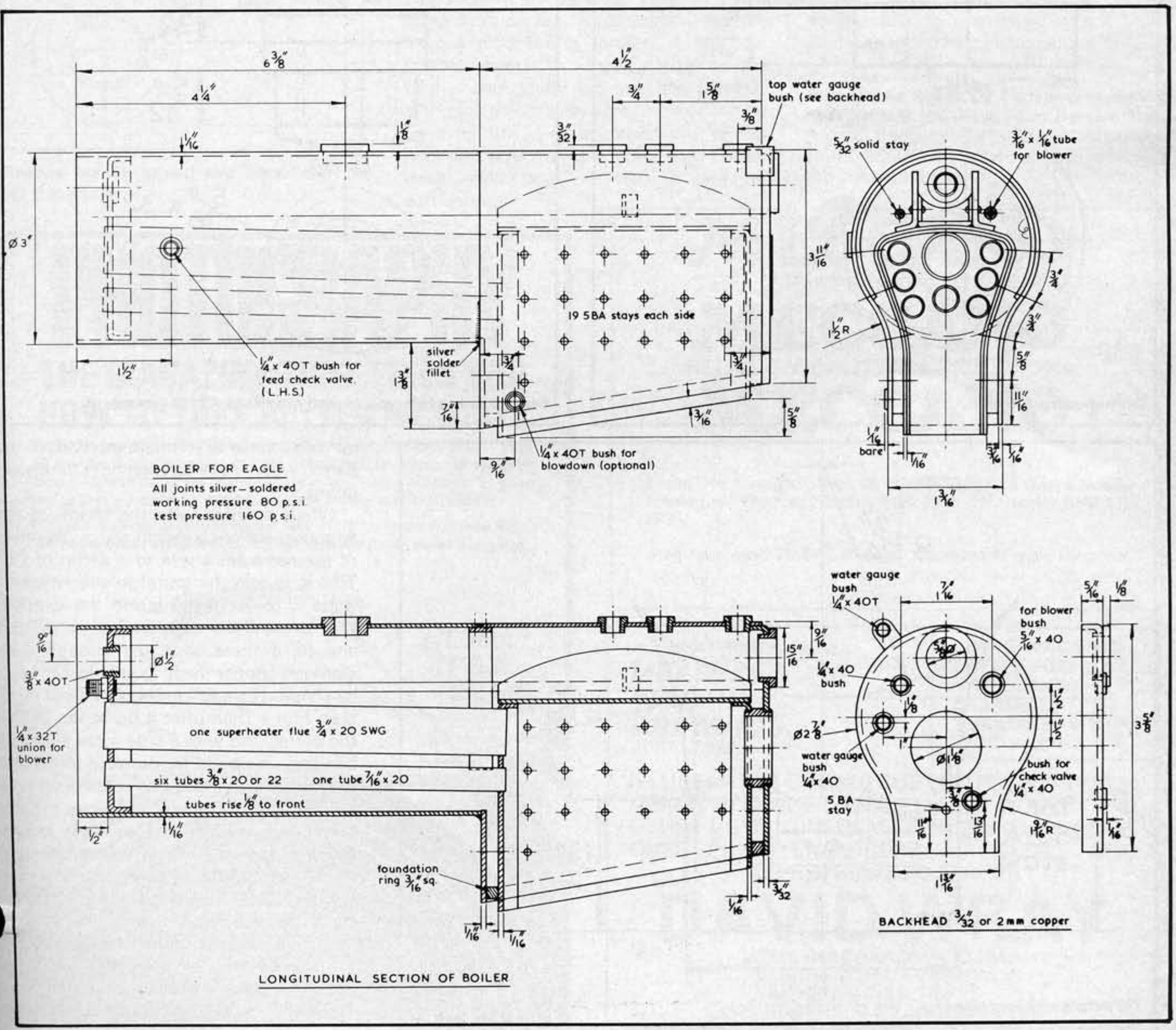
For the brazing alloy to be used, I can recommend Johnson Matthey's "Easyflo No. 2". Although rather expensive, this is the ideal silver-solder for the beginner as it flows easily at a comparatively low temperature and forms a nice fillet. It is also very strong and resistant to the constant expansion and contraction inevitable in boiler work. To go with the Easyflo, we will also require the appropriate flux.

