Model Mechanics

July 1979 45p
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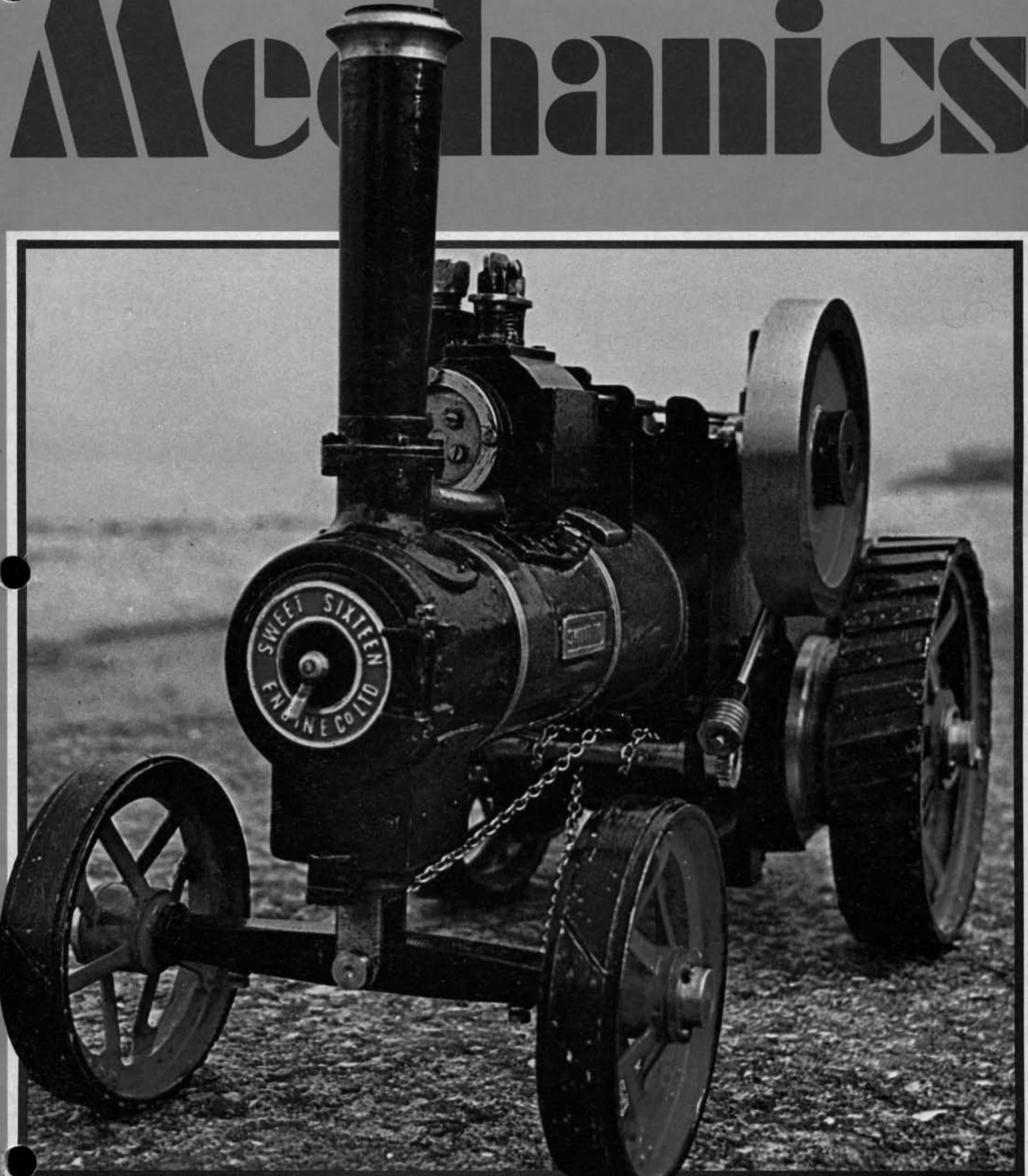
MAP HOBBY MAGAZINE



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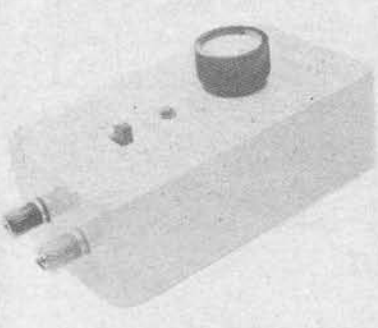
VOLUME 1 Number 6 JULY 1979

"Sweet Sixteen". Designed by Rex Tingey. This was built on a Unimat lathe. Construction details start in this issue.



Build a D.C. controller, full construction information in this issue!

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M.M QUERY COUPON
JULY
1979

Editor's Chat

The Sandown Park Model Symposium was organised by Elmbridge Model Club. I went along on 12th May and it turned out to be a marvellous event with superb weather. There were some very interesting models and accessories on show. One that impressed me very much was an inflight electric starter for a glow-plug engine, demonstrated by Harry Brooks. On the Fareham Engineering stand were some very interesting live steam kits being sold. I am hoping to review these in the near future.

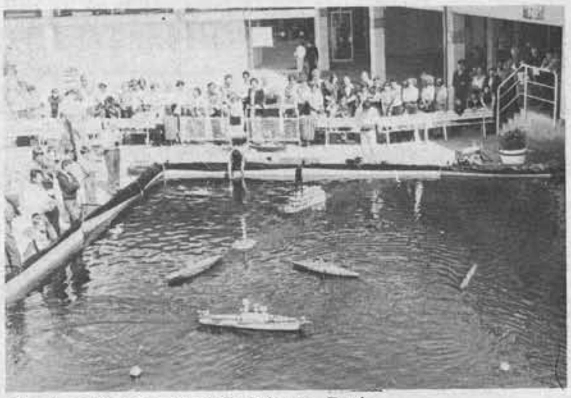
For those folks new to Model Mechanics and who are interested in building 'EAGLE', back issues are available from: Subscriptions Dept., M.A.P. Ltd., P.O. Box 35, Bridge Street, Hemel Hempstead, Herts, HP1 1EE. Prices at 45p plus 20p p&p.

The following gives a summary of contents: April 1979, general arrangement and introduction. May 1979, main horns, axlebox, drag beam, frame stretchers and pump body, hornstays, drive wheels and axle. June 1979, crank pins, coupling rod, bogie arrangement, plus parts, cylinders and steam chest.

Next month I am going to introduce a section for scale plans. I will illustrate this with models of the subjects in question. The first plan will be of an Austin 744cc single seat racer of 1937. I hope this will encourage readers to send in photographs of their models, which will help me in selecting the subjects for this section.

Sandown Park, great activity with the stox in the foreground, and control line flying in the background.

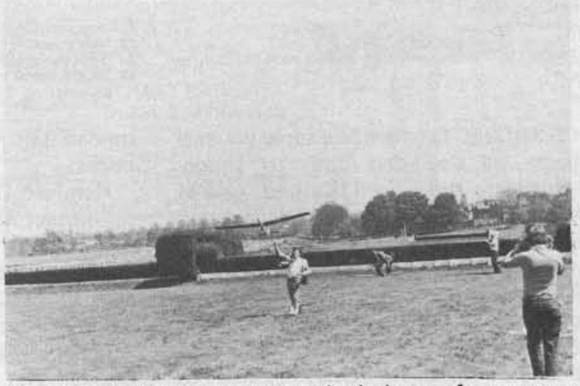
Start of a stock car race.



The boating pool at Sandown Park.

Carrying on the famous tradition established by his father who was a pioneer of ducted fan propulsion, Marcus Norman introduced his latest creation at the Sandown Park Radio Control Models Exhibition.

It is a scale 'Scimitar' with two 40 cu in engines driving his own designed fan units. This spectacular model is fully radio controlled and flies at over 80 mph.



The glider patch, the tow man had plenty of room to run.

Editorial Director R. G. MOULTON

Editor COLIN RATTRAY

Managing Director GOSPATRIC HOME

Group Advertisement Manager M. GRAY

Science today

Midlands Electricity Board integrated total energy station at Hereford noise secure engine house designed by ICI Acoustics

Central Electricity Research Laboratory	Acoustic Advisers
Ewbank & Partners Ltd.	Consulting Engineers
Considere & Partners	Consulting Civil Engineers
Ansell & Bailey	Consultant Architects
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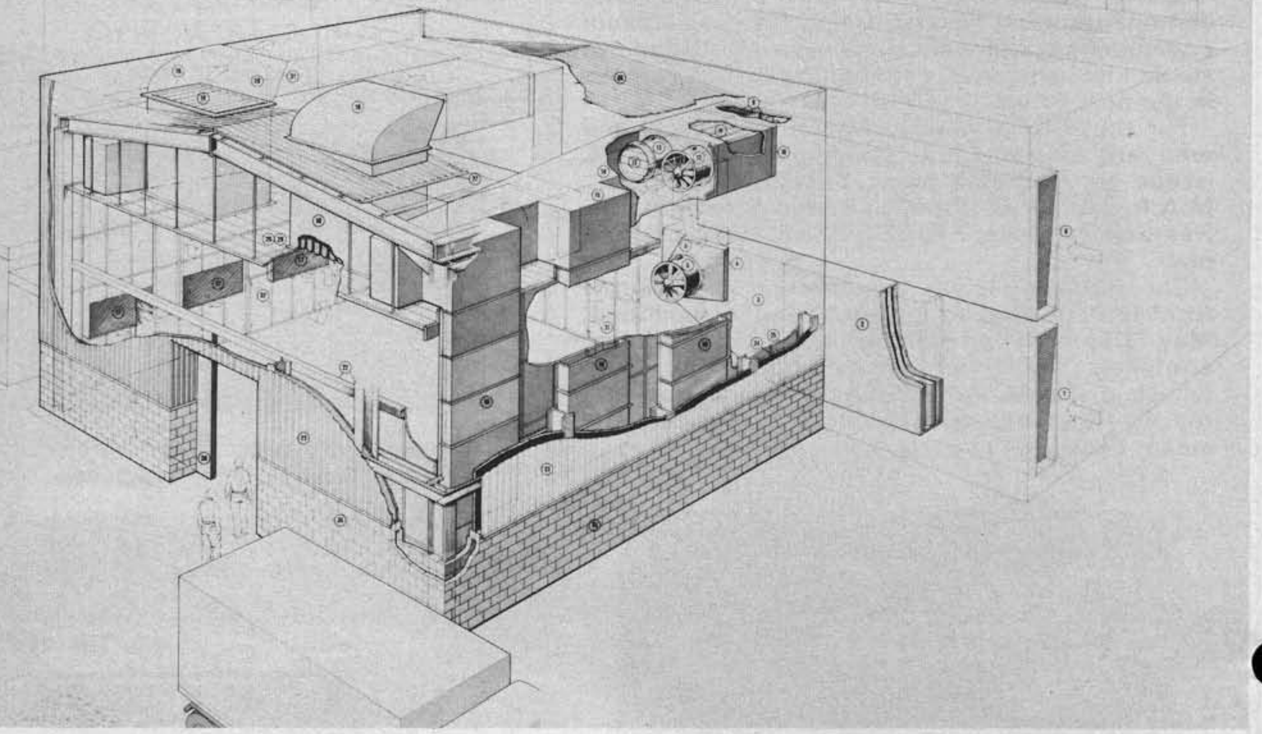


Combustion air—two systems—one LH one RH. Each system to include:
1 Inlet ducting with birdmesh screen
2 Acoustic splitter silencer
3 Acoustically lined inlet bend
4 Fire-damper
5 Acoustically lined transition
6 48" dia. combustion air fan—14.5 m;/s air flow
7 Fan guard (not shown)

Ventilation supply air—two systems—one LH one RH. Each systm to include:
8 Inlet ducting with birdmesh screen
9 Air turning vanes
10 Fire dampers
11 Acoustic splitter silencer
12 Two 48" dia. ventilation supply air fans each 11.8³/sec air flow
13 Two 48" non-return dampers
14 Roof distribution header duct
15 Three off take bends
16 Three acoustically lined dropper ducts
17 Three supply air inlet grills with balancing and shut off dampers

Ventilation outlet air—two systems—one LH one RH. Each system to include:
18 Roof outlet with acoustic splitter silencer
19 Roof outlet weather cowl
20 Fire damper
21 Birdmesh screen

Building structure and fabric
22 Main steelwork structure
23 Outer wall profiled plastics coated steel external cladding
24 Decorform 50 mm-thick outer acoustic panel wall lining system
25 Decorform 112 mm-thick inner acoustic panel wall lining system
26 Outer plastics coated steel roof cladding
27 Outer sound insulating barrier lining under external cladding in 26
28 Decorform 112 mm-thick suspended acoustic ceiling
29 Roof acoustically absorbent layer (not shown)
30 4m × 4m × 230mm-thick 55 dB steel sliding acoustic service door
31 Double acoustic door personnel access 'sound lock' to control room
31 Double acoustic door personnel access 'sound lock' to boiler room
32 Double acoustic door personnel access 'sound lock' to control room
33 Crane and bridge rails—for 5-ton bridge crane (not shown)
34 Electric light fittings—cable trays—electric control panels (not shown)ç
35 Block work cavity dado walls

THIS PROJECT, which has some unusual aspects, is designed both to supply electricity to the local 11Kv grid, and at the same time convert normally wasted heat into some 15 MW of steam power for direct use by nearby factories.

The generating system used will allow the two main 10,400 BHP diesel engines, each of which drive a 7.5MW generator to produce electricity, to operate at close to their full rating, whilst a series of heat exchangers pick up waste heat from engine exhaust gases, cooling water, and lubricating oil to produce the steam power.

An overall plant efficiency of around 76% will be achieved on full load, twice that of a conventional generating station, resulting in fuel oil savings of some 15,500 tonnes per year, or £750,000 at 1978 prices.

Hereford City Council was determined to protect the environment for people nearby and the scheme would not have been approved if the MEB had not been able to produce plans to muffle noise emission from the main engine-house.

Initial investigations by MEB engineers showed that noise levels of up to 120 dB (A) could exist in the engine house with both engines running, and this had to be reduced to 32 dB(A)—little more than a whisper—at 450 metres.

Subsequent to further research by MEB engineers, the specification for background noise was finally established at the more severe criteria of 38 dB(A)—at 100 metres!

ICI Acoustics set to work to design the engine-house and produced a scheme for an externally-clad portal frame structure, with a double-skin ICI Acoustics 'Decorform' panelling system internally (incorporating a separating cavity for optimum sound insulation). A comprehensive ventilation system was also designed, with all necessary fans, ducting, silencers, fire dampers and grilles, and the project was completed with acoustic doors, removable access panels, lighting, control panels and special crane supportrs built into the portal frame structure.

ICI Acoustics has it headquarters at Rosanne House, Bridge Road, Welwyn Garden City, Herts., AL8 6UF. (Tel: Welwyn Garden 23400).

Build a D.C. motor controller

by Roger Barrett

The completed controller.
Before switching to reverse it is advisable to turn pot to the minimum setting.

Last month I described in some detail the design of a circuit to control the speed of a small d.c. electric motor such as a model railway locomotive. At the end of that article I said that the design was complete, and this month I intend to describe the construction of the unit. I must ask you to bear with me however because I want to add still more components to last month's circuit. The final circuit of the unit that I will be talking about is given in Fig 1, which is as before but for two things. The first is a diode in series with the supply input to protect the transistors against accidental reversal of the supply. The other difference is that a switch has been added to the output to reverse the voltage. This, of course, reverses the direction of the motor.

A complete list of parts used accompanies Fig 1. These components are available individually or as a complete kit from Watford Electronics whose advertisement appears in this magazine.

Construction — General

The construction of this controller, like almost any electronic assembly, can be divided conveniently into the electronic circuit itself and the housing. This is the way in which I intend to divide up my description. The housing for this design is a simple proprietary plastic box which can be drilled and filed quite easily using ordinary metalworking tools. All the necessary dimensions are given below.

The assembly of the circuit board itself requires rather more specialised tools and I will describe this part of the work in more detail for the benefit of readers who are unfamiliar with electronic wiring techniques. I hasten to add that this unit is simple to build, and should present no difficulty to anyone who is reasonably adept.

Printed Circuit Board

There are many ways in which the components of an electronic circuit can be connected together physically, but by far the most common is by means of a printed circuit board, or PCB. The basis of this is a sheet of insulating material, usually a laminate of paper or glass cloth with some kind of resin, which has a sheet of copper bonded to it. This copper layer is normally about 0.001in. thick. The conductor paths are formed by etching away the copper to leave the required pattern bonded to the insulating material.

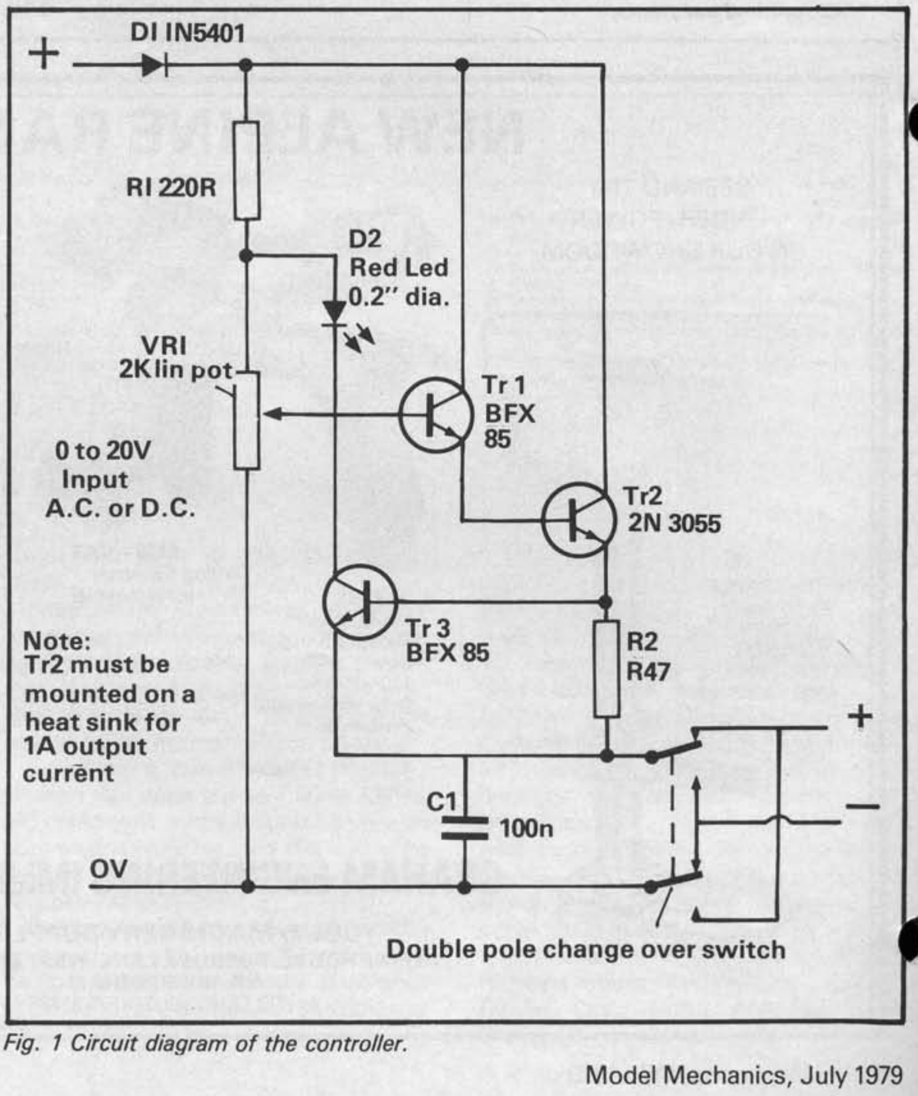


Fig. 1 Circuit diagram of the controller.

Although it is quite feasible for the amateur constructor to make his own PCB's I would not recommend this for beginners. For those who wish to make the PCB for this circuit the layout is given actual size in Fig 2, with the corresponding component positions. You will see that some components are shown dotted; this is because they are not actually mounted on the board but are on the box lid. These components are however wired to the pins in the actual positions shown.

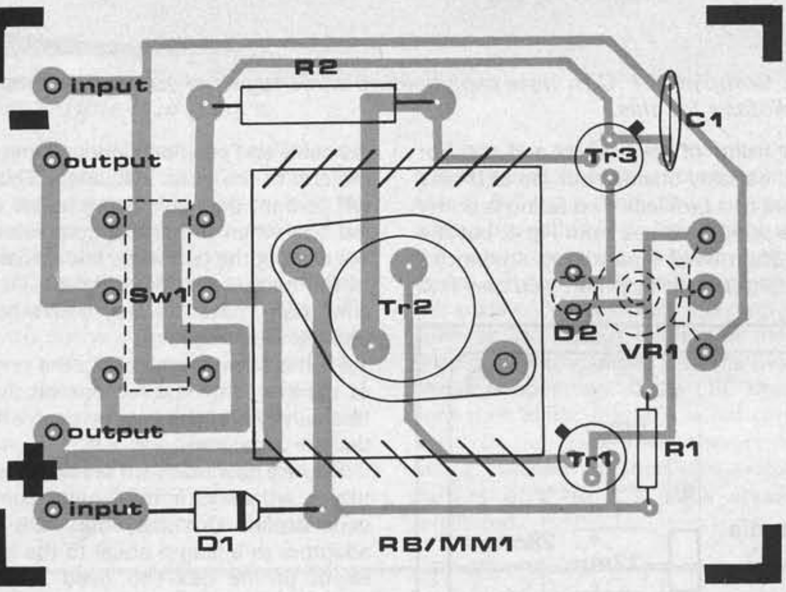


Fig. 2 Printed circuit board shown full size, seen from above i.e.: looking down on the components.

I will assume in the notes below that you have the following tools; fine nosed pliers for bending component leads; miniature wire cutters and strippers; a small soldering iron with a fine bit and flux-cored solder not thicker than 18 s.w.g. It is possible to use 'electricians' pliers, cutters etc but the work will be course be easier with the correct tools.

The order in which the components are fitted to the PCB is not critical but you will probably find it easier to follow the sequence given below.

1. Insert the small terminal pins into the appropriate holes, carefully pushing them in until their heads are in contact with the copper track. Solder all the pins to the copper pads taking care to avoid dry joints and stray splashes of solder.

2. Bend the leads of the resistors and of D1 as shown in Fig 3 and insert them into the board. When bending component leads it is advisable to hold the lead close to the component body, as shown in Fig 3, to avoid straining the joint between the lead and the body. Solder these leads in position, making sure that the component body in each case is flat on the PCB. MAKE SURE THAT D1 IS THE RIGHT WAY ROUND. Trim off excess lead length close to the board.

3. Fit C1, Tr1 and Tr3 and solder in position. Try to keep the transistors upright without having them in contact with the PCB. The leads are fairly close together here so be extra careful with the iron. Trim off excess lead length close to the board.

4. Place the heat sink on the board in the orientation shown and fit Tr3 so that its leads pass through the holes in the heat sink and the PCB. (There is only one orientation in which the holes will line up). Before soldering these leads fit the two 6 BA screws, with washers, and tighten the nuts on the copper side of the board. When the transistor and heat sink are securely mounted on the board, solder the two leads and trim them to length.

5. Next cut thirteen pieces of wire, each to a length of 100mm. This length is not critical but for neatness try to keep them all the same. Strip the insulation off each end for about 5mm and lightly tin the ends. Solder one of these wires to each of the pins except the two marked 'input'. For reliability and ease of assembly it is best to wrap the tinned end round the pin (about ¾ to 1 turn is sufficient) before soldering.

6. Attach the wires from the pins marked 'output' to the 4 BA solder tags and solder them securely.

7. Solder the six leads to the switch, noting that each lead is taken from the pin to the corresponding position on the switch. When these are all soldered, pull the switch gently up from the board and ensure that the leads are not crossed over one another.

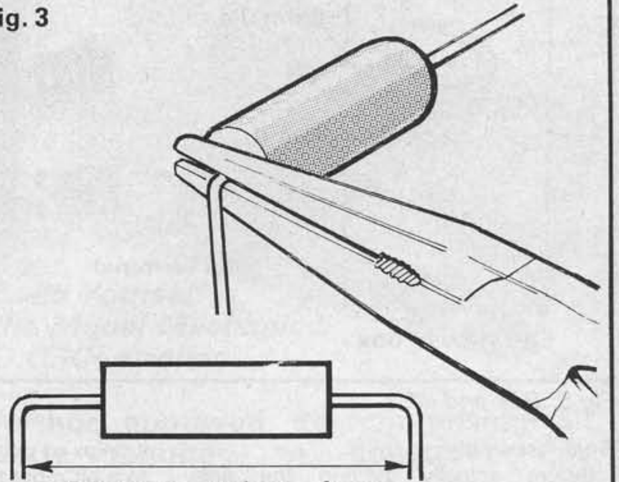
8. Fit the leads to the potentiometer in the same way, again ensuring that the leads run straight from the PCB to the tags on the pot without crossing.

9. Carefully cut the leads of the LED to a length of 8 to 10 mm ready to solder the last two wires to them. Before they ae actually soldered it is necessary to thread them through the locking collar of the plastic mounting bush. The reason for this should be clear if you refer to Fig 4 which shows the way in which the LED is retained in the panel by the bush. The leads can now be soldered to the LED. The polarity of the LED is indicated by the

List of component parts

D1	1N5401
D2	Red LED with mounting bush 0.2" dia
Tr1	BFX85
Tr2	2N3055
Tr3	BFX85
R1	220R ½ watt
R2	R47 1 watt
VR1	2k linear rotary ½ watt
C1	100n ceramic disc 25vw
Double pole slide switch	
Hardware.	
Heatsink	TV3 (Redpoint)
Box	ABS; size 120 × 40 × 65mm (ref RJPB3)
Terminals	4mm screw/plug; 1 red, 1 black
Pins	Vero 18-0217G 20 off
PCB Guide Adaptor 4 off	
6 BA screws, nuts & washers	
Connecting wire	
Two-core cable	

Fig. 3



small flat on the body, and this must be wired to the pin adjacent to the flat shown on the PCB.

The assembly of the PCB is now complete and you should have a thing that looks like the one shown in Fig 5. Check yours carefully against this and against Fig 2. If there are any mistakes it is better to find them now than after the unit is completed. Also check the solder joints and examine the copper side of the PCB for odd splashes of solder.

Box Assembly

The housing of this unit is, as I said, simply a plastic box. This must be drilled to accept the components which are mounted on the lid, and also the terminals and cable on the end face. The positions and sizes of all the holes are given in Fig 6 and I think I need hardly comment further on this part of the work. Remember that the outside surface of the box is ready finished so be careful not to scratch it during the drilling and filing.

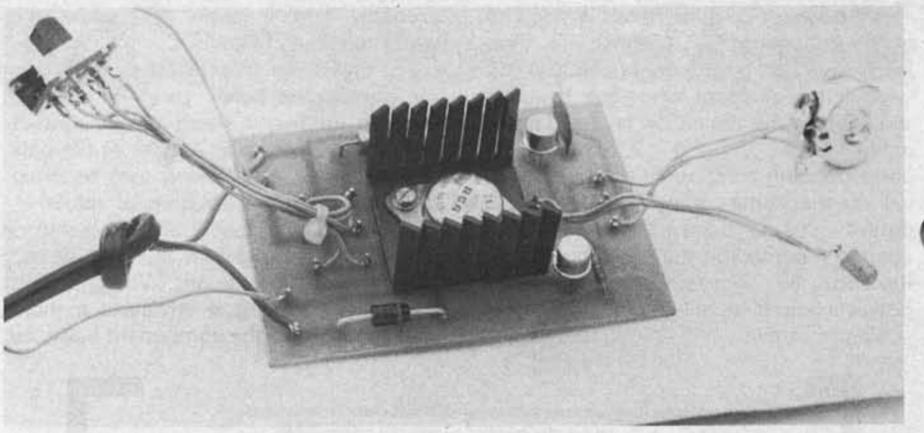


Fig 5. Completed P.C.B. note clips holding wires together you can use masking or cellotape for this.

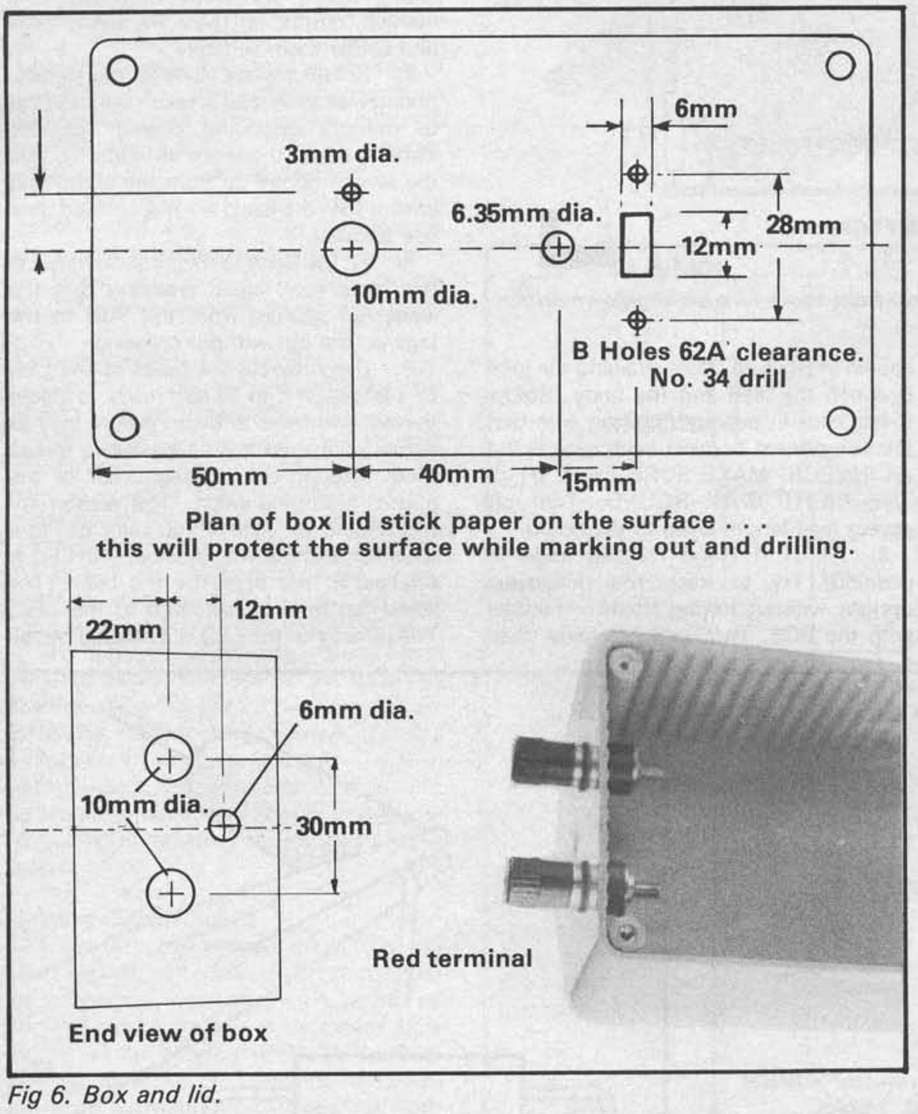


Fig 6. Box and lid.

Final Assembly

Before actually starting the final assembly put any marking that you want on the lid. It is far easier to do this on a flat surface without the components sticking out.

The fixing of the switch and the pot should be fairly obvious but the LED may be more of a problem. The fitting is pretty simple as you will see from Fig 4, but the parts often need a surprising amount of force to get them together. You may find it helps to open out the hole in the panel to a bit more than 6.35mm specified.

The input cable should now have its outer insulation removed for a length of about 60mm and the two wires stripped for about 6mm. Next tie a single knot in the cable and position it about 10mm from the end of the outer insulation. This knot will prevent the cable being pulled out of the box when the unit is completed. Tin the ends of the two wires and solder them to the two pins marked 'input'. To avoid confusion, make the brown wire positive and the blue negative.

Fit the screw terminals to the end face of the box, with the red one on the left. Use only one of the nuts on each one and tighten it securely.

You are now ready for the last step, and this is where your third hand comes in very useful. Cut the four PCB guide adaptors to a length equal to the internal depth of the box (no need to be too accurate) and clip them to the PCB as shown in Fig 7. The input cable is fed through the hole in the end face of the box and the complete PCB plus lid is offered up to the box so that the guide adaptors slide into the slots moulded into

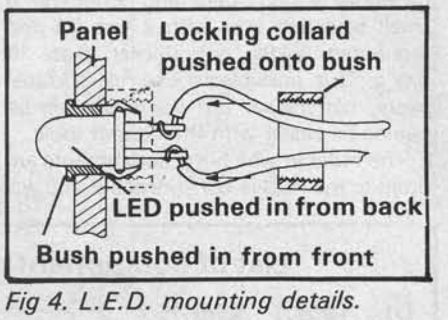


Fig 4. L.E.D. mounting details.

the inside of the box. When this is properly located, fit the solder tags of the output leads to the output terminals and secure with the two remaining nuts. Screw down the lid of the box and fit the knob to the pot shaft so that the grub screw tightens on the flat. The unit is now complete and ready for testing.

Testing

This circuit is very simple, and the testing is therefore simple too. First turn the control knob fully anticlockwise and set the direction switch to 'forward'. Now connect the input cable to 12v d.c., either from a battery or from the output of a suitable power pack e.g. a model railway controller. Connect a 10v meter across the output terminals and observe the

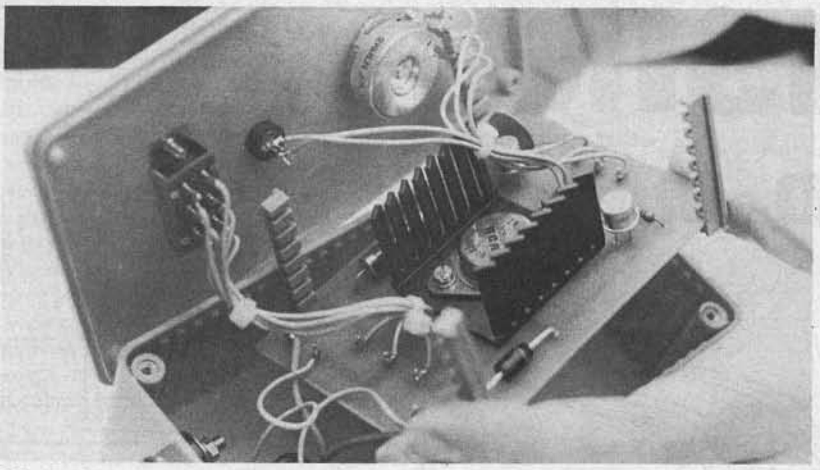


Fig 7. Note PCB guides.

meter as you slowly turn the control knob clockwise. You should find that the output starts at zero and remains zero for the first part of the pot's travel. The voltage should then rise slowly in sympathy with the rotation of the control to a maximum of about 10v at the fully clockwise position. If the fully clockwise position gives 0v and the anticlockwise position gives 10v, the pot is reversed.

With the output set to about 5v, switch to 'reverse' and see that the output voltage reverses. If the voltage has been of the wrong polarity from the start, simply reverse the switch on the panel.

When you are satisfied that the voltage can be varied smoothly, set the voltage to about 5v again and short circuit the output by 'dabbing' a piece of wire across the output terminals. A better method is to use a meter set to read 1amp or more full scale to short circuit the output. As soon as the output is shorted the LED should light to indicate that the overload circuit is operating. If the LED does not light then check that it is wired correctly and that the leads are not shorted. If a meter is used to short the output, a current of 1 to 1.3 amps should be registered.

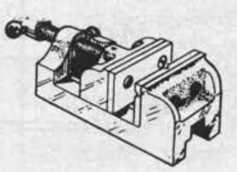
Assuming that all of these tests are satisfactory, the controller should be working correctly and can be put to use.

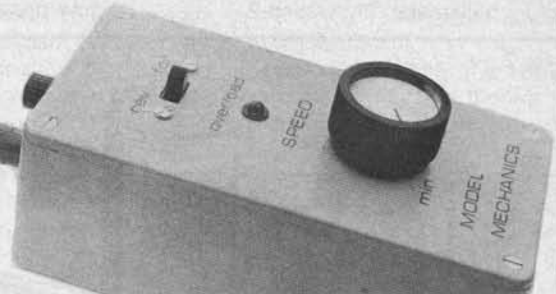
Operating Precautions

The controller can be used safely for any motor of a rating up to 1 amp. The input voltage should not be more than 2 volts higher than the motor rating and must not be higher than 20 volts.

It is quite common for model railway controllers to incorporate a 'half-waved' feature. This delivers pulses of current to the motor which often gives better control at low speeds. The half-wave feature can also be obtained from this unit by feeding it from a LOW VOLTAGE a.c. source instead of d.c. This voltage should not exceed 20 volts a.c. which will give a maximum output of about 8 volts to the motor. If you do use this type of drive you will probably find that the overload indicator glows or flickers continuously. This is because the circuit is responding to the current peaks and no damage will be done. Incidentally, it is recommended that half-wave power should not be used with the smaller motors since these tend to overheat.

IT IS VITAL TO REMEMBER THAT THIS CONTROLLER IS NOT SUITABLE FOR CONNECTION DIRECT TO THE MAINS VOLTAGE.





VAPORISING FUN by D. Moore

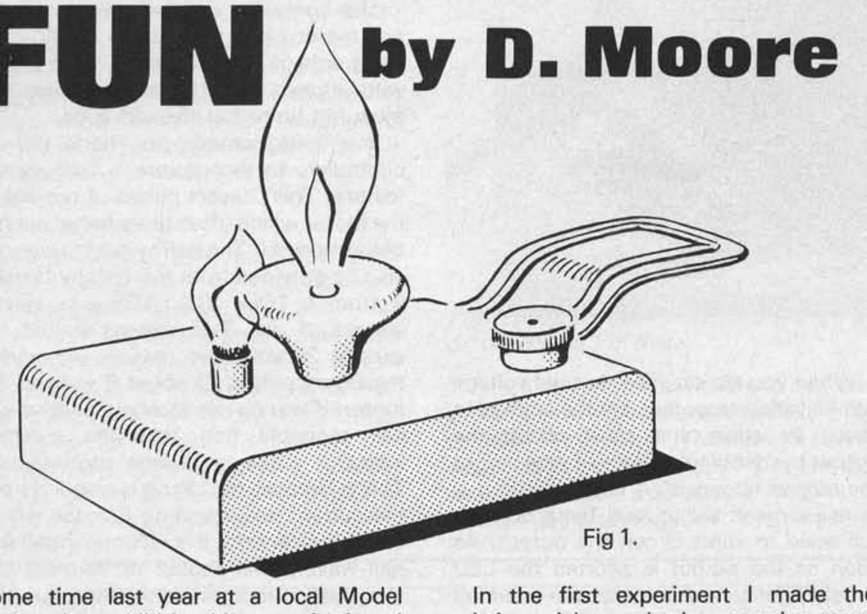


Fig 1.

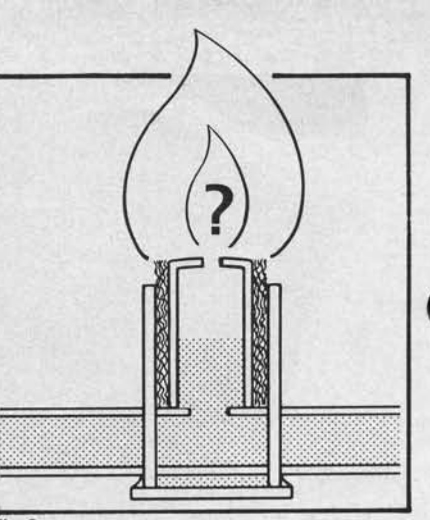


Fig 3.

Some time last year at a local Model Engineering exhibition I became intrigued by a small German toy, turn of the century hot air engine which was shown operating with that traditional and remarkable efficiency which we now seem to associate with all things Teutonic.

This engine derived its heat from a simple vaporising burner on the lines of Illustration 1.

Under the hollow tin of the "drawer knob" shape there was no doubt a second wick, probably for production ease, of the same size and shape to the visible one which did duty as a pilot wick in heating the "drawer knob" and igniting the vaporised meths fumes as they emerged from the hole in the top.

Now I possess a small marine steam plant which operates from a good old fashioned wick type burner. Two rows of four wicks in brass tubes of approximately half inch diameter. Illustration 2.

In the first experiment I made the existing wick annular by removing some of the centre and inserting a small length of tubing sealed at the top end except for a small hole. (This tubing was conveniently the end ferrule from a Bowden type motor cycle clutch cable!) Illustration 3.

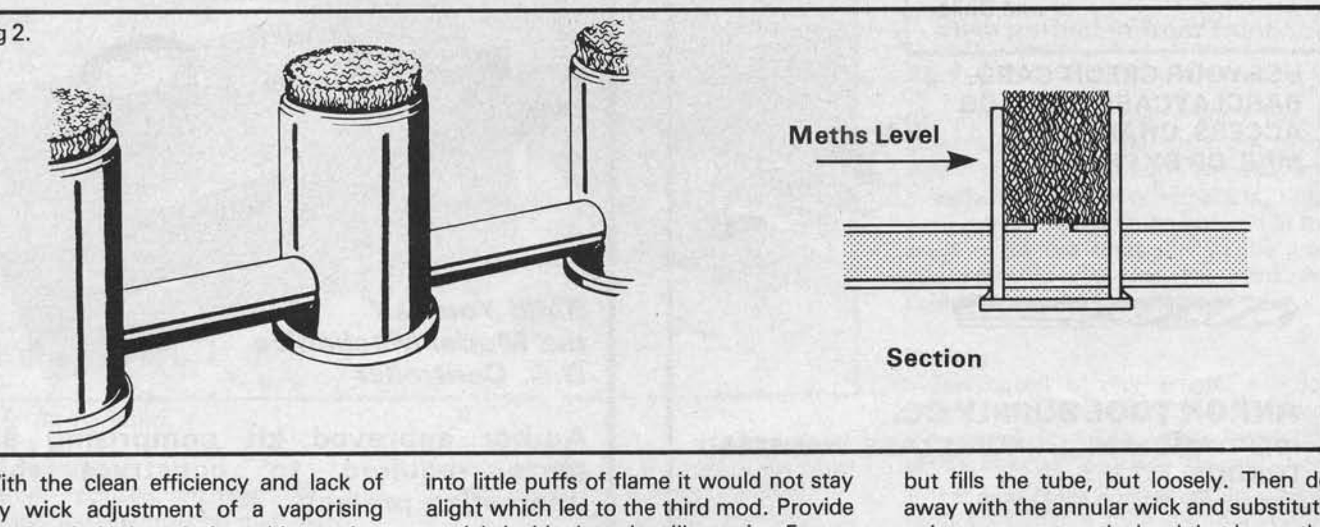
Result? Well nothing much I'm afraid. The main flame from the annular wick surround the small hole anyway, see illustration. So whether it was producing its own flame I could not tell — therefore on to experiment two. Use a small tube inserted in the wick again but with a slightly domed overlapping head silver soldered on top. Rather like a drawing pin head. This would hopefully transfer more heat to the top of the tube while at the same time spreading the annular flame away from the hole in the centre of the domed top. Illustration 4.

Result? Promising. But although it was now possible to light the vaporising hole into little puffs of flame it would not stay alight which led to the third mod. Provide a wick *inside* the tube. Illustration 5.

The breakthrough! The vaporising hole would now stay alight after a short warm up period, burning with a steady flame. The snag now was that it had to be lit because surprisingly it was just too far from the annular warm up flame to ignite from it by itself. This produced alteration number four. Seal up the top hole in the centre of the dome and instead provide four smaller holes (No. 60 Drill) spaced at 90° around the tube top and drilled immediately under the projecting "drawing pin" head and up at a slight angle matching the slope of the projection. This too worked and after an initial warm up period four flames gradually appeared, fanning out with a gentle hissing from the more subdued ring of pilot/warm up flame. Illustration 6. (In section of course only two of the four holes are visible.)

O.K. Fine. But by now as you can see things are getting rather complicated. We don't really need that warm up flame for instance. Once the four vaporised jets have appeared there is obviously ample heat; a great improvement on the old wicks. so try some more experiments. A completely wick-less version for instance that is pre-heated by a pool of burning meths until the flames duly appear? Yes even this worked but it did need a lot of heating to start up and tended to die out. So an interim. Retain and even increase the size of that centre wick so that it all but fills the tube, but loosely. Then do away with the annular wick and substitute a ring spacer at meths level that keeps the loose inner tube central. There should be enough spirit swimming around and

Fig 2.



With the clean efficiency and lack of fiddly wick adjustment of a vaporising burner in mind I thought I would see what I could do to convert my spirit lamp to this principle of operation.

pulled into radii by capillary action to provide pilot heat without a wick? Well not quite. In practice a little externally applied meths from a lighter fuel tin was necessary for a minute or two, but with an eight wick (thirty-two flame!) burner once one set of four flames had sprung into life it was simple with the lighter fuel squirter nozzle to keep a meth trail to the adjacent burner going until that obliged, and so on. By the time one was up to number six there was so much heat around that the final pair more or less fired into life on their own! Anyway illustration 7 shows the final set-up.