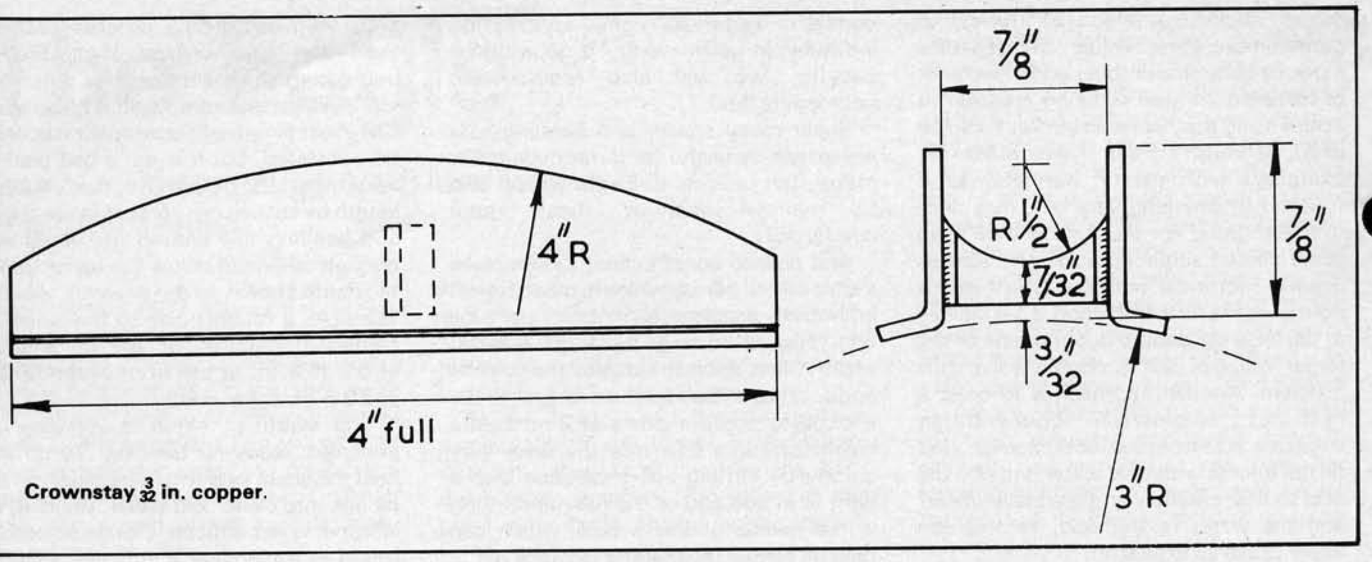
Sheet metal shears and bending rolls are extremely useful for the serious boiler maker, but builders of **Eagle** will be able to manage without these quite comfortably.

And now to construction. Let us make a start on the barrel, which is made from 3 in. outside diameter seamless copper tube $\frac{1}{16}$ in. thick or 16 swg. Its length is $6\frac{3}{8}$ in. and the first thing to do is to true up the ends. Those builders who are lucky enough to possess lathes of 3 in. centre height or larger can true the ends very quickly by cutting out a wooden disc a tight fit in one end of the tube and fitting in the middle of this a bolt, which can then be centred so that the tailstock of the lathe can be used to support the outer end of the tube, the tube being held in the outside jaws of the three-jaw chuck.

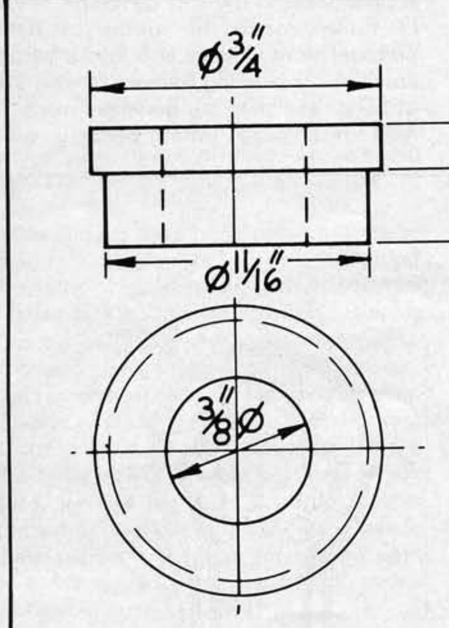
After machining one end, using a sharp "knife" tool with a little cutting oil or paraffin as coolant, knock out the wooden disc and press it into the other end, then repeat the process. Next, tackle the outer wrapper of the firebox, made from sheet copper, also $\frac{1}{16}$ in. thick (16 SWG or 1½ mm.) and 4½ in. wide. The exact length of the wrapper can easily be calculated, but it is not a bad plan for beginners to determine the required length by cutting out some thin cardboard and bending this around the barrel with enough to extend below the barrel to give the depth shown on the drawing, which is $1\frac{3}{8}$ in. (As a rough guide to the length of cardboard required, it will be a shade under 10¾ in. at the front of the firebox and 9½ in. at the rear.)

The wrapper sheet must now be annealed, ready for bending. To do this, heat the sheet evenly to a medium red and plunge into clean cold water. Bending the wrapper is not difficult. Obtain something round of a diameter a little less than the diameter of the barrel, and with the copper sheet in the soft condition, it can be pulled round the former by hand pressure alone. (Some soft drinks bottles are O.K. for bending formers for this size of boiler and they are generally made of fairly thick glass). During bending, offer

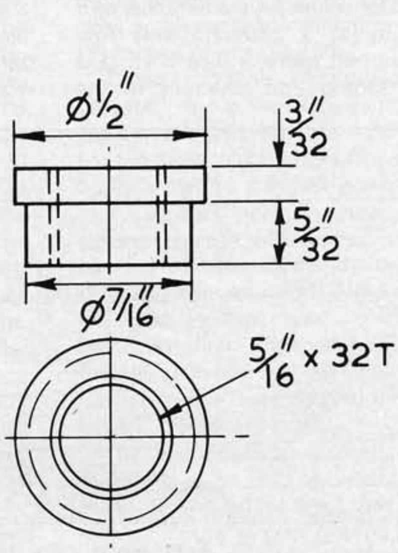




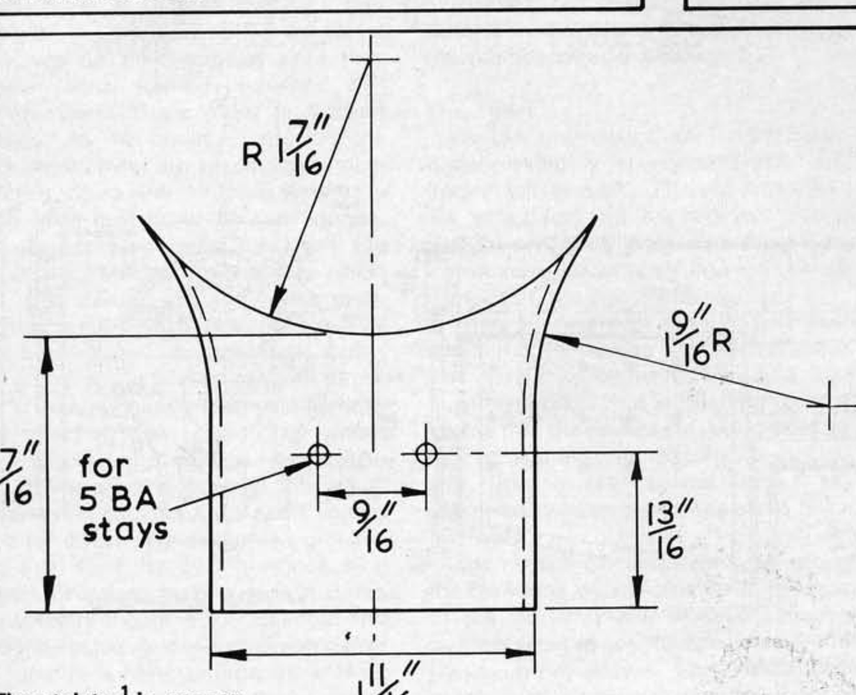
Crownstay $\frac{3}{32}$ in. copper.



Domebush gunmetal.



Bushes for safety valves and manifold. (3 off gunmetal).



Throatplate $\frac{1}{16}$ in. copper.

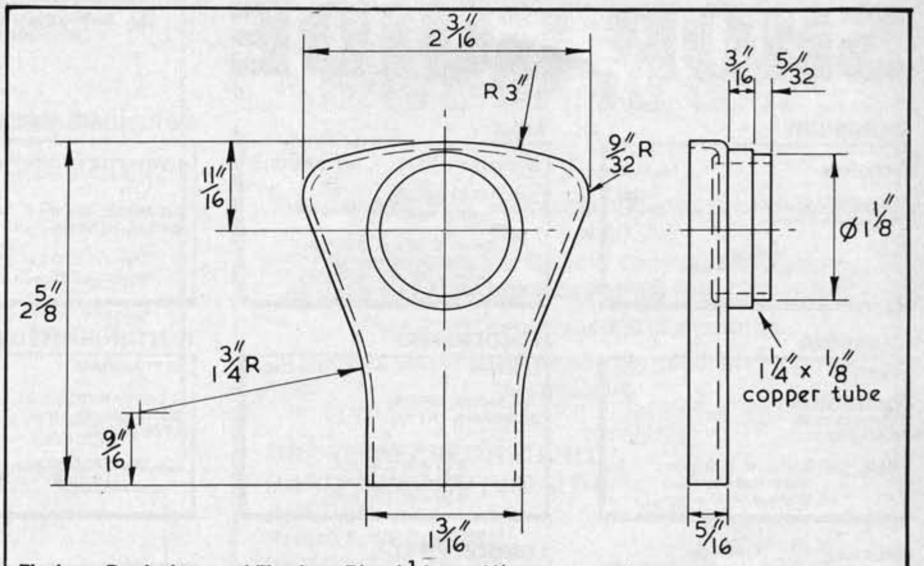
up the wrapper at frequent intervals to the barrel, when it will be seen how things are going.