Well we have achieved our objective of making a vaporising burner operate from an original design that was never meant to be any such animal. Also you will notice in no way did I interfere with the original burner metal. Revert to wicks any time we feel like it; which is perhaps as well — but I'll come to that in a moment.

The head height too, vital with this type of burner remained unchanged. Snags?? There must be some? Well more trouble lighting up. Compensated for by no adjustment. Trying to get eight wicks with equal length flames. Meths consumption must have increased I suppose? The only real snag is that this vaporising burner with "wet levels" is far more sensitive to tilt. Just a degree or two and the flames in the end burners go berserk, sprouting to over an inch in length. No great danger in this case for the meths level is controlled by an efficient chick feed, but it could be a real snag with a boat. Not many designs allow this type of burner to be slid beneath the boiler while being kept perfectly horizontal. Certainly not the vessel for which this plant is one day intended. Mind you I think we could overcome that problem if necessary.

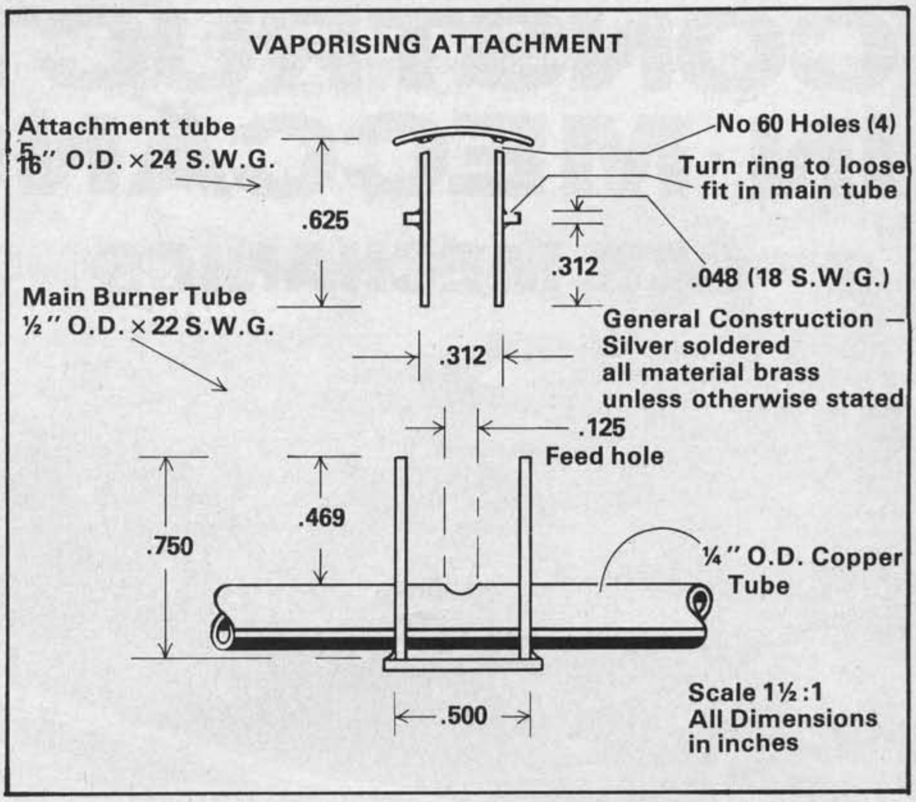


Fig 8.

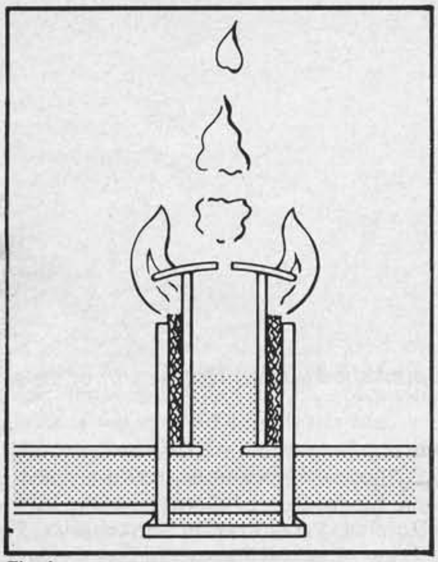


Fig 4.

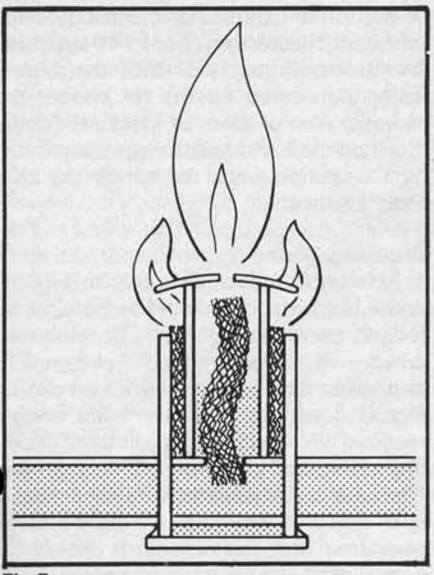


Fig 5.

So a success story with a happy ending? Well no. Not quite. Whats the problem then? The problem is too much success. i.e. Too much darned heat!! You see this boiler steamed its powerplant (a three cylinder radial engine of around $\frac{7}{16}$ in. bore) with no trouble at all with the wick burner. Now we have a roaring conflagration! Three thousand revs on the engine. Top whack. Any speed you like, and the safety valve merrily blowing. Never stops. Apply the hand pump. Doesn't worry it a bit. Running light the engine speed drops to about two thousand revs, but not for long! Remove that hissing meths bonfire and the engine runs light for about 3 minutes on stored steam. Magic! It actually works quite well and efficiently on four of the original eight burner tubes converted to vaporising with t'others blanked off! But you see, whats the point of that?

So having proved our point, back to the wicks.

Well although its theme is rather Victorian by the standards of today I thought this little tale might interest, inspire, or even help some of the readers of Model Mechanics?

Final diagram Fig 8 with the actual measurements of my burner, though of course the whole thing is absolutely wide open to experiment.

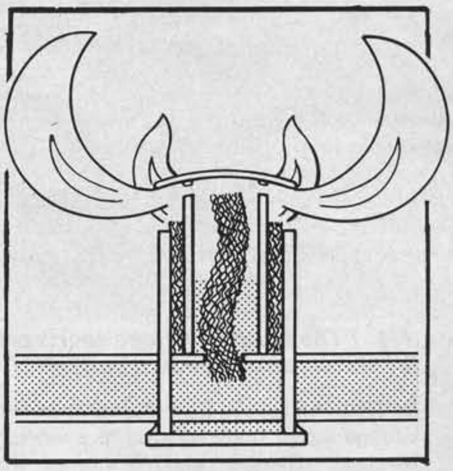


Fig 6.

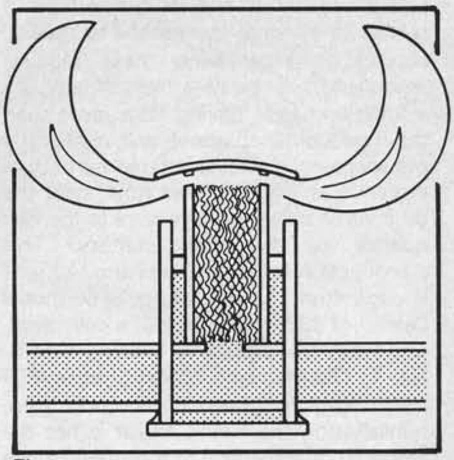


Fig 7.

CONSTRUCTION IN MECCANO

by Bert Love

CAR MECHANICS

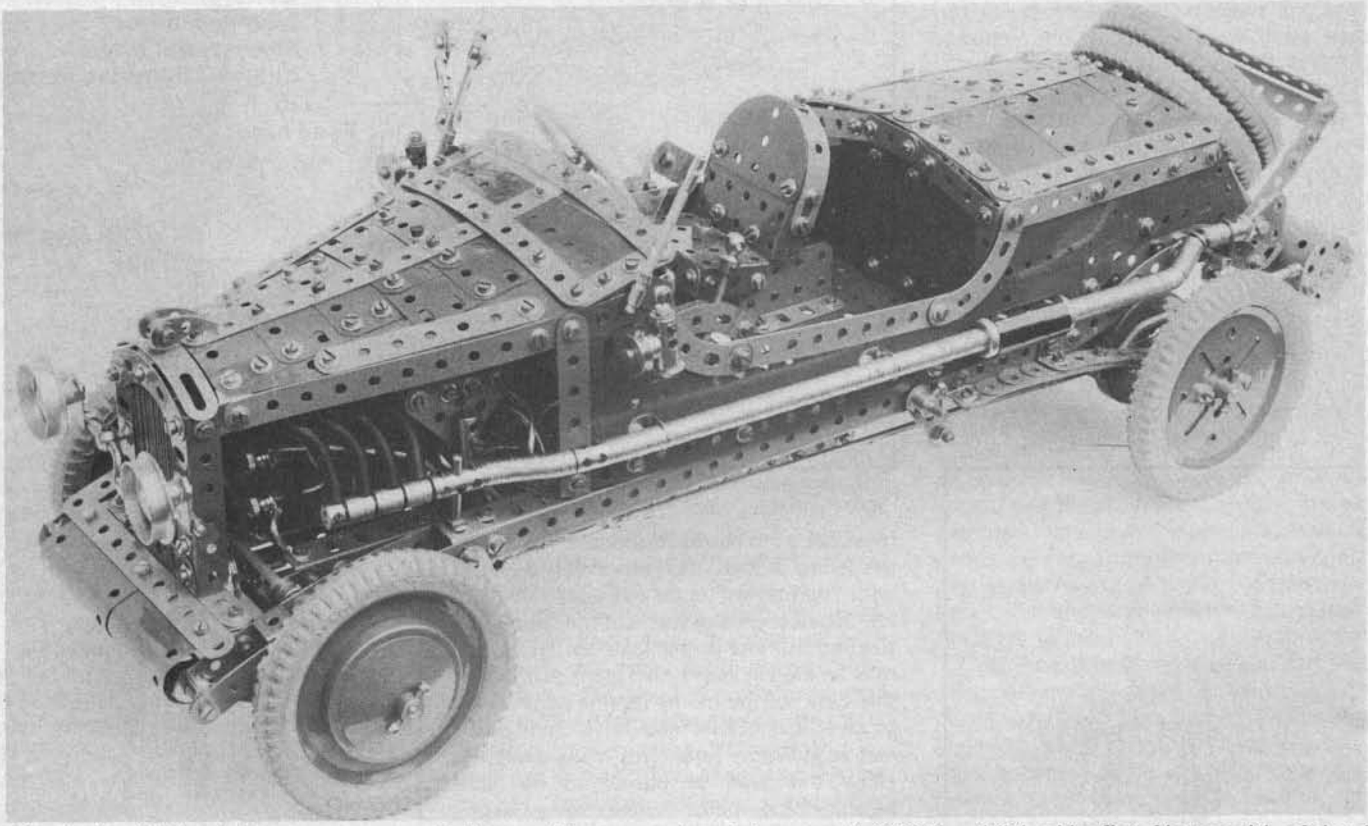


Fig. 1 The finished vintage sports car built on a Meccano chassis to an early (1927) published leaflet. Not wealth of detail by skilful use of standard parts

IN THIS ARTICLE, Bert shows us how a vintage motor body is fitted to a veteran Meccano Chassis and illustrates the basics of car mechanics in the process.

Basic requirements of a motor car are really quite few and may be summed up by providing a suitable receptacle for passengers, mounted on three or more wheels, a means to start the vehicle moving, a motor to keep it going, a steering system to alter its direction and a means of bringing the vehicle to rest. In automotive engineering these requirements used to be met, very simply, by a 'utility' chassis having little more than the needs outlined above and typified by the Meccano model illustrated here. Just a glance at Fig. 2 shows how stark the outlines of motor chassis were in the first quarter of the 20th century. This reproduction (courtesy Meccano Ltd.), of a page from the Meccano Supermodel Leaflet of 1927 in the author's collection, show the first stages of building S.M.L. No. 1, The Meccano Motor Chassis. Full instructions for the original model were published in the leaflet and it is not the intention of this article to reproduce those instructions here. However, the basic points will be covered and we will start with a brief description of the framework. Referring again to Fig. 2, side members of the chassis (1) are pairs of 12½" Angle Girders bolted in channel section and extended by parallel sets of Curved Strips at either end as shown. Leaf springs made from varying lengths of Perforated Strips are fitted to the front of the car chassis in swinging shackles made from Fishplates (3) and this form is known as "semi-elliptic" springing. Rear springs have rigid attachments to the side members of the chassis with a rear overhang and this form of springing is known as "cantilever". Such an arrangement was quite typical of the period, especially with heavier vehicles. At either end, 5½" Double Angle Strips space the chassis side members with further reinforcing at strategic points by 5½" Angle Girders as shown in Fig. 2. The 'cradle' at the rear was fitted to hold the 4 volk Meccano Accumulator of 1927 to power the original 4 volt "sideplate" Meccano Electric Motor of the same period. Internal expanding brakes for the rear wheels were also fitted in this early model and may be seen in Fig. 2. They were very crude, however, relying on the bosses of Cranks sliding in the slots of Faceplates to rub against the inside of Wheel Flanges bolted to the 3" Pulleys with Tyres, acting as road wheels. A 2½" Strip (38) was connected by a pair of Loom Healds to a Crank (41) operated by the handbrake lever (43), the system being duplicated on the far side of the chassis. A small piece of Meccano Spring Cord on the brake 'pads' kept them in the "off" position when the handbrake lever was released.

Steering Gear

Reference should be made to Figs. 3 and 4 from which it should be possible to follow the steering gear construction which is based on Ackermann's principles. Although the arrangement of Fig. 3 does not give the exact angles required in the steering links it does provide a good compromise. Each part in Figs. 3 and 4 is labelled with its Meccano part No. and assembly should be quite clear from the illustrations. It should be noted that Fig. 3 shows dotted lines

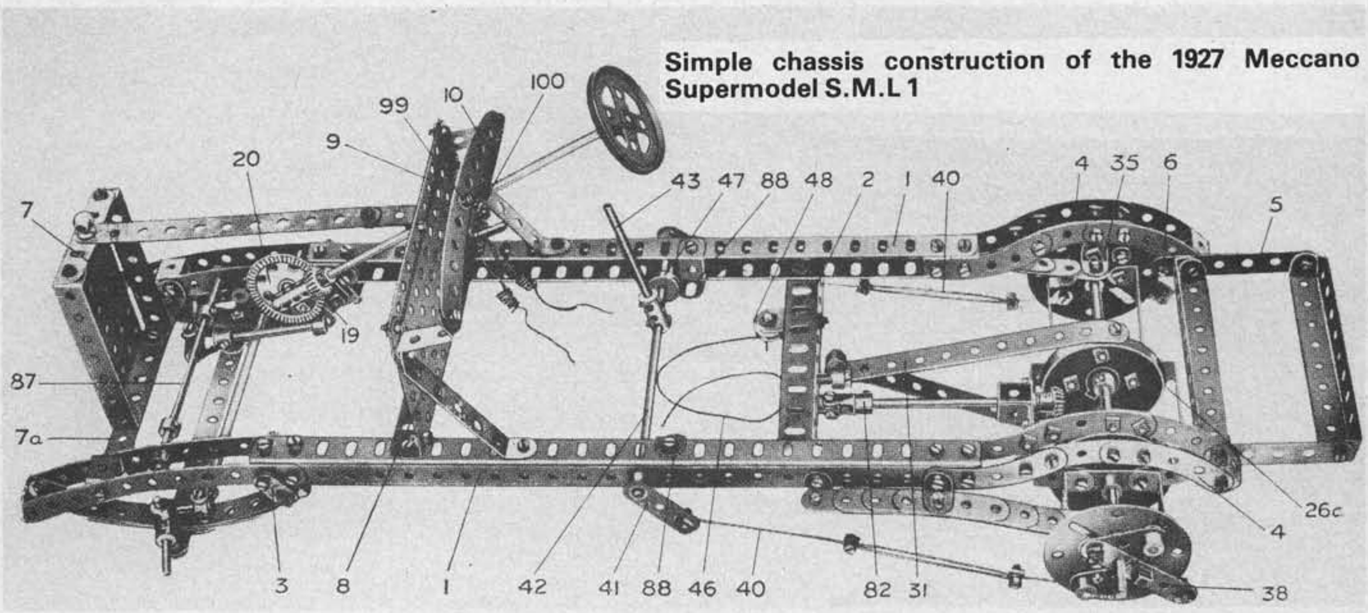


Fig. 2 Bare outline of the Meccano chassis for Supermodel No. 1 "The Meccano Motor Chassis," circa 1927. Note internal expanding brakes on rear axle .

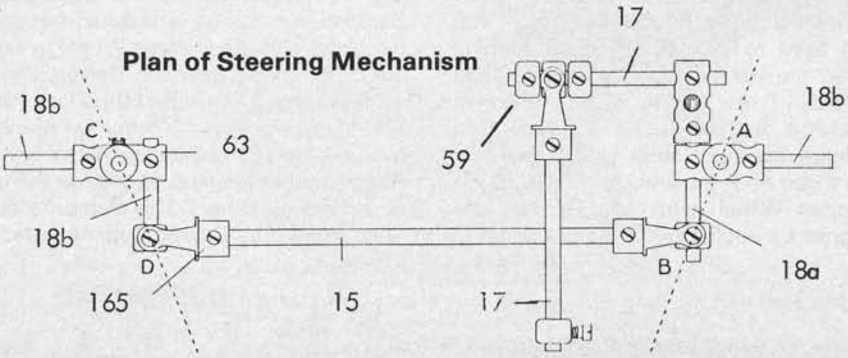
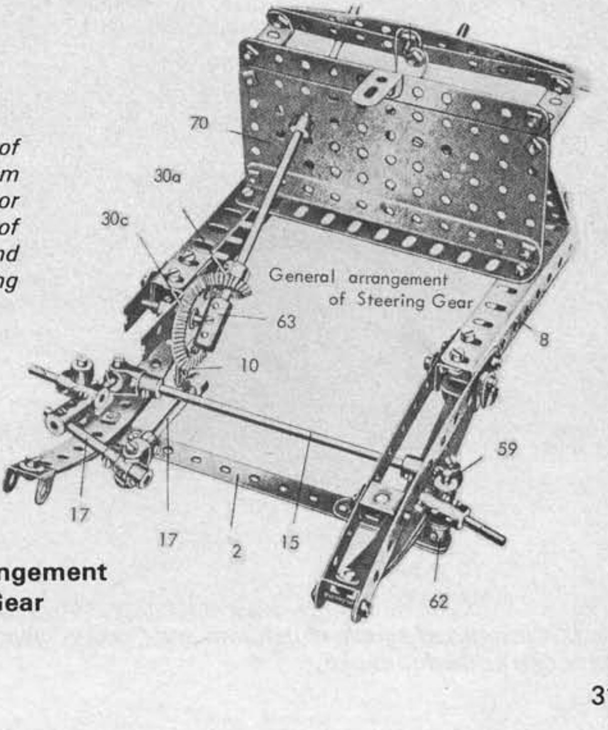


Fig. 3 Left Ackermann principle steering geometry simulated in Meccano parts. Lines A...B and C...D show effective angle of the steering arms

running through points A. . .B and C. . .D and these are effectively the geometric lines of the steering arms in this Meccano model. Even if this portion only of the model is constructed it will be shown, on fitting the stub axles (18b) with road wheels that one wheel will steer through a greater steering angle than the other. It is, in fact, the wheel on the 'inside' of the car's turning circle which has to make a sharper turn to negotiate the smaller radius of turn and these principles are fully explained in various motor engineering manuals and in the author's book "Meccano Constructor's Guide". Fig. 4 shows the actual Meccano construction where the front axle is made from a pair of 5½" Strips to make a double thickness and reinforced with 2½" Strips at each end which carry Cranks at either end, the bosses of which form journals for the vertical 1½" Axle Rods acting as "Kingpins" for the steering. The two 2" Rods (17) form the drag links to the bevel gears (30a and 30c) but the brassware used permits swivelling of the Swivel Bearing (165) so that this drag link drops clear below the tie-rod (15). This tie-rod (known as the track rod) is fixed to the steering arms at each end by further Swivel Bearings. A short Axle Rod on

Fig. 4 Cut-away view of the steering mechanism on The Meccano Motor Chassis with details of drop-arm, drag-link and front semi-elliptic spring suspension .



General arrangement of Steering Gear

which the large Bevel Gear rotates freely, is journalled in the parallel 5½" curved Strips forming the chassis front members and a Coupling (63) is locked on the inside end of the Rod by a Grub Screw through its centre hole. The Coupling should be adjusted so that the small Bevel meshes smoothly with its partner.

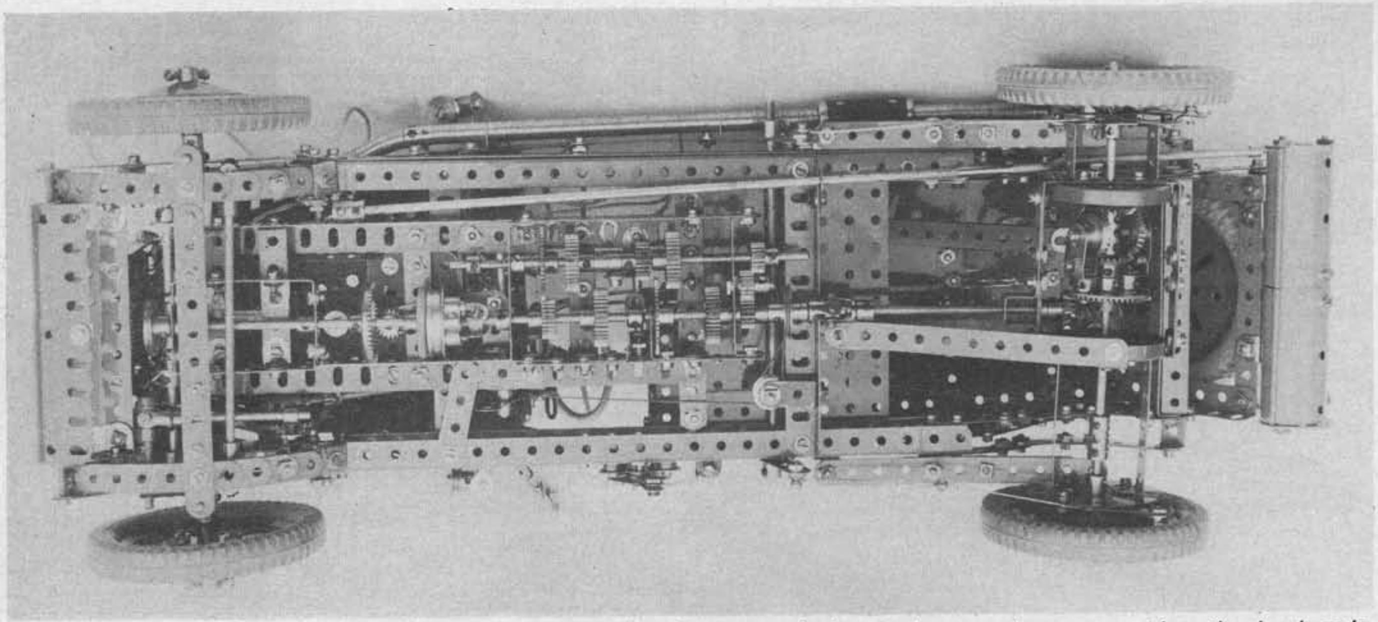


Fig. 5. General view from below the chassis showing the transmission and toque bars supporting the back axle differential box.

Transmission

Drive to the road wheels of a motor car comprising all the mechanical links from the engine is known as the transmission which is a simple "in-line" arrangement in the model and basically identical to that found in modern production cars with rear wheel drive. Fig. 5 shows the complete transmission from below and a close-up of the clutch and gear-box is seen in Fig. 6. A friction clutch is made from a 1 in. Pulley fitted with a rubber ring and fixed to the take-off shaft running below the electric motor. For the sliding section of the clutch, a large Flanged Wheel is free on a 3½ in. Axle Rod forming the input shaft to the gear-box but a pair of ½ in. Brackets bolted to the Flanged Wheel with collar spacers are trapped by Set Screws in a Collar fixed to the Axle Rod. One half of a meccano Compression Spring is inserted between the Collar and the Flanged Wheel to keep the clutch in engagement. Declutching is achieved by a 2 in. Slotted Strip (see Page 204, May 1979 Model Mechanics) running over the top of the Flanged Wheel with a Bolt locked in the strip to engage the rim of the Flange Wheel. The clutch pedal is fitted to a 2½ in. Curved Strip mounted in

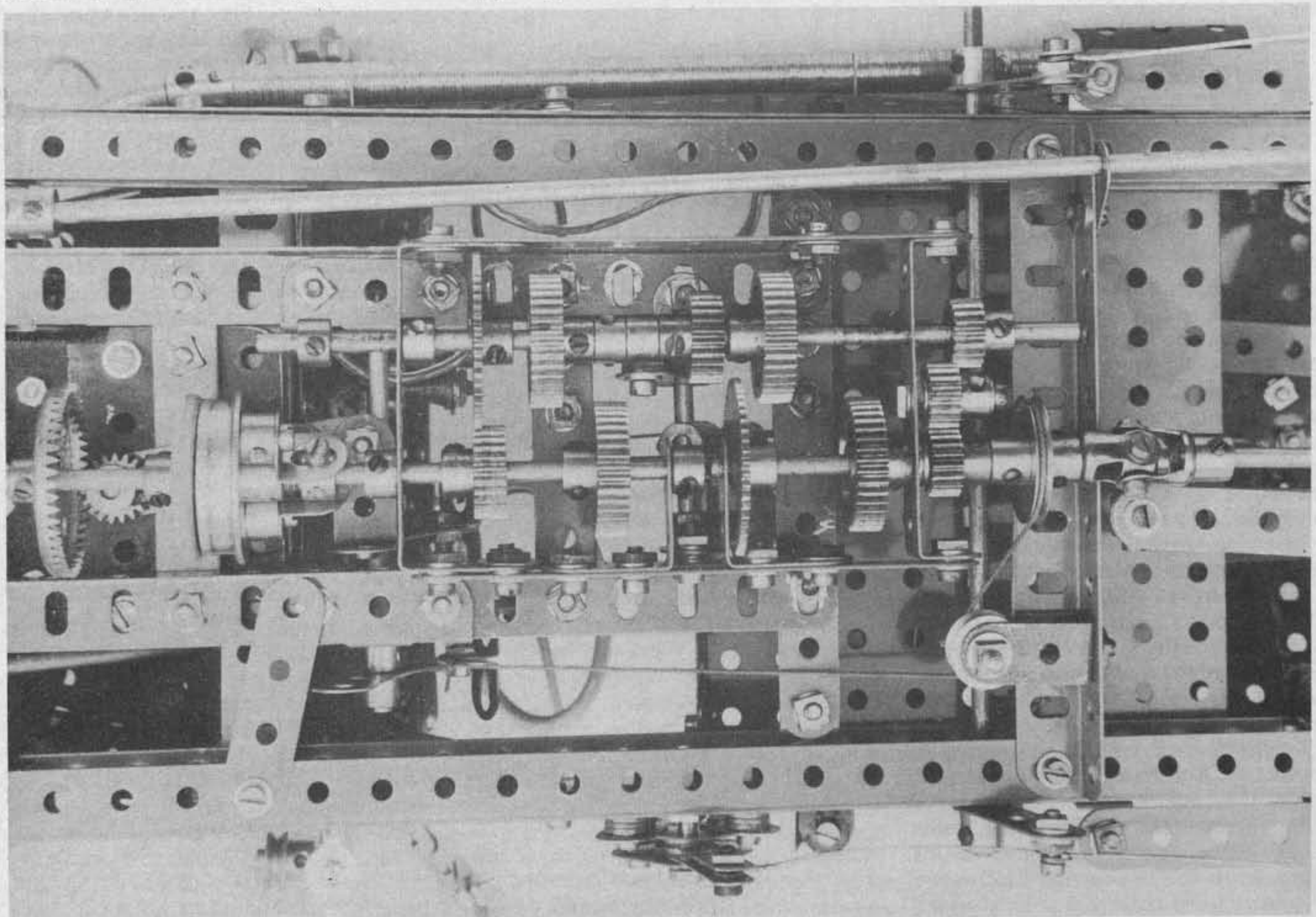


Fig. 6. Close-up of simple clutch unit and "crash" gear-box. Note pulley and cord on transmission shaft connected to and acting as the footbrake.

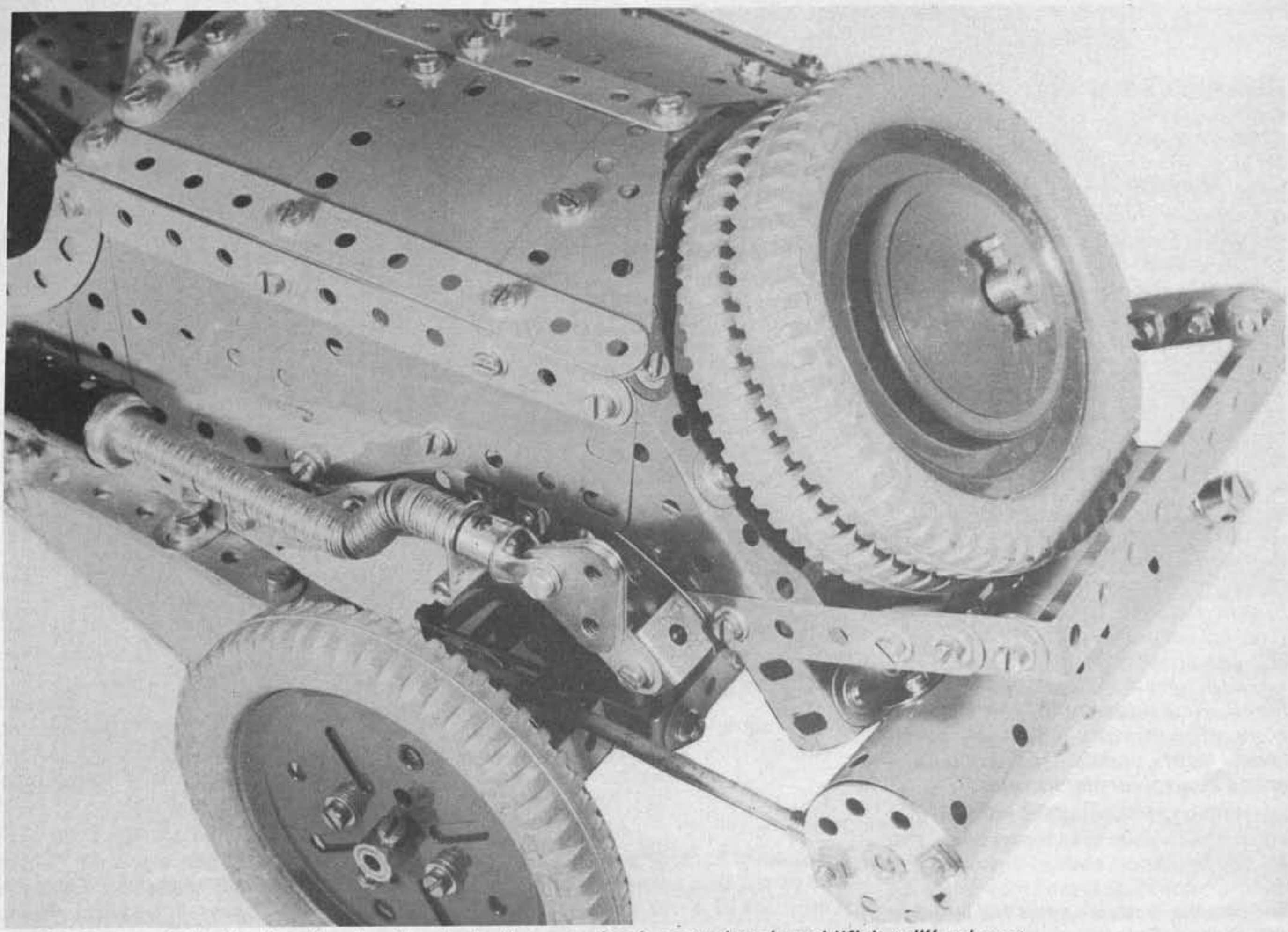


Fig. 7. Rear end details showing double stacked spare wheels, petrol tank and "fish-tail" exhaust.

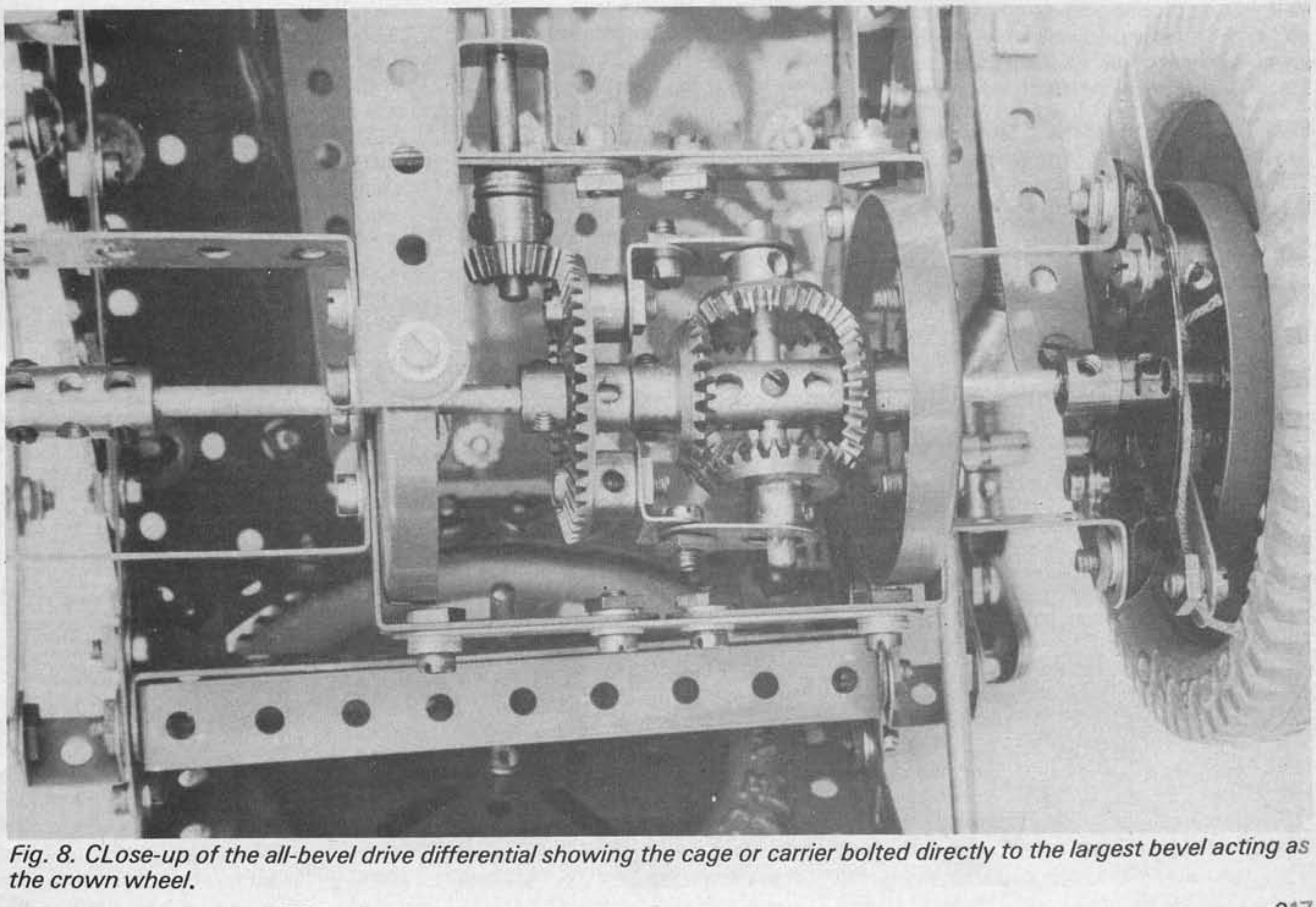


Fig. 8. CLose-up of the all-bevel drive differential showing the cage or carrier bolted directly to the largest bevel acting as the crown wheel.

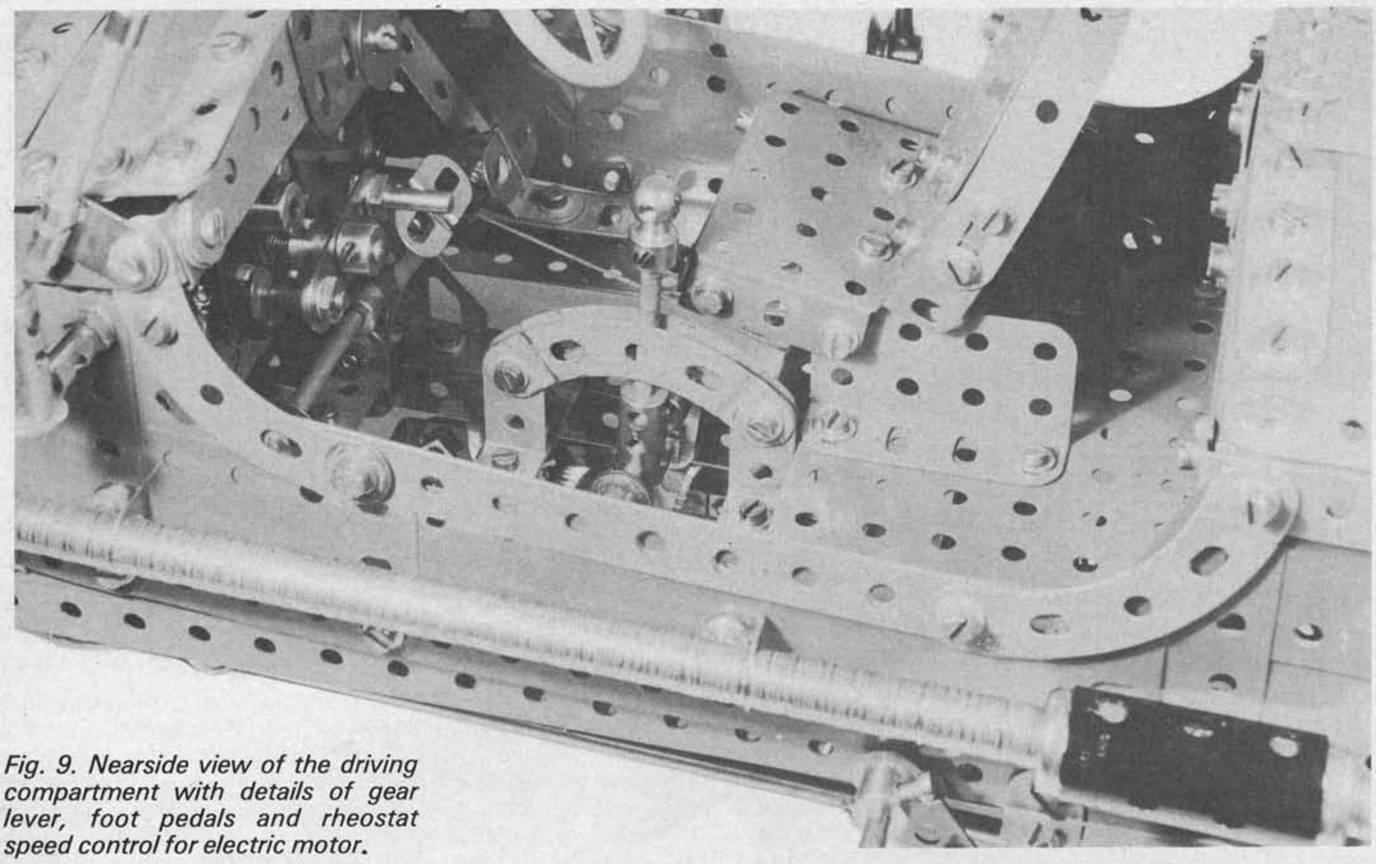
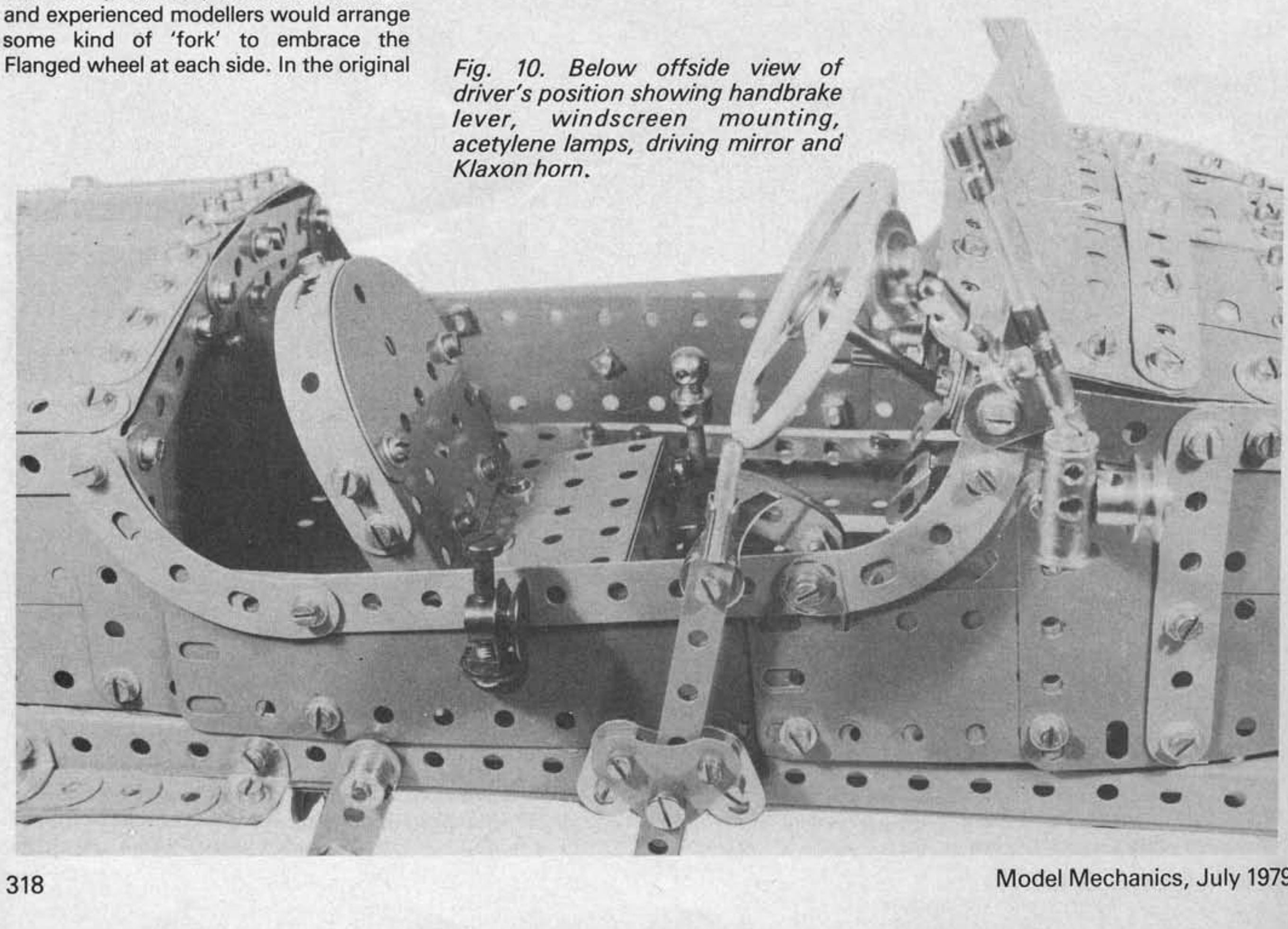


Fig. 9. Nearside view of the driving compartment with details of gear lever, foot pedals and rheostat speed control for electric motor.

line with the footbrake pedal and linked to the Slotted Strip by a 1 in. × ½ in. Bracket lock-nutted as shown in Fig. 6. This is a particularly crude construction and experienced modellers would arrange some kind of 'fork' to embrace the Flanged wheel at each side. In the original

Fig. 10. Below offside view of driver's position showing handbrake lever, windscreen mounting, acetylene lamps, driving mirror and Klaxon horn.