When satisfied with the shape of the wrapper, cut out a length of copper sheet of the same thickness to a width of $\frac{3}{8}$ in. This is to join the barrel to the wrapper. Bend it to lie neatly inside the wrapper first (anneal the copper first as before) and fix it there with just enough $\frac{1}{16}$ in. diameter copper rivets to enable it to keep its shape. (This will probably be not more than four.) Then offer it up to the end of the barrel, and with a little more judicious bending, it should be possible to get the two nicely in line and flush all around. It is a good plan to chamfer the edges of both barrel and wrapper, before finally joining the two, as this will assist penetration by the silver solder. Again, use just the minimum of $\frac{1}{16}$ in. copper rivets to attach the ring to the barrel.

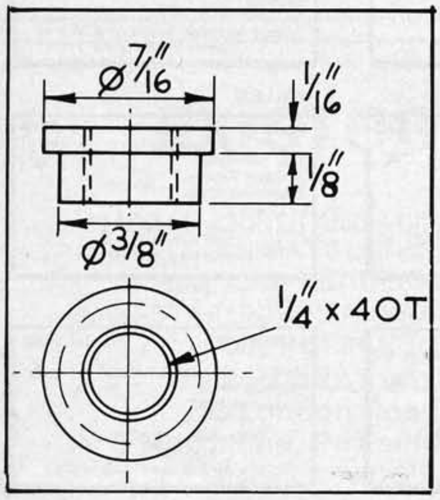
At this stage, perhaps I should explain, for the benefit of beginners, what is meant by silver-soldering as distinct from brazing. Very briefly, the two processes have no distinct dividing line. The silver-solders are hard solders containing, among other metals, a proportion of silver which enables them to be melted at temperatures between about 600°C. and about 850°C. Brazing on the other hand is done with higher melting point alloys which may be nothing more than ordinary brass wire.

Throatplate

The throatplate should be made next. This is a very simple flanged plate, made from the same $\frac{1}{16}$ in. copper sheet. Cut out a "former" from any suitable scrap piece of steel about $\frac{1}{8}$ in. thick, allowing $\frac{1}{16}$ in. on the sides for the thickness of the copper



Firebox, Backplate and Firedoor Ring ($\frac{1}{16}$ in. or 1½ mm copper).



Bushes for Backhead and Blowdown. (4 off gunmetal).

to be flanged over it. Then cut out an exactly similar former from hard wood about $\frac{3}{16}$ in. thick (the exact thickness doesn't matter). Glue the wood to the steel, and put a couple of small woodscrews in as well, keeping these quite flush on the "steel" side. Then we have a nice strong former. Anneal the copper sheet thoroughly, clamp to the former and gently tap over the flanges. Although an ordinary light hammer can be used for this, I much prefer one of the hammers now available with a hard plastic head, which does not mark or dent the soft copper.

After flanging, offer up the throatplate to the barrel/wrapper assembly and obtain a good fit by careful filing, after which it can be attached to the wrapper by four $\frac{1}{16}$ in. copper rivets, two on each side. We should now be ready for the first silver-soldering operation, which I will deal with in the next instalment.

Eagle plans: Sheet 1 & 2 are now available; Plan No. L.O. 955, from Plans Service, P.O. Box 35, Bridge Street, Hemel Hempstead, Herts. Sheet 1 & 2 priced at £1.80 each plus 20p postage & packing.

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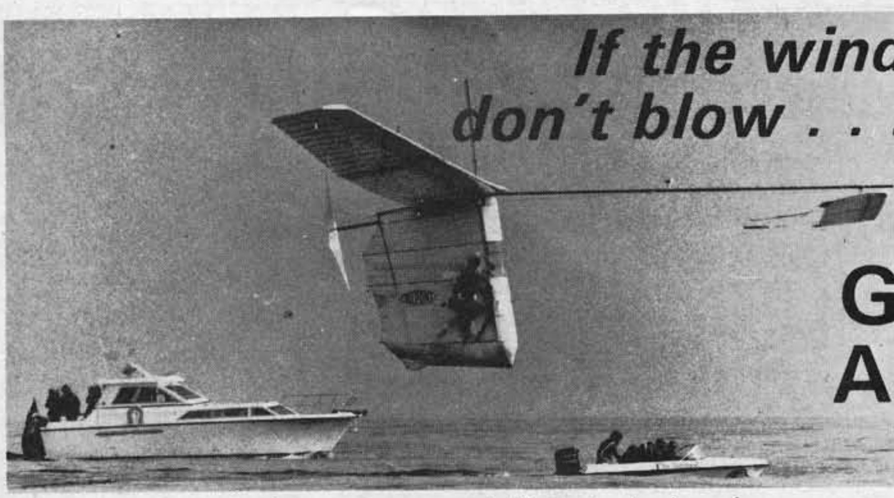

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