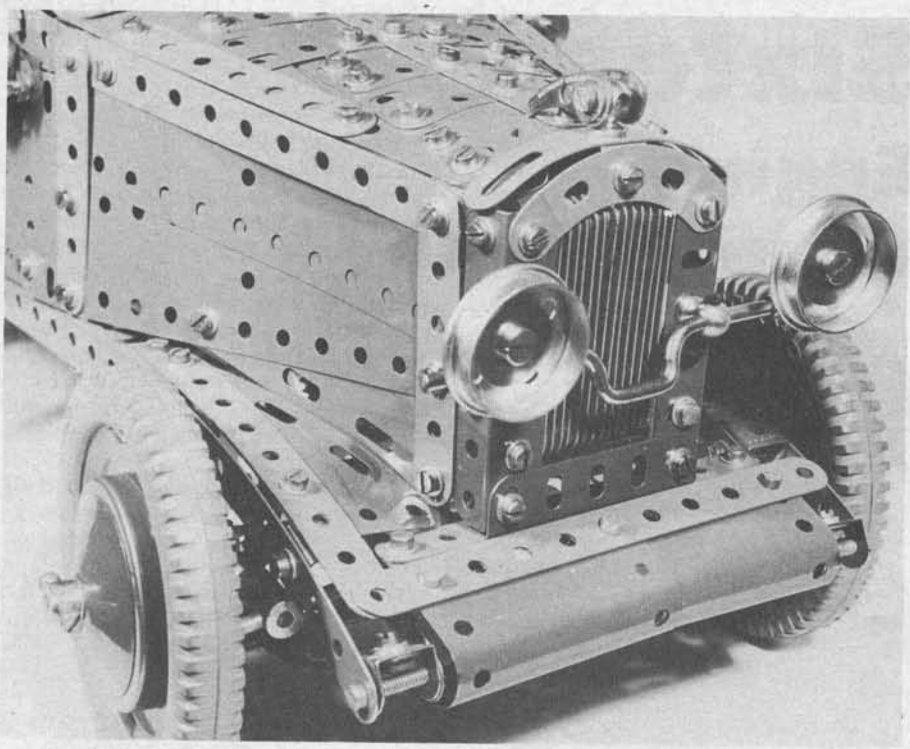


Fig. 11. Details of frontal bodywork. Note headlamps and badge bar, "winged" mascot and radiator grille reproduced in stacked 2½" Strips separated by Washers on 2 in. Screwed Rods.

model, the slot of the special 2 in. Strip rides on a bolt shank secured to a cross-chassis member.

Where gear changing is effected by sliding gears in and out of mesh, the arrangement is known as a "crash" gear-box and this is typified in the model. Modern cars have their gears in constant mesh and gear changing is carried out by sliding 'dogs' on splined shafts and it is quite an easy matter to design a four-speed and reverse gear-box in standard meccano parts with synchromesh operation. However, in our simple model, the 3½ in. input shaft runs only half way through the gear-box. It carries a 25 tooth Pinion followed by a 1 in. Gear (38 teeth). Running parallel to the input shaft is a 6½ in. Axle Rod known as the layshaft and this is free to slide backwards and forwards over a range of about one inch. It carries three Collars at approximate mid way along, two of these being fixed and sandwiching the third collar which is free on the shaft but has several turns of a standard bolt screwed into its tapped bore. This bolt is then lock-nutted to the Collar and the shank rides in the slot of a Meccano crank attached to the gear lever cross-rod. On the layshaft, from front to rear, is a 50 tooth Gear Wheel, a 1 in. Gear Wheel followed by a 25 tooth Pinion and another 1 in. Gear Wheel. Finally, a 19 tooth Pinion is fixed to the rear end of the layshaft as part of the reversing train as shown in Fig. 6. Using a ¾ in. bolt, a second 19 tooth Pinion is fixed as a reversing "idler" to the rear of the gear-box framework. An output shaft for the gear-box is a 3 in. Axle Rod set up in line with the input shaft (both of these shafts are supported inside the gear-box by 1 in. × 1 in. Brackets). Fixed to the output shaft is a 50 tooth Gear Wheel, then a 1 in. Gear Wheel and outside is a third 19t Pinion to complete the reversing train. One peculiar aspect of this gear-box is the Pulley and cord brake fitted just before the universal coupling on the propeller or "Cardan" shaft and this form of Cardan shaft brake was commonly fitted to motor vehicles in the early part of this century. In fact, the powerful 'inboard' brakes fitted on some Formula 1 Grand Prix racing cars to-day are a development of the Cardan shaft pulley and strap brake. Fig. 6 shows the gear-box engaged in reverse gear with only the first pair of gears and the reversing pinions in mesh so that we have a simple 2:1 reduction ratio through the box. By moving the gear lever one 'notch' forward, both sets of 25 tooth Pinions and 50 Tooth Gear Wheels engage giving a 2:1 × 2:1 or 4:1 overall reduction providing "first gear" (forward). Further movement of the lever will put the first pair of 1 in. Gears in mesh (ratio 1:1) but leave the second pair of 25 tooth Pinion and 50 tooth Gear in mesh providing "second gear" with an overall ratio (reduction) of 2:1. Third gear (Top gear) is selected by pushing the gear lever fully forward when all four 1 in. Gear wheels will be in mesh giving a 'straight' drive, i.e. no reduction, right through the gear-box. This design would not score many marks for design, efficiency, operation or selection of gear ratios to-day but in 1927 this model was really the "Cat's whiskers" and was often displayed in leading toy shops to the admiration of thousands of enthusiasts of the time. Its appeal to-day is largely one of nostalgia.

The final stages of the transmission requires a variable drive to the individual back wheels to permit them to rotate at different speeds when the car is cornering. Obviously the 'outside' wheel must travel faster than the 'inside' one as it has a longer arc to cover in the same time. To provide this "difference" of speed a "differential" gear is provided in the model and is clearly shown in Fig. 8. Each road wheel is fixed to its own separate axle known as "half shafts" and these meet in the middle of the differential gear. A Coupling is used as a centre journal for the half shafts in the model and it has a 2 in. Rod locked through its central cross-bore on which the free running bevel gears are carried. The largest bevel gear in Fig. 8 is known as the "crown" wheel which receives the direct drive from the transmission via the small bevel and the crown wheel is free to revolve on one of the half shafts. Its job is to rotate the "cage" or "carrier" inside the differential box and it is the cage which provides the differential speeds to the two half shafts as the car turns a corner. It is much easier to build and to experiment with a differential gear than it is to describe one in theory but differential gears as a whole have such a wide range of applications outside motor cars and are so easily constructed in Meccano parts that they will be dealt with separately in a later article. Construction is clear from Fig. 8 but it should be noted that only the small bevel gear on the transmission shaft and the two medium bevels on the inside of the half shafts are fixed, the other bevels being free to revolve on their rods.

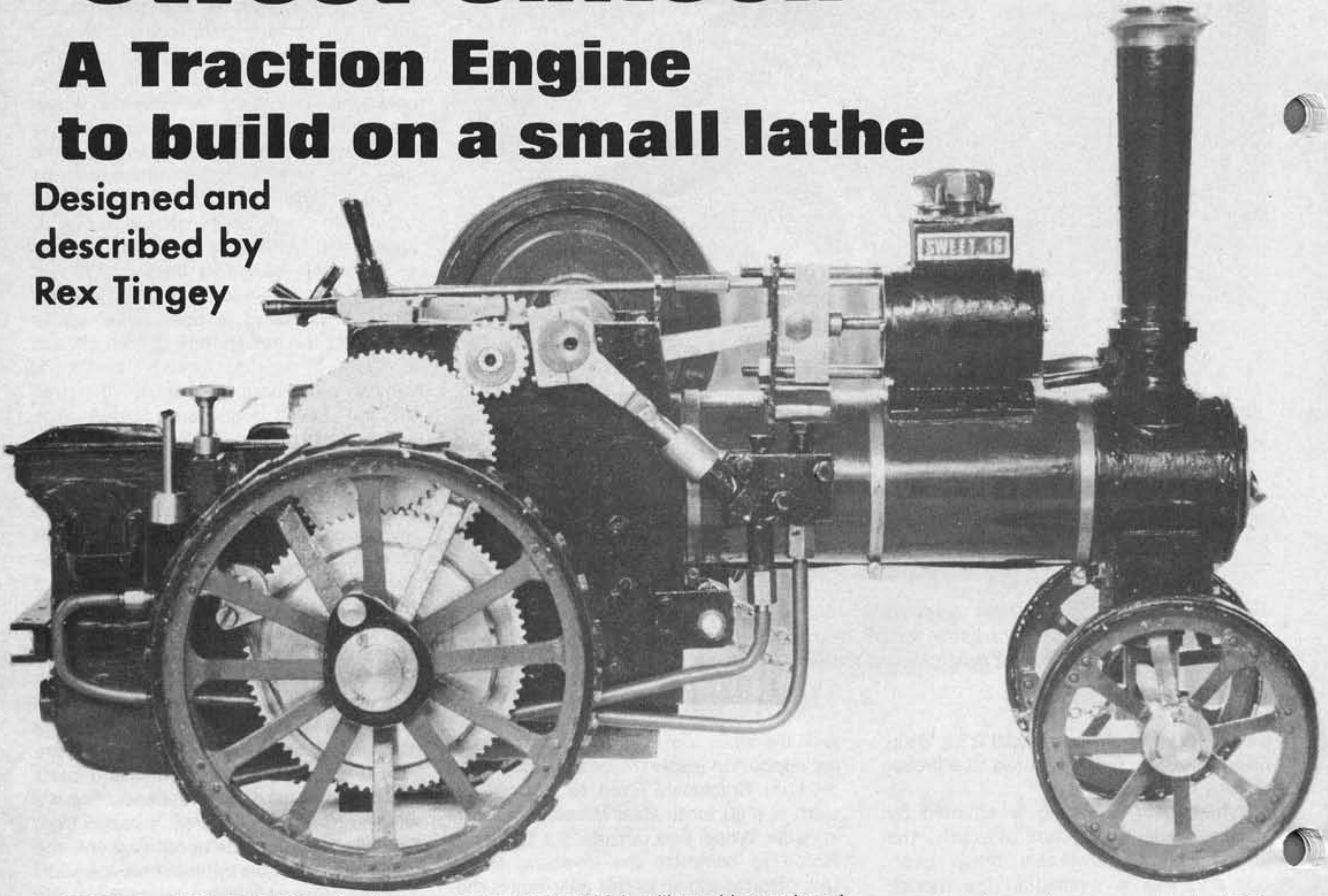
Bodywork

Enhancing this veteran chassis with vintage bodywork is the result of the skill and enthusiasm of Roger Lloyd, a quantity surveyor of Solihull who produced the "Grand tourer" appearance to the model forty five years after the bare design of the chassis leaflet. It is entirely freelance but reproduced here just to show the enthusiast how modern (Flexible Plates) parts can be expertly combined with the more limited range available in the 20's. A handful of 2½ in. × 1½ in. Flexible Plates cover much of the bonnet work, 2½ in. square Flexible Plates and associated Triangular Plates filling in at front and rear. Details such as exhaust pipes, lamps, brake lever, Claxon horn, windscreen and driving mirror are all made from standard parts as illustrated in Figs. 9, 10 and 11 but "dressing up" the model is wide open to the adventurous enthusiast. Readers who have no parts list for reference or wish to know the address of the nearest Meccano stockist may write directly to the author at the address below but should include a stamped addressed envelope with any enquiry. B. N. Love, 61 Southam Road, Birmingham B28 8DQ.

'Sweet Sixteen'

A Traction Engine to build on a small lathe

Designed and described by Rex Tingey



I STARTED THE DESIGN of *Sweet Sixteen* in 1976, making it all on the Unimat SL. Every part presented something of a challenge and lead towards most of the modifications and improvements which I have made to the Unimat. It was for this traction engine that a new type of valveless engine was designed with the consideration that formal valve gear might be difficult in this small size. All this took time, time over and above the work of completing the Engine itself, which was finished early in 1978. However, that design was spirit-fired and proved messy and perhaps a little dangerous as spilt spirit is not easily seen. The rear end has now been redesigned and firing is by butane gas, which has proved to be very reliable, clean and easy to handle, besides being safe.

All the parts of the engine are to be made, apart from the steering chain and the pressure gauge; the gear wheels are self-cut, using techniques fully described in my book "Making the Most of the Unimat".* The scale chosen is 16mm to the foot, hence the name *Sweet Sixteen*. In this scale a maximum rear wheel diameter of 4 in. is required, and this scale be reasonably machined on either model Unimat using one of my modifications. Reeves can supply alloy castings for the rear wheels which will machine to just 4 in. with care, (order *Minnie* front wheel castings), thus avoiding the long chore of turning wheels from solid—a long job on the Unimat.

Sweet Sixteen is a freelance design, and has most of the features of the full-size engine, but it dispenses with valve-gear and eccentrics, using a "valveless" engine with a self-acting shuttle valve system. The crankshaft is of the counterbalanced type with webs, not at all like the old hammer-forged jobs really fitted; you may make one if you wish! The boiler is a simple stayless design a little slimmer than is usual, but with the pads for the motion and engine saddle on the outside, and after lagging and sheeting around, the boiler is about scale size, with a slender teenage look. The "backhead" has water space, but the sides and front are solid copper, the double layer at the sides making the hornplate fitting very simple. This set-up is not suitable for coal firing, where it is necessary to have a water space all round, but with a tank-full of butane in the tender there is enough fuel for around 25 minutes running. I have had this engine running for 32 minutes at one time, which is rather longer than the small lubricator can provide oil for.

The engine is designed to be made cheaply and simply. A one foot length of copper tube and a square foot of 16-gauge copper will make two of these boilers with some to spare. Parts are generally made from block. For example, the feed pump is a brass block with inserted fittings: this means that the clacks can be made and tested before inserting, Loctiting them into place. Bearings for the moving parts are nearly all phosphor bronze, but just simple cylinders of the bearing metal inserted into metals easier to work, usually duralumin. The smokebox can be made from tube $\frac{1}{8}$ in. larger than the boiler, or can be of the same diameter as the boiler, split and rivetted to the brass rings before filling the gap and silver soldering. The chimney is taper-turned from duralumin, with a row of false rivets, but the inside is step-drilled, and the chimney top is turned from brass rod.

The front wheels are turned from solid dural stock, and the rear wheels from the castings. The strakes and spokes are of mild steel, all rivetted up with round hubs to be hard soldered. On the rear wheels oval hub plates are fitted either side to make them appear correct, and pretty little brass hub caps are fitted, turned from solid. The tender is rivetted together from brass sheet, with a water tank Comsol-soldered in place, and the fuel tank sliding underneath presenting the fuelling valve at the rear end. The engine unit is the same as the one previously described in *Model Engineer* but modified with a saddle and steam dome, the exhaust being taken from the front directly into the chimney saddle. The motion work is mainly of mild steel, and the drive and change gears are cut from aluminium alloy. All of this is to be fully described in the course of construction.

The boiler, by the way, has only three fire tubes and, so that water can readily circulate from the rather isolated backhead space, two small diameter syphon tubes are fitted through the firebox, assisting the heating-up operation considerably.

The Order of Construction

With my designs I try to determine the order of construction first by fabrication variations which may occur and alter positionings, secondly by the way interest must be kept alive, and finally by the sheer thought of the slogging necessary to get the thing constructed.

1. First make the boiler as everything has to fit around this, and pressure test, hydraulically.
2. Cut the gears so that the hornplates may be marked out to fit the bearing in the right places, make the hornplates.
3. Make the smokebox, chimney and boiler fittings.
4. Construct the engine unit, saddles, flywheel and crankshaft, fit them so that a test run can be carried out and the engine be seen to work.
5. Make the tender, boiler feed pump and by-pass valve, and with the gas burner make a further, self-contained, run to see the pump working.
6. Make and fit the wheels and axles, stand back and look at the lovely job. Lag, sheet, and paint the boiler and smokebox.
7. Fit all the spindles, change and running gears, plates, steering, winding and brake gear. Dismantle to finish everything and paint before final reassembly.
8. Complete a trial run on steam, taking care not to burn off all the paint.

Sweet Sixteen is fun to make and to run, is unique in design and quite simple in construction, giving many pleasant hours of soothing work on the Unimat machine, as well as the usual frustrations of fitting and fretting. It can be made on other small lathes as well, of course, as long as they can swing at least 4 in. So now to work.

Sweet Sixteen. Specifications

Length: 12 in.
Width: 6 in.
Height: 7.9 in.
Rear Wheels: 4.1 in. diameter
Front Wheels: 2.6 in. diameter
Wheel base: 7½ in.
Engine: Single cylinder, double-acting, ½ in. bore × 0.6 in. stroke.
Flywheel: 3 in. diameter
Boiler: 1½ in. diameter. 3 × $\frac{3}{8}$ in. firetubes and 2 × $\frac{3}{16}$ in. syphon tubes. Butane fired.
Working Pressure: 40 psi
Gears: low ratio, 15.6:1; High ratio 9.75:1.

The Boiler

Cut the length for the boiler shell, making the ends nice and square, checking with an engineer's square. Use a 32 tpi blade in the hacksaw frame for this job. Cut out the other pieces using 10 in. general purpose snips from a sheet of 16 gauge copper, following the economy cutting guide; do not worry about bends and buckles at this stage. Copper marks out very easily for this work with a sharp scriber, a 6 in. rule and small, spring dividers. Cut the firetubes from $\frac{3}{8}$ in. O.D. copper tube, 29 S.W.G., and the syphon tubes from $\frac{3}{16}$ in. O.D. × 22 S.W.G. With all the pieces cut place them on the brazing hearth and, one by one, heat them up and then dunk them in a pickle bath, picking them up with a pair of old combination pliers. This both anneals and cleans the copper.

The pickle bath should be around 3 per cent sulphuric acid (add the *acid to the water* when mixing from concentrated) and can be used in a plastic bucket for all the pickling work with small boilers: the sides of the bucket help to contain any splashing. Always rinse the hands, the pliers and the work before proceeding. A pickle bath can be safely stored after use in a plastic jerrycan, and will continue to perform its function even when quite a deep blue colour.

With the copper annealed, the parts requiring a flange will need working on before any holes are cut. For the smokebox tubeplate, use a piece of 1¼ in. diameter aluminium alloy as a former, turning the end of the former square in the lathe. For small boilers all flanging can be carried out over formers held in the small vice using a medium weight ball-pein hammer. For rounded edges use softer alloy formers, and for hard straight edges use 90 degree mild steel edges. 16 gauge copper can stand the filing off of small buckles and roughnesses.

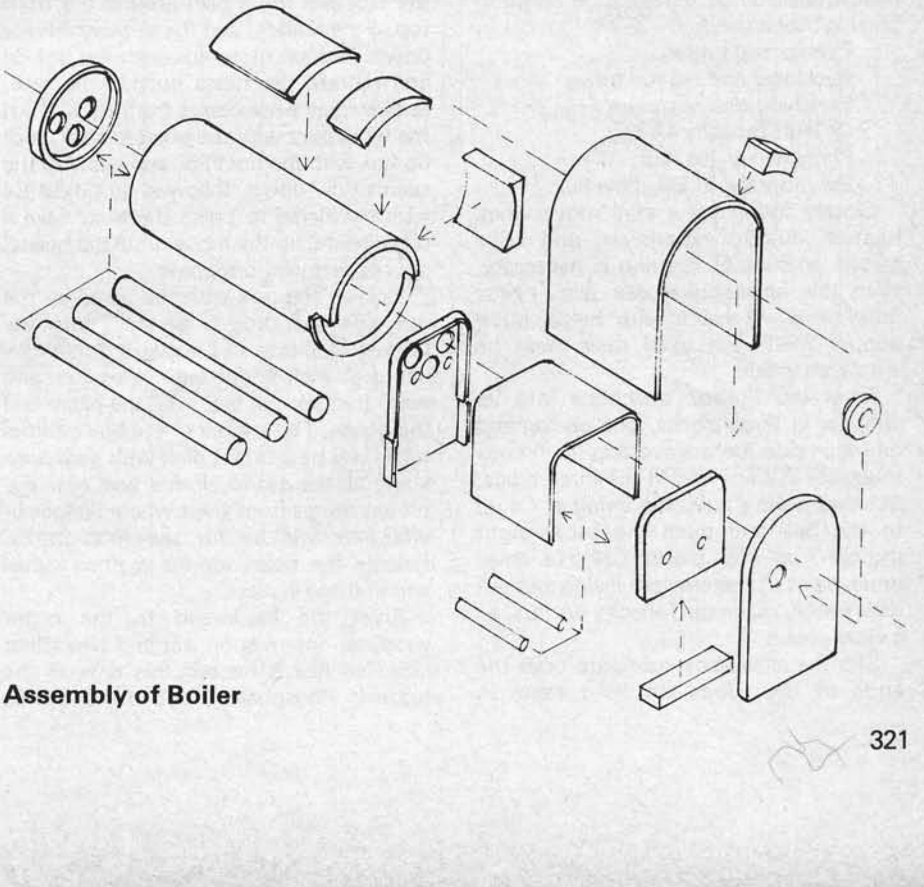
Flange the firebox back, using a piece of round mild steel at the corners. Fold the firebox wrapper around the firebox back and use the wrapper as a guide when flanging the firebox tubeplate; it has a step in its flange, either side, to come level with the firebox wrapper and provide a flat surface for the outer wrapper. If any flanging becomes difficult re-anneal the copper.

The backhead top can be flanged on the 1¼ in. former, or a 1$\frac{3}{8}$ in. diameter more easily used, here, bending the sides down to right angles when the round flange is halfway made, then finishing the round flange right down. The bottom of the box comes down a little too far at present, and will require cutting away, eventually, but this makes a good strong job with room for a little error. Do not flange the boiler barrel at this stage.

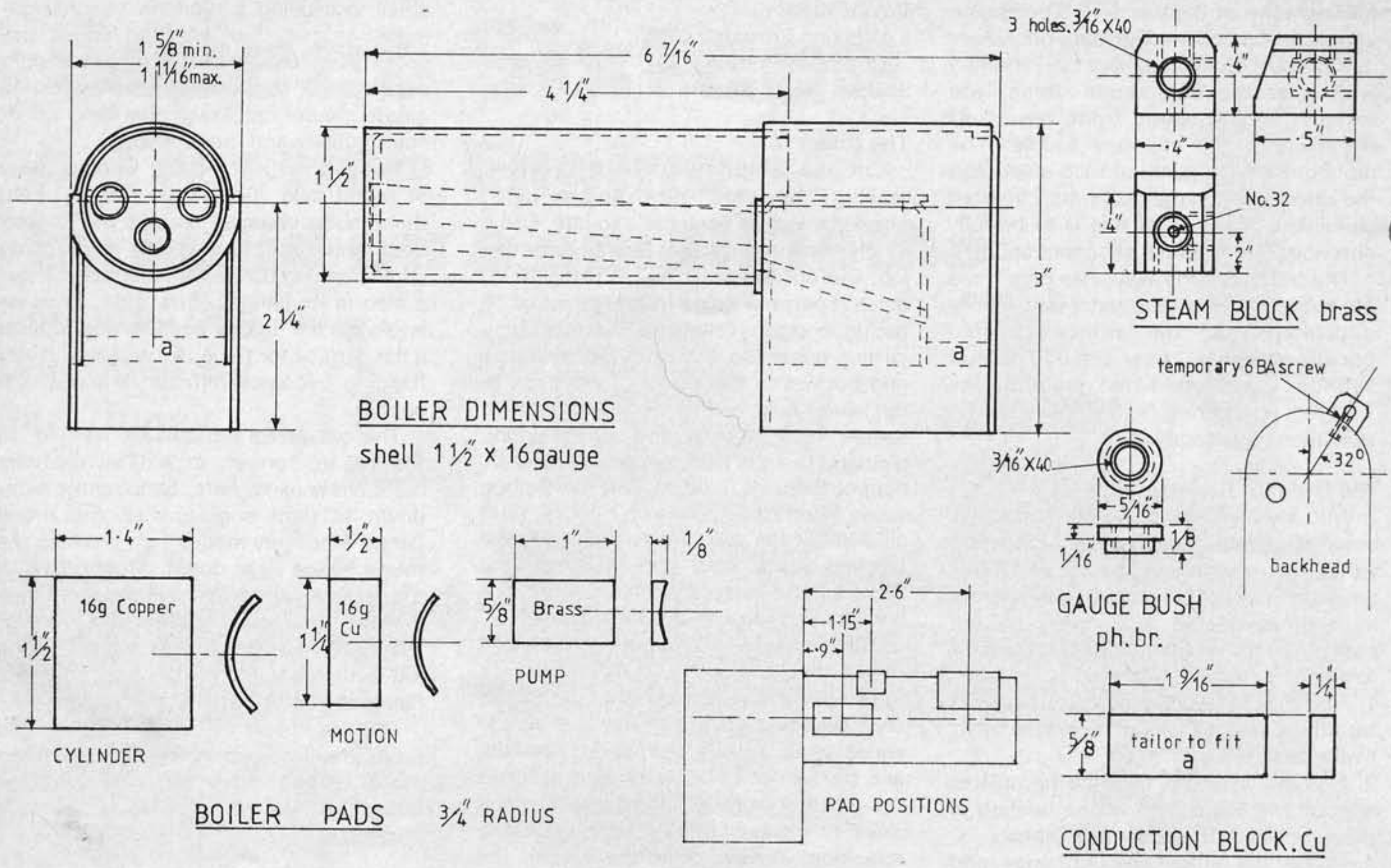
Drill out the plates for the firetubes and syphon tubes, remember that the tubes rise a little in the boiler, and make the holes for the syphon tubes a little undersize.

Safety First

When brazing a boiler indoors have plenty of fresh air circulating, and avoid breathing fumes of flux. If the hearth is of asbestos use only pure white asbestos sheet, as used in fire doors, and *not* cement/asbestos sheet as used in wall and roof sheeting as this will certainly explode when heated. Do not strip off to braze, and wear shoes, long trousers and a shirt with sleeves. Keep tools off the hearth where they can be heated up without noticing. Avoid working in bright



Assembly of Boiler



Boiler

sunlight where flame cannot be seen or red-heat readily observed. Wash off flux and pickle splashes from the skin immediately.

Brazing

For small boilers a blowtorch using butane from a standard 10 lb. blue cylinder is sufficient. As the job gets bigger the increasing mass of copper makes the brazing need progressively more heat. To avoid the use of excessive heat a descending temperature range of brazing fillet is used.

Firebox and tubes
Backhead and syphon tubes
Everthing else
C4 with Tenacity 4A flux
Phosphalloy. No flux
Easyflow No. 2. Easyflow flux.

Closely fitting parts may move when heated, due to expansion, and so a certain amount of rivetting is necessary. With this small boiler use $\frac{1}{32}$ in. rivets; brass rivets will melt in with the C4, but if copper rivets are used they must be emplaced in flux.

Rivet the firebox backplate into its wrapper in three places, one on top and one each side. Before rivetting the firebox tubeplate in place first fit the three tubes, bell their ends a little, slip a ring of C4 up to the bell and push the tubes right through, up into place. Using a small brush paint all the crevices inside and out with freshly made up Tenacity 4A flux, as a weak cream.

Slip the smokebox tubeplate onto the ends of the tubes, to hold them in position, and place, one side down, on the hearth. Check that the pliers and a pointed prodder is on hand, not too near to get hot, and the C4 is within reach (also called Silver-Flo 24) with its flux.

Use a medium blowtorch, output nozzle aperture between ½ in. and $\frac{5}{8}$ in., and on full blast put the tip of the blue cone of the flame up to the point where the tubes enter, from the outside, until the rings melt inside, with the flame moving a little all the time. Dip the C4 in the flux and run a fillet around the front top of the firebox, and the sides which are down. Pick up more flux with the hot C4 and rebraze the tubes outside the box until a small bead hangs from each. Turn the work over with the pointed stick, pick up flux with the hot stick and apply to the seams now down, followed by fluxed C4 with the flame to finish the box. Give a blow inside, up the tubes, until the beads, now uppermost, disappear.

Pick up the box with the pliers by the top side and drop it carefully into the bucket of pickle and leave it for a few minutes. Pick it out with the pliers and wash it under the tap, with the pliers and the hands. The copper of the box and the tubes will be a bright pink with gold lines along all the seams, inside and out. File off any lumps from areas where flanges or wrappers will be for the next braze. Enlarge the holes for the syphon tubes and fit these in place.

Rivet the backhead to the outer wrapper, one rivet on top and two either side. No flux is needed this time as the braze is Phosphalloy, and the annealed copper is clean enough to make a perfect job. Place the rivetted work, backhead uppermost, on the hearth and cut a short length of Phosphalloy and place it at the start of one side. Heat up with the blowtorch and the braze will melt suddenly and flow to be followed around with more Phosphalloy and the flame, the braze going a bright silver as it flows. Pickle the open-sided box, and bring over the firebox to braze in the syphon tubes from the inside, before pickling this again. Wash both parts.

Easyflow No. 2

The rest of the boiler is to be brazed with Easyflow No. 2, which is a more expensive silver solder. However, it is not wise to be mean with the silver solder as it is false economy to make an expensive copper boiler which leaks due to shortage of silver solder filler in the joints.

The wrapper is to be brazed, now, onto the sides of the firebox whilst being clamped tightly in place. Gauge the distance from the back by temporarily slipping the copper block in sideways, it has to be tailored to fit for its final positioning. Before clamping up one side apply a mean coat of Easyflow paint to the inside of the wrapper and the outside of the firebox. Cut a length of the braze to fit along the inside top after clamping up the side to be uppermost, remove the block and slip another length of Easyflow, this time down the back of the firebox on the unclamped side. Paint along the lengths of silver solder with Easyflow flux.

With two $\frac{1}{8}$ in. mild steel blocks on the hearth place the unclamped side down and with the blowtorch heat from slightly below and into the box opening until the flux flows red and the Easyflow runs neatly, by capillary action between the copper surfaces. Turn off the torch, unclamp to turn upside down. With the pointed stick pick up flux and run into the new gap, cut the Easyflow strips for this side, flux them well before manoeuvring into position before heating as before. The easyflow paint makes a good starter for an operation such as this, helping the additional silver solder to flow well. Pickle the work.

Take the strong, but well annealed, copper box and check that it is all square, and particularly that the sides of the outer wrapper are parallel, tapping carefully, using a flat wooden block as a protector, to gain perfect sides before fitting the barrel. If the sides are out of true it will make the fitting of the hornplates very difficult, and little correction can be made once the barrel is brazed into place.

Take the 1½ in. tube, and, against the brazed box, mark exactly for the half circle to enter the wrapper and carefully saw into the tube and across to leave the part for the flange standing. Flange over against a block of mild steel held in the vice. Check with the barrel in the box to ensure a flat fit with the top and sides parallel. The trick here, to ensure perfect alignment, is to braze the smokebox tubeplate and tubes first, pickle, and then realign with the barrel being held by the firetubes during brazing.

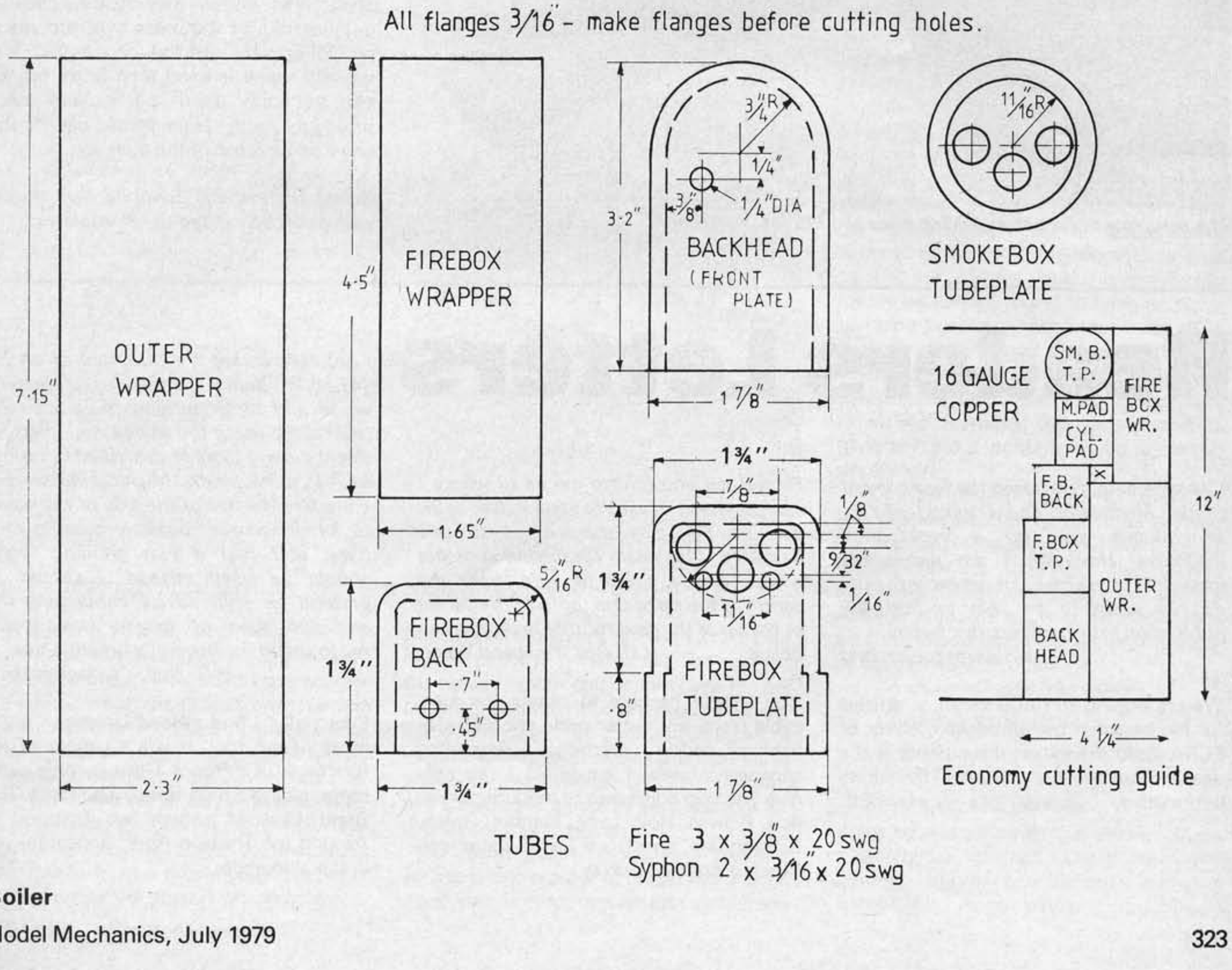
Use plenty of silver solder at the smokebox end, well fluxed, and have about ½ in. of the three tubes projecting, to be sawn off later. When brazing the flanged shell, after realignment, flux and then tap gently all around to tighten the copper together. Use slips of 16 gauge steel, on a flat hearth, to keep everything lined up when hot. Assist the flow of the silver solder at each end with the help of the pointed stick, assisting fillet.

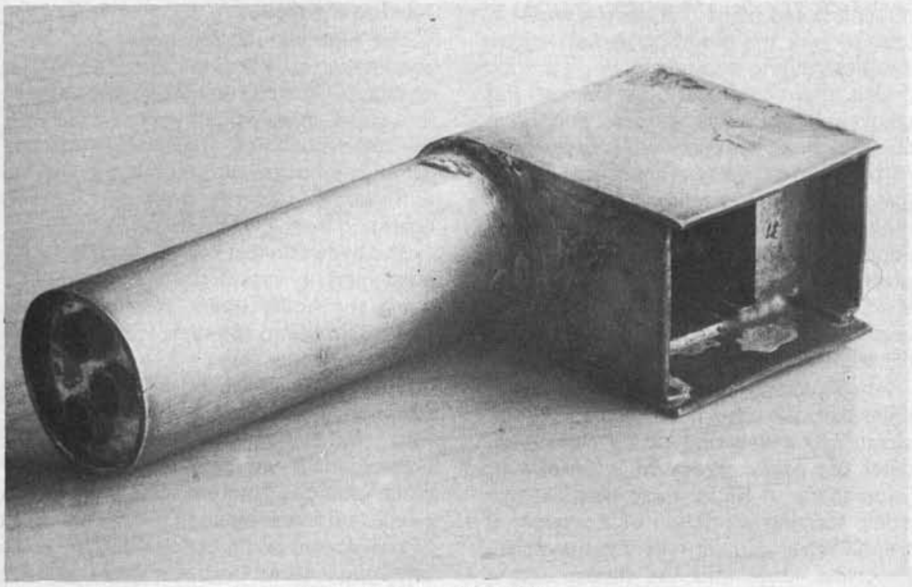
After pickling and washing, drill the holes for the backhead bush and the steam block securing screw, and then tailor the copper block to a perfect fit, underneath. A slight angle filed on two sides, forming a fraction of a wedge, is helpful when carrying out this operation. Flux the inside and the block, before pressing and tapping home. Prop the boiler upside down and cut a length of easyflow No. 2 to fit along the back edge. Heat the block from one side, concentrating the flame on the block and when the flux, then the braze, flows, prick the easyflow right around, liberally adding more, well fluxed. Pickle the boiler, allowing it to fill quickly (that's why the holes were made first). Make the water gauge bush and silver solder it into position. Tap the steamblock hole 6 BA, and the bush $\frac{3}{16}$ in. × 40.

Testing the Boiler

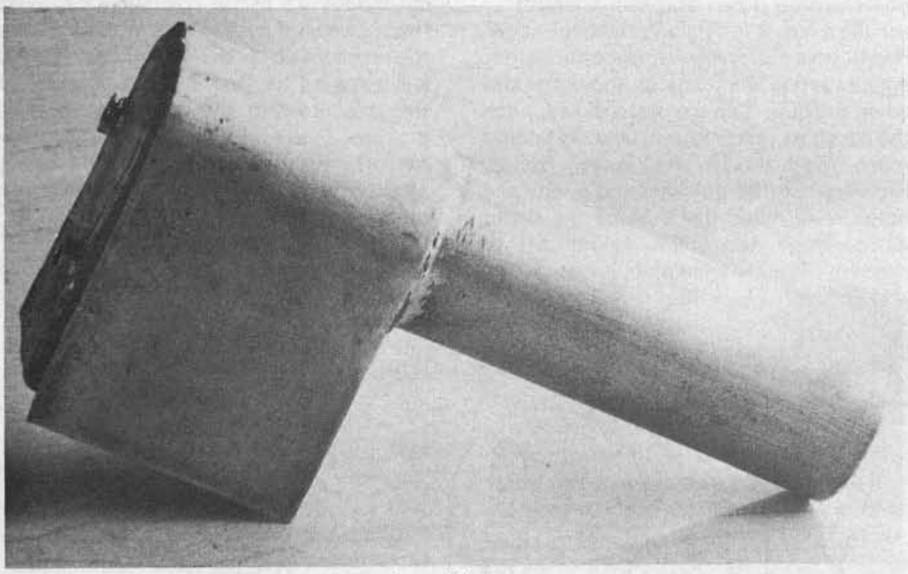
The first test of the boiler can be a pneumatic test using an air pump. Make an adaptor into the water gauge bush and fit a 6 BA screw with a soft washer into the steamblock hole. Totally immerse the boiler in a bucket of water and pump up with air to observe lines of bubbles emerging from any leaks.

The hydraulic test can be made straight away and is essential for safety when using the boiler under steam pressure. Use a ram-pump together with a full-size pressure gauge; I use a 2 in. gauge, 0 to 200 psi. Open up the top screw and pump Open up the top screw and pump water into the boiler (it will have to be connected up with copper tubes) until the water emerges from the screwhole, shake a little and pump again to release air-bells. Screw up and pump up to 50 psi. Wipe up any water around the boiler and if no leaks are apparent take the pressure up to 100 psi and leave it at this pressure for at least five minutes. If everywhere is still dry take the pressure up to 150 psi, when the back will bulge a little. This is about three times the pressure that the boiler will raise in practice, and gives an excellent safety factor: the boiler easily stands this pressure, I actually went to 180 psi with no effect. If a weep of water does appear, mark the spot with a circle of dye marker to be rebrazed after picking out the hole with a sharp point and fluxing well. If a





The boiler on its side, the syphon tubes are just visible .



The complete boiler before adding pads and fittings.

definite flow occurs anywhere, this will need to be drilled into, plugged with a fluxed copper rivet and rebrazed.

Finishing the Boiler

The motion and cylinder pads are made from copper sheet, annealed and tapped to the curvature around a 1½ in. diameter; finish with emery around the same former. The pump pad is of brass, one surface taken down on the emery cloth around the same former, the other side being finished on fine emery cloth held on flat glass. Make the steam block, which is fitted with a brass screw after painting with Easyflow paint. paint the copper pads and secure them both in place with a single copper rivet, just pushed through centrally, after drilling.

Place the boiler, nose down at a slight angle, on the hearth and locally heat each part in turn, applying a little stick Easyflow down the angle. Pickle, wash and examine by scratching all around with a needle point to ensure that there is a fillet of braze all around each part. Turn the boiler on its side and braze on the pump pad, no rivet this time, and check as before.

Drill through the steam block screw, No. 30, taking care to avoid the other threads. At this stage a blowdown valve can be fitted, if required, into the underneath of the copper block.

Criticism has been levelled against the use of brass fittings on copper boilers as electrolytic action may result, causing deterioration of the brass over the years. providing only distilled or purified (de-ionised) water is used then brass fittings can be safey used, particularly since prolonged high temperature, use of this small boiler is out of the question.

Sweet Sixteen will continue next month with gear cutting and the Hornplates .

Readers Letters

Q.

I have recently purchased the first copy of Model Mechanics and I would like to congratulate you on a very good magazine. However, I am particularly interested in 'electric slot car racing', but I do not seem to be able to find any publication which covers this hobby.

David Barber, Scotland

A.

We are hoping to run a series of articles for the beginner by Ian Jensen, editor of ECRA Association, on this subject in the near future. This should be quite informative. **Ed.**

Q.

Please can you inform me as to where I can purchase miniature steel cable, $\frac{1}{16}$ in. dia. or 1½ mm dia., of reasonable flexibility. Also chain for driving sprocket wheels with a space of $\frac{7}{32}$ in. from the centre of the tip of one tooth to the centre of the tip of the next tooth. I hope you can oblige. *J.G. Bell, Tyne and Wear.*

A.

You should be able to obtain the steel cable from any motor-cycle shop or sea-fishing tackle premises. Regarding sprocket wheels; I am afraid I can only give you two addresses of manufacturers: A.J. Reeves, Holly Lane, Marston Green, Birmingham, and Tracy Tools, 58 London Road, Kingston, Surrey.

Q.

I am considering the purchase of an Elu 147, 6 in. Bench Grinder for sharpening wood and metal turning tools and also twist drills, using the side of the wheel for metal turning tools as described in various M.A.P. publications. My local Elu stockist considers the use of the side of the wheel to be dangerous, possibly causing it to burst and that a cup grinding wheel should be used instead. I should be grateful for your advice concerning this and the tupe of grinder you would recommend for general workshop use.

P.G. Bull, Cambridgeshire.

A.

Personally, I find a Band Linisher a much more useful tool. It will do most of the functions of a Bench Grinder, plus many more, giving a high finish. The Little Gem Band Linisher, which we featured in Around the Trade in April, is ideal for use in the workshop. **Ed.**

Simple pattern making

Part 2 by L.C. Mason

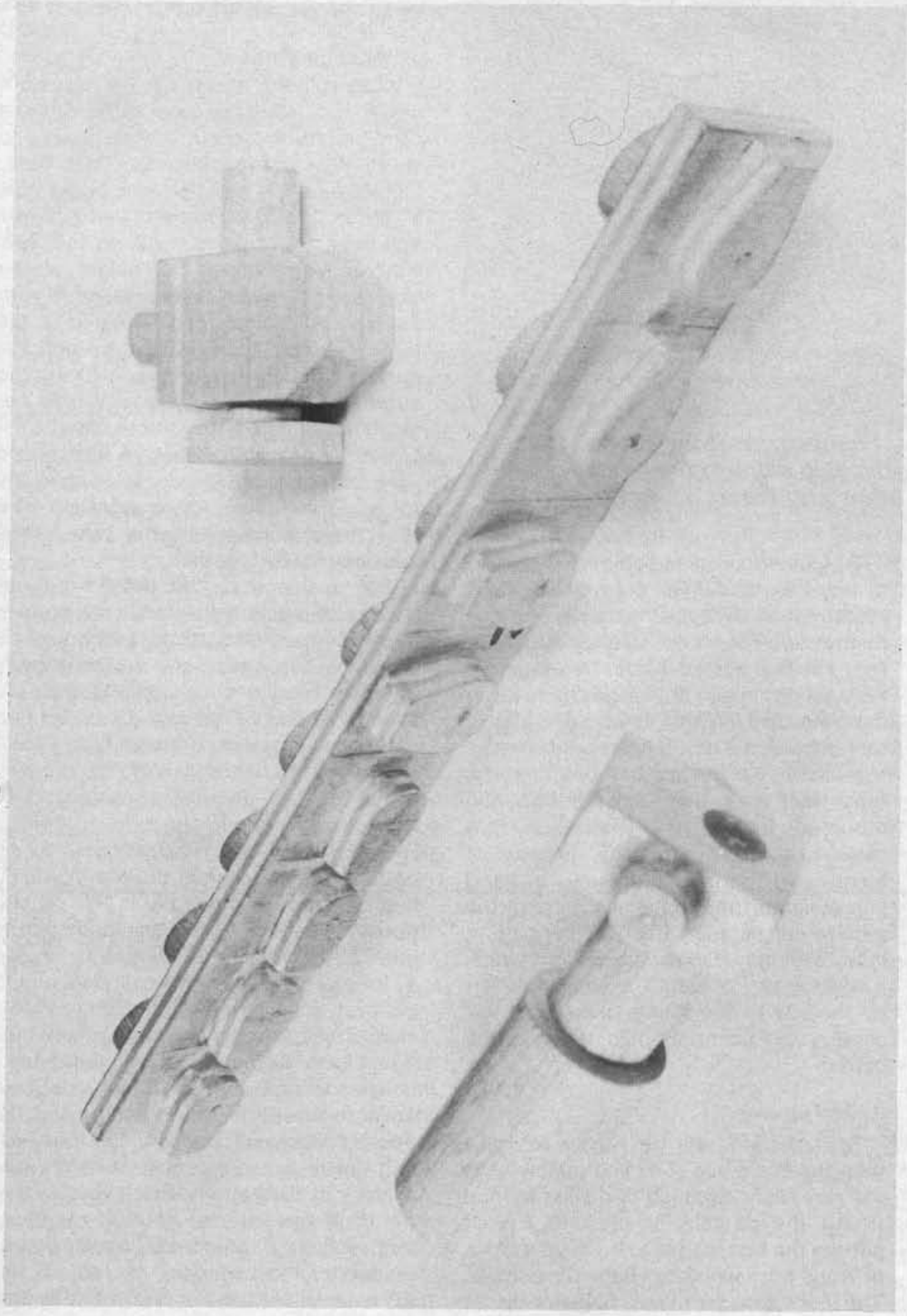


Fig. 1 Patterns producing more than one component in the one portion.

IN MENTIONING attaching small additions to the main pattern, it is in fact, generally preferable to build up anything of a complex pattern shape from separate pieces. Apart from this procedure being simpler than carving a fancy shape out of the solid, there is the big advantage that the grain of the wood can be arranged to run in the best direction for strength. The edge of a circular flange, for instance, when made from a disc of plywood, will be much stronger than if shaped from a thin single thickness. In the case of an engine cylinder pattern, the flat pad on the side of steam engine cylinders for the port face could well be an attached piece, as could the "D" shaped block to accommodate the valves on a side valve petrol engine cylinder pattern. Cylinder end flanges are generally very suitable for this sort of treatment, too.

A useful point to remember when adding bits to a pattern, is that it is often a good idea to make one pattern combining two or more small components, the casting to be cut up as the components are required. Not only does it result in a more easily handled single pattern, but it comes out cheaper on moulding time! The photograph Fig. 1 shows some examples; the groove round the alloy carburettor body shows where the separate top should be sawn off, while the enlarged top of the gunmetal oil pump pattern provides the cast blank for a main bearing bush. This only applies where both items are required in the same metal, of course! The long thin pattern is for a set of flanged bearing bushes in gunmetal for the shafts of a traction engine. The plywood base strip is made long enough here to allow for the widths of sawcuts in cutting the strip into individual bearings, plus a machining allowance on the edges of each.

Circular items

The use of plywood lends itself very well to the construction of a pattern of a circular item. The very thin plywoods available can easily be bent into quite small radius curves, and strips can be built up into multi-layered laminated constructions, resulting in immensely strong wheel rims and similar items. The first requirement is something the right size to bend the first layer round. This could be anything reasonably stout—a lathe chuck, tin can, bottle, or a roughly turned up disc of wood. The first strip is cut full long, bent tightly round the former and cut to length for a butt joint. The second layer is cut to length over the first, remembering that it will need to start slightly longer than the first. The outside of the first layer is then coated with glue and the second layer wrapped round it, the two being bound tightly in contact with each other and the former. When the glue is set, further layers are added one at a time, till the desired thickness is built up. The joints in the various layers should ideally be spaced round the ring an equal distance between each other—not all in the one place. When the whole thing is solid and slipped off the former, it will easily stand up to sanding, for the final finish or forming the taper, and is generally stout enough to be turned if necessary.

For fair sized patterns, there is theoretically another factor to be allowed for, and that is the amount of shrinkage of the metal on cooling. This varies according to the metal being cast, and the average amounts allowed on the metals that the model engineer would normally be concerned with are:

Aluminium—$\frac{15}{64}$ in. per foot
Brass—$\frac{3}{16}$ in. per foot
Bronze / Gunmetal —$\frac{5}{32}$ in. per foot
Iron—$\frac{3}{32}$—$\frac{1}{8}$ in. per foot.

In my own experience, this allowance can normally be ignored. The pattern will already have—or should have—a reasonably generous machining

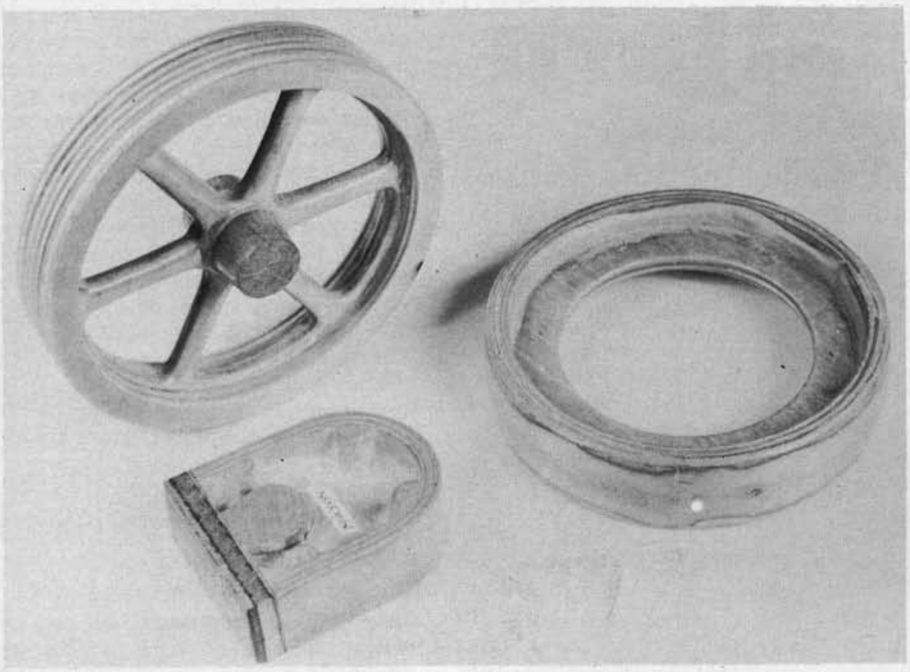


Fig. 2 Thin plywood used in the making of patterns involving circular shapes. Laminated rings for the flywheel, bent laminated strips in the traction engine wheel rim, and a combination of bent strips and blocks in part of a water-cooled cylinder head.

allowance plus an extra little bit to accommodate the draught taper. On a pattern whose biggest dimension is say, 2-3 ins., the amount of shrinkage is very small. When the moulder raps the pattern to loosen it in the sand preparatory to lifting it out, or taps the spike in, both these actions slacken the pattern in the sand, leaving the impression fractionally big. Adding to this the oversize allowances already on the pattern, these all add up to the casting being sufficiently bigger than finished size to completely swamp out the tiny amount of shrinkage that will have taken place. It is infinitely easier to add a generous $\frac{1}{16}$ in. or so by way of machining allowance than to keep strictly to something slightly less, plus $\frac{1}{64}$ in. or so for shrinkage, maybe on something of a fancy shape; at least, I find it so! On something pretty big—say, a traction engine rear wheel rim—it could be worth while remembering the shrinkage, but on much smaller items it can safely be forgotten.

In the various mentions of the moulding procedure at the foundry, it will probably have been assumed that on lifting the top half of the box after moulding, the pattern will naturally be left laying in the bottom half. This is not necessarily so; should the sand happen to be tighter in the top half, the pattern will be lifted out of the bottom half, sticking in the top. It could easily be partly lifted out of the bottom to fall back in again, with the risk of damaging the bottom impression. In any case, when the box probably contains several different patterns of varying shapes and sizes, opening the box becomes something of a tricky operation, needing a dead straight gentle lift for at least half the depth of the deepest pattern.

To guard against possible mishaps and to make life easier for the moulder, it is customary with deepish patterns to make them in two halves, split along the parting line. The two pattern halves peg together with dowels in one half engaging holes in the other half. With this sort of pattern, the half with the dowel holes can easily be moulded in the bottom half box, and the other half then being pegged on and moulded in the top half box. On separating the box halves, instead of having to gently withdraw a sand impression off the top of the pattern, the pattern comes apart freely at the parting face, leaving half in each box from which it is easily withdrawn. The small hole left by the use of the lifting spike, too, will come on the unimportant joint face of the pattern.

Split Patterns

Split patterns are no harder to make than the one-piece sort; you merely have the very slight extra job of drilling for and fitting the dowels. In making a split pattern the first step is to build up a block of wood from which to shape the pattern. The block consists of two half-size pieces of wood, glued together to make the required size of block. There is a dodge here in making the block so that it is easily separated into the two halves again when the shaping of the pattern is completed. The procedure is to make the joint in the normal way, but instead of sticking the two pieces of wood face to face, a sheet of good quality paper is sandwiched in the joint. This results in a joint strong enough to stand up to the normal shaping operations, and when that part is finished, a wood chisel gently bumped into the joint line will split the paper "meat" in the sandwich, leaving two good surfaces which only need a light sanding to remove the fluffy paper surface. The last operation before splitting apart is to drill the finished pattern for the dowel holes. On the average sized small pattern, two ¼ or $\frac{3}{8}$ in. dowels are adequate to locate the two halves. Drill the holes through one half, through the joint, and about half an inch or so into the second half.

Hollow castings

After splitting apart, cut the pieces of dowel rod full long, pop each into the blind-ended hole and mark the dowels to show how far each enters the hole. Lightly sand the end that was in the hole as far as the mark till the dowel is a free and easy fit in the hole; unless the fit is light and quite free, the object of the exercise is defeated. When satisfied with the fits, the dowels can be glued in the through-hole half of the pattern and the outside ends finished off smooth with the outer surface of the pattern. Where the glued dowel enters the joint surface of the pattern is one place where a fillet at the joint is not needed, so wipe off any squeezed out glue. Any suggestion of a fillet there will prevent the two halves bedding closely together.

The positions of the dowels do not have to be precisely located in any way. In a perfectly symmetrical pattern it is preferable to position the dowels slightly unsymmetrically, which indicates clearly to the moulder which way round the two halves peg together, because fitting them together the wrong way round will produce an obviously wrong and awkward pattern.

So far we have only been considering patterns which result in the casting being a solid lump. In many cases the casting needs to be hollow, with sometimes the internal space being quite a fancy shape. If, for example, all engine cylinders had to be cast solid, then the casting would show little gain over machining the whole thing from the solid, there would be a considerable amount of metal machined away to waste in boring it out, and the whole thing would cost more in tool wear and time spent on it. So where the size justifies it, the pattern is arranged so that the necessary internal space is produced in the casting. In the main, small bores in model engine cylinders of say, ½ in. diameter or so, are not worth the trouble of arranging for the bore to be cast in. While the pattern is no more complicated than that for a solid cylinder, the moulding procedure is, and the amount of metal wasted as swarf in boring out the small solid cylinder is so small as to be negligible.

A point to be remembered here is that you need a machining allowance in the bore of the cylinder, so that the hole through the casting must be distinctly smaller than the finished bore size. This means that a bore to be cast in needs to be a fair size—in model terms, that is—before it becomes worth while to start

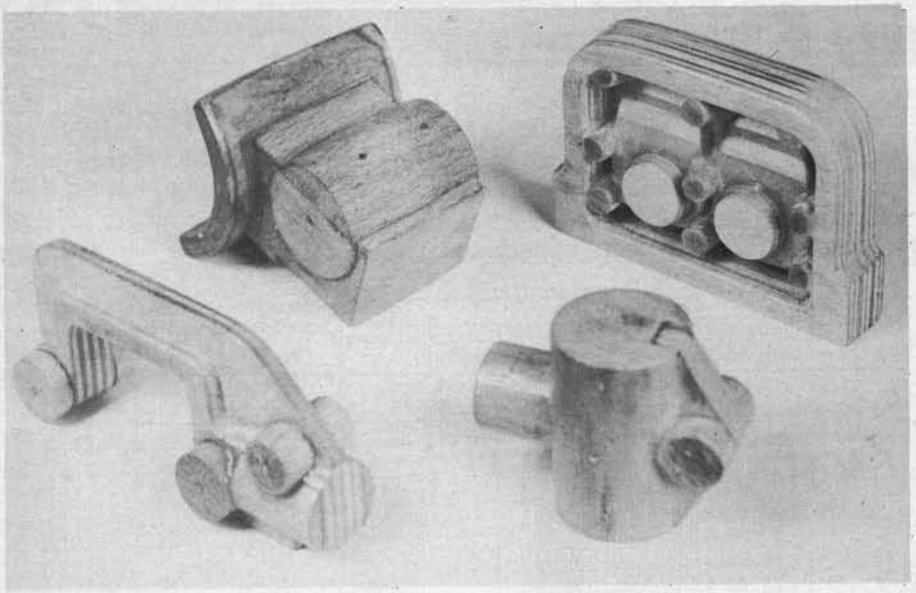


Fig. 3 Various patterns built up from several pieces; a traction engine cylinder, water-cooled twin cylinder petrol engine head, and two component for a camera accessory.

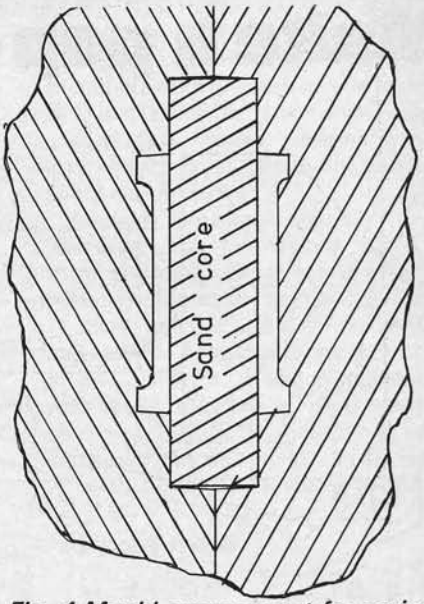


Fig. 4 Mould arrangement for coring cylinder.

thinking of having the bore cast in. Personally, I look on a bore of about ¾-1 in. diameter as the minimum at which it begins to become worth while having it cast in. It depends to some extent on the metal being used for the casting. Aluminium alloy is quite cheap, so a cast-in bore in light alloy is less worth while than in a similar casting in bronze or gunmetal, where the metal itself is considerably dearer.

Considering the example of a fairly big steam engine cylinder, if a hole for the bore is required to be produced at the time of casting, then there must be something solid the shape of the hole required, present in the moulded impression in the sand to prevent the metal completely filling the impression, and round which the metal can flow to produce the hollow cylinder shape. That something is a core, and this like the mould itself, is of sand. If one could hav a stick of sand laid in the right place in the mould, then that would do the trick.

And that is just what is provided. If you obtained a piece of tube with a bore the same size as the stick of sand you need, filled it with sand rammed hard and then pushed the sand out of the tube, you would have the necessary round sand stick core. The actual making of cores is a bit more elaborate than that, as the sand is mixed with a bonding agent and then baked, to produce a more robust core which can be handled. Foundries generally have a big collection of odd pieces of tube in various lengths and conventional sizes, kept especially for core making, so that it is unnecessary to provide anything of the sort for core making unless it is a very fancy size or there is something else unusual about it. A check with the foundry before taking the pattern in would soon show if they can cope with no further effort on your part.

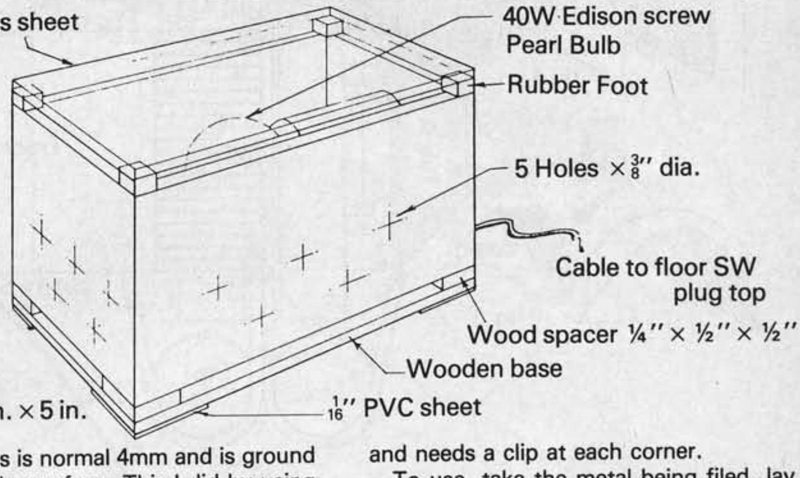
A light box

by C. V. Herbert

If, like me, most of your modelling is carried out during evenings—and late into the night at times—you may also find the following a useful tool when you're sweating over producing a straight edge. I find it kind to not only my eyes and neck muscles, but also my patience.

The drawing is pretty well self-explanatory. The box is made from ¾ in. chipboard, it being to hand, and simply glued and nailed together. The wooden spaces, like the holes in the sides and the rubber blocks at the top all exist to allow a stream of cooling air to flow, since if the box is left on for very long the glass becomes hot. It was for this reason that I, er, borrowed the foot operated floor switch from the standard lamp.

The light fitting is an Edison screw fitting, it being easier to change the bulb than with a b c because of limited handspace, and i was in Germany when I built the box where the ES is standard. The socket is plastic as I used two core flex, but if a metal fitting is used it should be earthed.



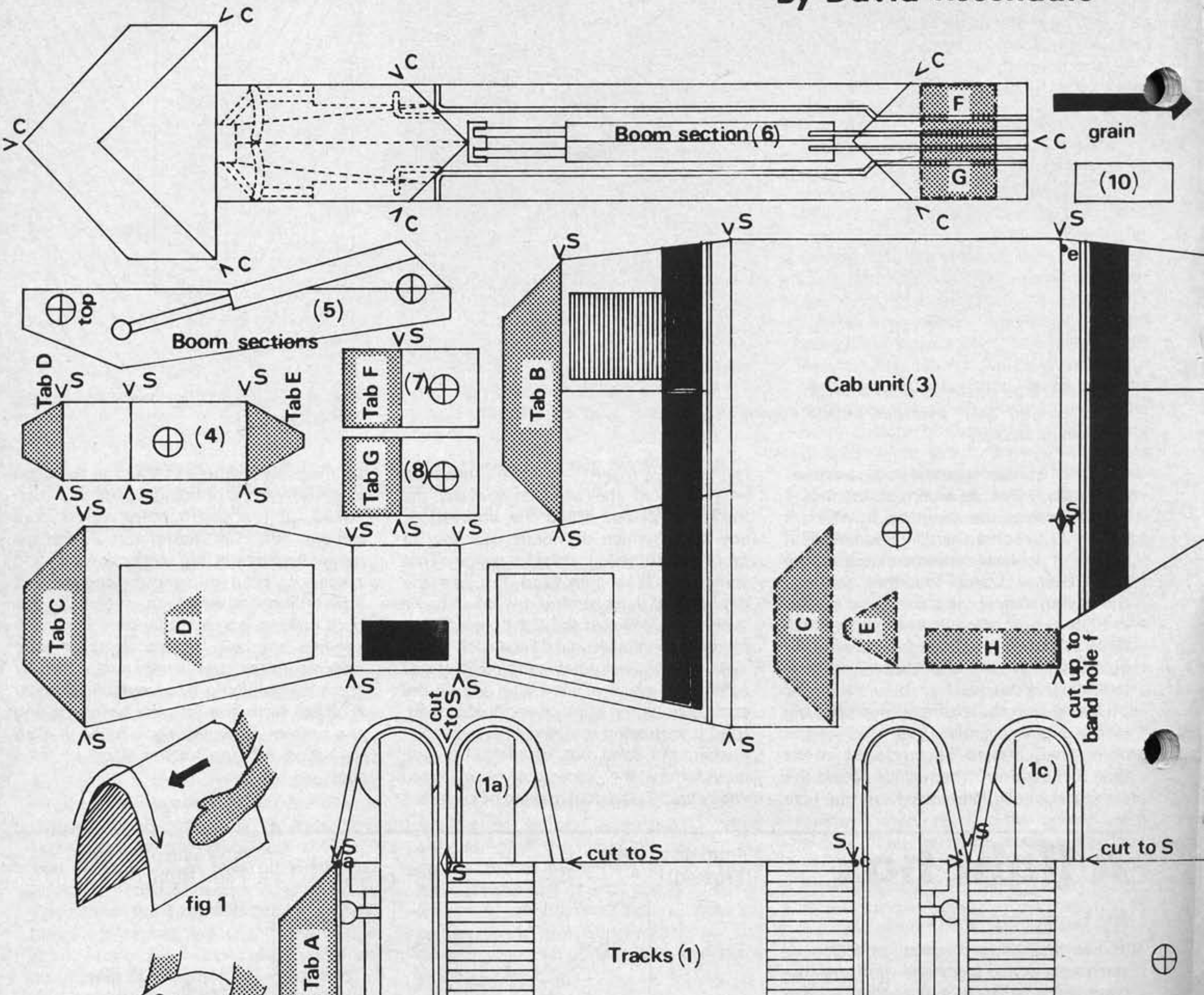
The glass is normal 4mm and is ground on the under surface. This I did by using automotive grinding paste (Holts) and a small bottle, spreading the paste onto the glass and working in with bottle until a nice, even pearl-like surface was achieved. I tried window cleaning cream at first, but could not get a nice even light. To get a better light spread I painted the inside of the box with matt white lead, and use a 40W pearl bulb.

Finally, the rubber blocks are erasers, to give a high friction support to the glass, which ought really to be more permanent and needs a clip at each corner.

To use, take the metal being filed, lay flat on the glass, switch on, lay the straight edge against the filed edge and look for a nice parallel band of light. This saves holding your work piece up to a light bulb, straining your eyes, and being inefficient anyway because of a single light source not having an even spread over, say, a footplate length. I always find it difficult when holding two thin pieces of material together—a rule and say, 10 thou brass, so that flat surface of the light box is ideal.

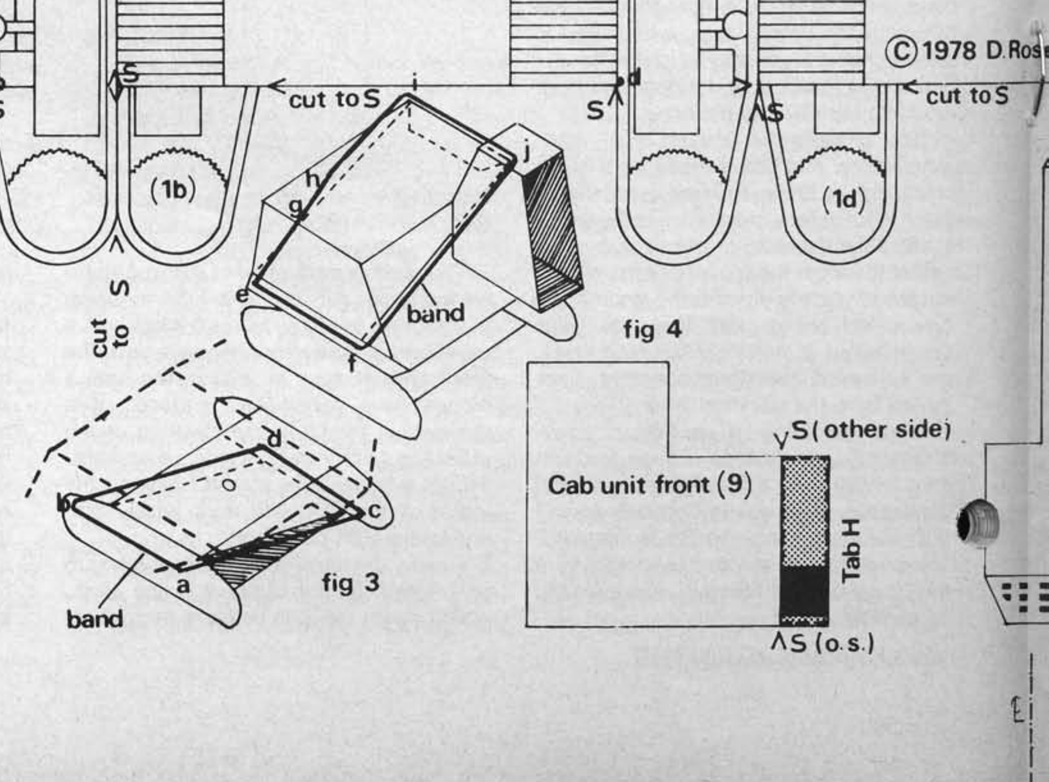
Make a pop-up Excavator

By David Rosendale



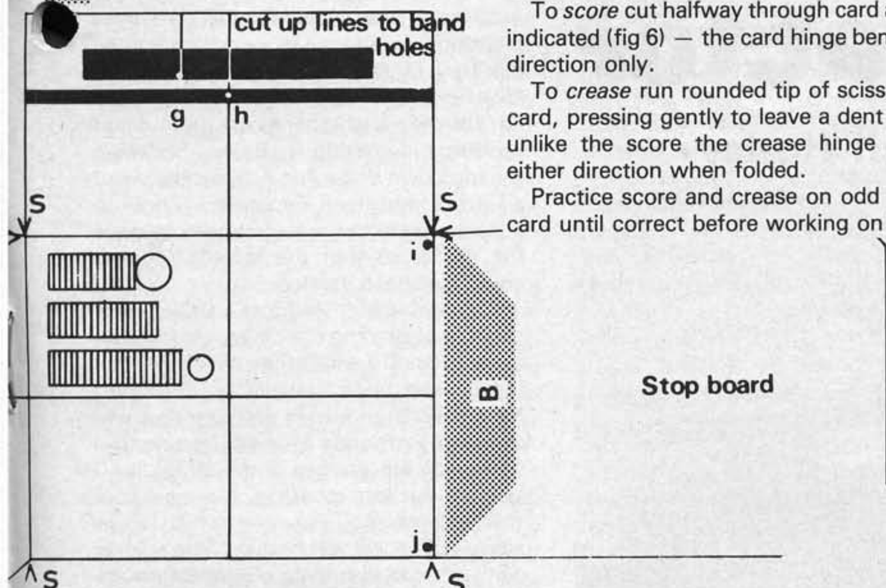
GRAIN DIRECTION

Before drawing the plans on the card you must find the direction of the grain. When you hold the card and bend gently (figs 1 and 2) you will find that it bends more easily in one direction than the other. The rigid way is cross-grain and cross-grain scores make the model's sides rigid.



TERMS

- - - - - Draw on other side of card.
<S Score.
<C Crease.
•a Elastic band hole.
⊕ Eyelet hole.
Tabs and tab positions (with dotted lines place on other side of card).



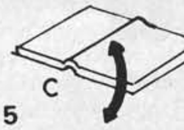


fig 5

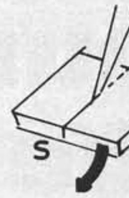


fig 6

CREASING/SCORING

To *score* cut halfway through card along line indicated (fig 6) — the card hinge bends in one direction only.

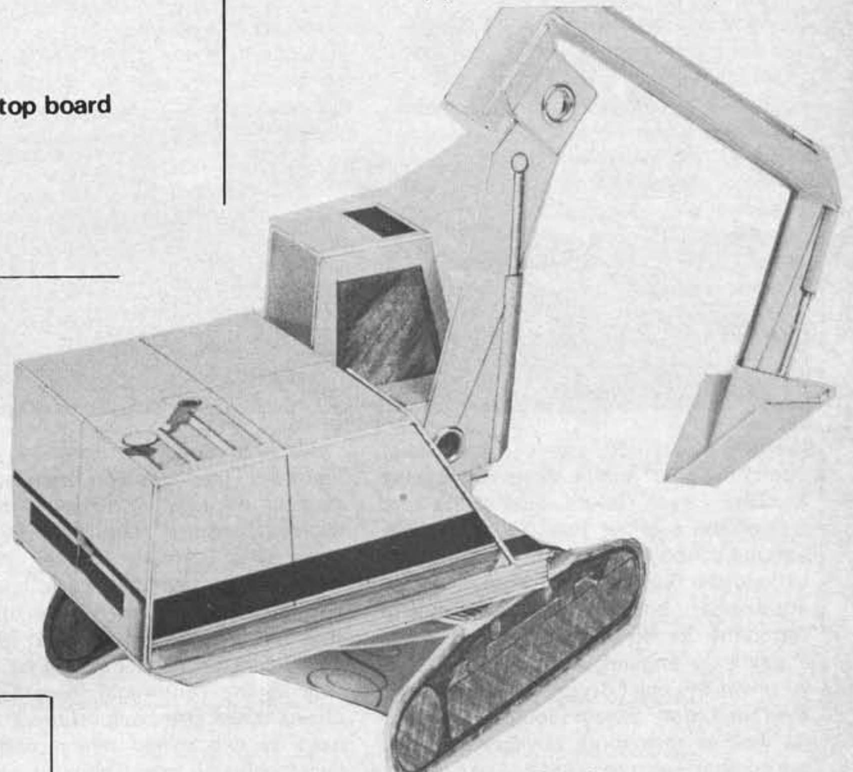
To *crease* run rounded tip of scissors along card, pressing gently to leave a dent (fig 5) — unlike the score the crease hinge bends in either direction when folded.

Practice score and crease on odd pieces of card until correct before working on model.

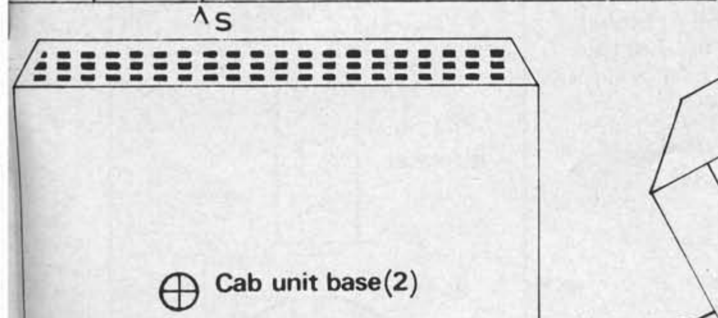
CONSTRUCTION

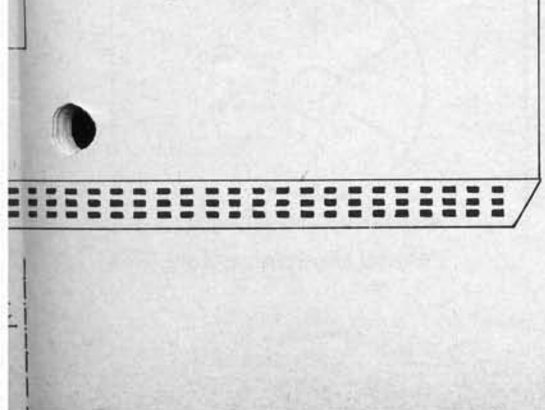
Materials 3 sheet Bristol Board except for piece (6) which is 2 sheet Bristol board (ivory card can be used as it is cheaper but is not such high quality). 3 brass eyelets or alternatively brass paper fastenings and 2 elastic bands.

Method Trace plan carefully (for reference. Line and colour model, score and cut out pieces and eyelet holes. Crease boom section (6) (fig 7). Glue 1a, b, c and d to inside of main tracks. Stick 2 onto the bottom of 3. Connect 1, 2 and 3 together with eyelet. Glue tab A into position on stop board (fig 3). Glue tab B to stopboard and tab C to (3) (fig 4). Fix (4) with bottom eyelet hole to (5).



Place elastic band through holes a, b, c and d and one through holes e, f, g, h, i and j. Stick piece (10) across bands g and h to give additional strength. Glue tab E and D into position. Fix (7) and (8) to (5) with eyelet. Glue tabs F and G onto (6) (see figs 7 and 8). Finally glue H onto (3). Open V shape section of (6) to lift away the boom from the excavator, close the V shape and boom will return (fig 7). To collapse the excavator, place as in photograph but with cab side facing you. Note drive wheel of tracks are to the back. Hold model sides between thumb and forefinger and push down and away from you. This will flatten tracks. Then lift back flap of cab unit and pull unit towards you. Keep the excavator in a folder when it is not in use.





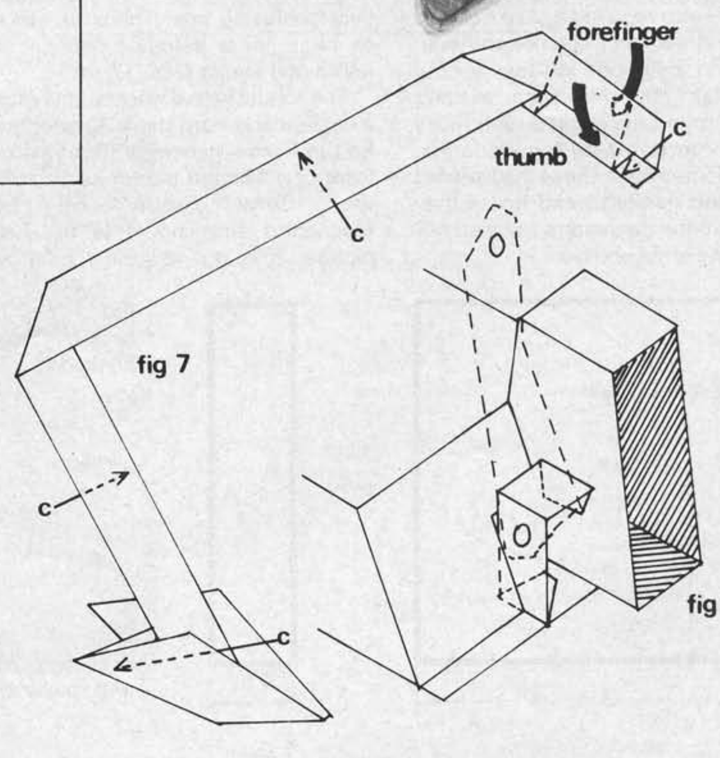
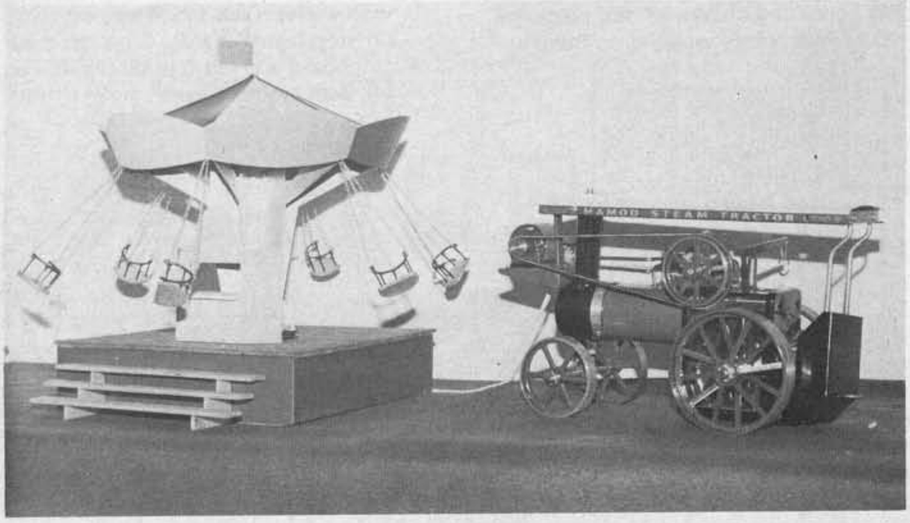


fig 7
fig 8

A Fairground ride for the Mamod Tractor

By Basil Harley



When I was a boy, between the Wars, one of my great annual treats was to visit St Giles' Fair in Oxford, held at the very end of the summer holidays before the autumn school term began. I was not, of course, the only one for whom it had its attractions but I was particularly fortunate, in those days of the great showmen's engines, in having a father who was the chief designer for what was then the Oxford Steam Plough Company. As well as their more obvious activities the company also repaired and re-boilered many of the showmen's engines and even designed and built one or two special rides. So fair day meant an exciting progression round the engines with many an invitation on to the driving platforms. By the afternoon the engines had settled down, rocking gently to and fro as they steadily drove the generators perched out in front of the smokeboxes.

Although supplying a myriad of bright lights was their main job there was also a number of rides which were driven by electric motors supplied by these generators. Among them was the Chairoplane, a simple roundabout with a number of chains carrying seats which flew out dramatically when in full flight. This could be quite exciting because as well as the centrifugal force effect the chains could also be spun round on their axes by determined riders producing a very confusing ride. There are still a few to be seen at summer traction engine rallies and steam fairs.

The model I have chosen this month is a chairoplane from the 1930s designed to be run from a generator mounted on the front of a Mamod tractor as described in the June issue of Model Mechanics and shown in the heading picture. It is not a scale model of any particular ride but gives, I think, a fair impression of the original machines in the same spirit in which the Mamod model resembles a traction engine. The two together look remarkably effective and my own version has had a lot of admirers.

A fairly wide choice of materials is possible including plywood, plasticard or even good quality cardboard. The base platform is in effect a wooden box 9 in by 9 in by 2 in deep (Fig 1) and it is a good idea to make this first. I have used hardboard and there are no great problems in making it. Before fastening the top down drill a $\frac{5}{32}$ in hole centrally and also drill (and file if necessary) a hole to accommodate the motor chosen to drive the model so that the spindle projects about $\frac{3}{8}$ in above the floor.

A permanent magnet DC motor capable of running effectively on 1.5 volts is needed and a wide range of suitable and inexpensive ones is available. The one I have used is about $\frac{7}{8}$ in diameter and was supplied by Proops Bros Ltd as one of a packet of ten costing under £2.00. As I pointed out last month, some are better than others, so pick one which spins easily with a 1.5 volt battery. The spindle of the motor should be checked to make

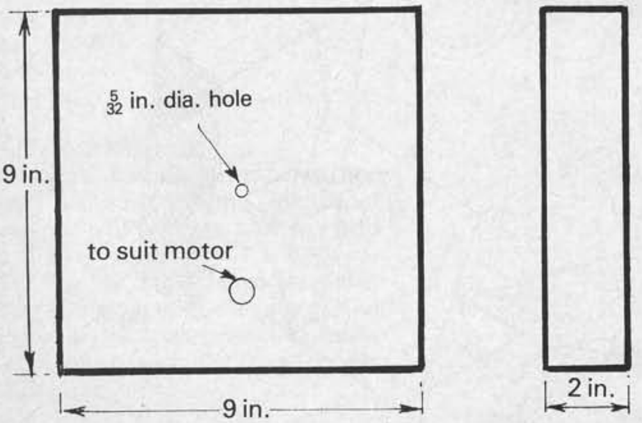


Fig 1 Left. Box base hardboard or plywood

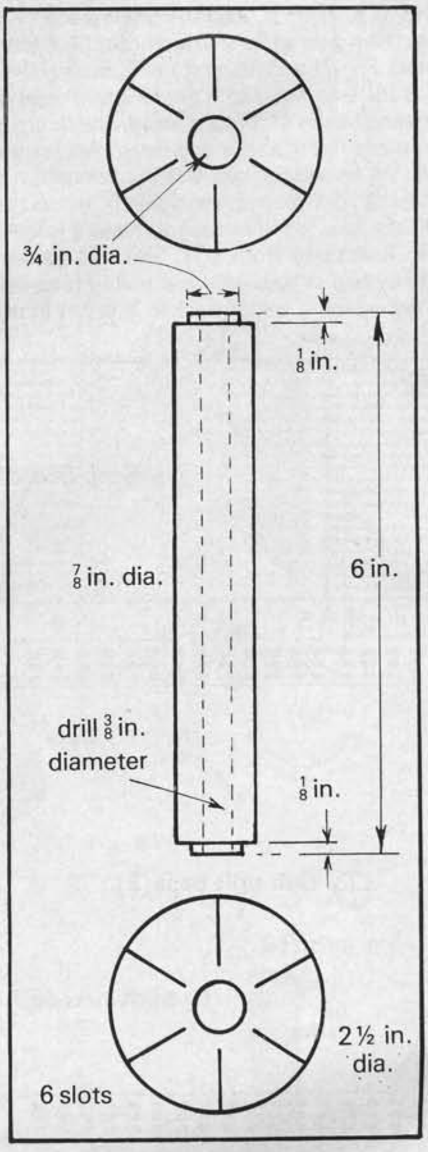


Fig 2 Right. Centre column and spacer discs

sure it is vertical before the glue which holds it in place, Bostik is suitable, has set. The wires will probably need extending so solder on a short length of flex and bring it out at the side of the box.

The chairoplane revolves on a fixed spindle and this can be either a Meccano rod or a $\frac{5}{32}$ in dia. length of silver steel. This is set vertically in the box and one way of doing this is to screw a 1½ in dia. Meccano pulley on the bottom and fix the spindle in the boss. Before finally measuring it and securing it the top should be turned to a 60° point on which the centrepiece revolves.

At this stage it looks a bit like one of those old-fashioned spikes they used to file invoices on!

Fig 2 shows the revolving centre column with two spacer discs to hold the six cantilever arms. A 6 in length of $\frac{7}{8}$ in dowelling is drilled $\frac{3}{8}$ in dia. This is to clear the spindle, accept the boss of a 3 in dia. Meccano pulley wheel at the bottom and also to hold a brass pivot at the top. It will be much easier to do this is a lathe is available to face off the ends squarely before drilling the centre hole (start from either end if your drill isn't long enough). The spacer discs are cut from $\frac{1}{8}$ in plywood 2½ in dia and have six radial slots as shown. These can be cut by hand with care, using the well known trick of dividing the circle by compasses set to the same radius. Saw cuts will suffice for the slots but, again, if a lathe is available to turn the discs and a slitting saw can be used to make the slots a better job will result. Having made them glue them centrally, with the slots in line, to the ends of the column. Fig 3 shows the assembly.

A short length of $\frac{3}{8}$ in. dia. brass bar is chucked in the lathe and centred with a Slocombe drill to provide a pivot on which the column can revolve. This is driven in to the top of the column and fixed with a touch of glue. Now is the time to check that the spindle length is right and that the 3 in pulley clears the base by about $\frac{1}{16}$ in—small adjustments can be made by altering the pivot position in the column. Put a rubber band from the motor spindle to the pulley, get out a 1.5 volt battery and make sure everything revolves freely. You will see in Fig 3 a small projecting piece of wood between motor shaft and pulley. In the event of the band running off during trials etc, this prevents it getting stuck deeply in the Meccano groove and having to be extracted with a pin! Not vital but it saves a lot of frustration and bad language in the development stages.

The rest of the revolving portion (apart from the chairs) consists of the six cantilever arms (Fig 4), six segments of the tilt (usually a canvas cover in the prototypes) shown in Fig 5 and six facia boards (Fig 6). Fairground rides were made almost entirely of flat sections bolted together so that they could be dismantled for travelling. Ours is made in much the same way but glued together rather than bolted. The six cantilever arms are made from $\frac{1}{16}$ in plywood (or good quality card of the same thickness would serve) and are shown assembled and painted in Fig 7. Don't forget the holes for the wire hooks that will hold the seat chains.

I made the six segments of the tilt from heavy coloured paper, red, blue and yellow, and glued them in place between the cantilevers, covering the joints with ¼ in wide strips of black paper. Just remember that the radius is 4¾ in, less than the length of the edges, because of their angle to the horizontal. Lastly, on the main revolving structure come the facia boards. Since only six are used I have made them curved and have used good quality card. I think they look better like this but with a larger number of cantilevers and seats they could well be flat. I have faced mine with segments of the paper used for the tilt but those with

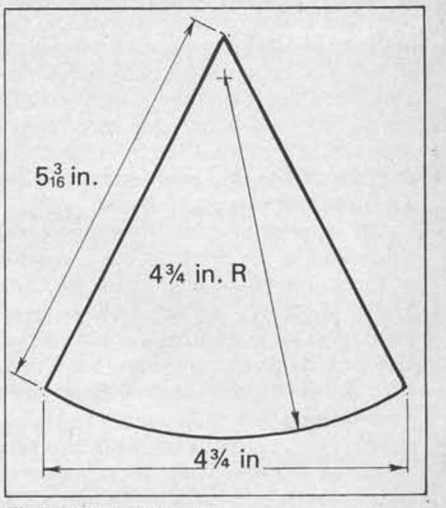


Fig 5 Template for tilt

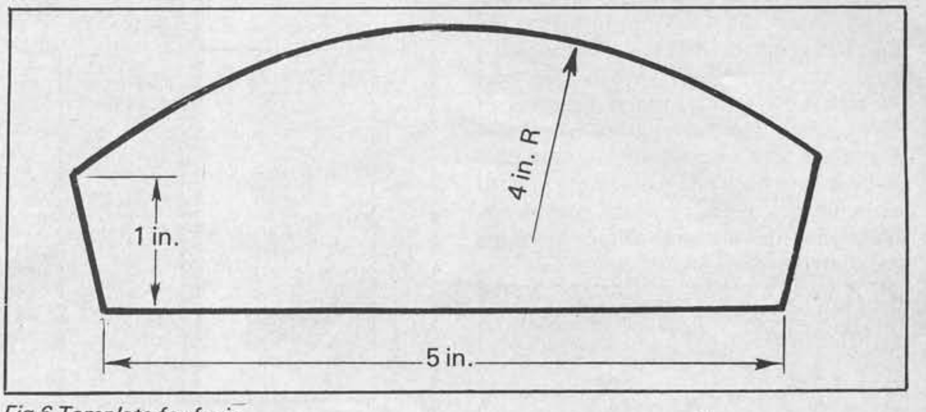


Fig 5 Template for facia

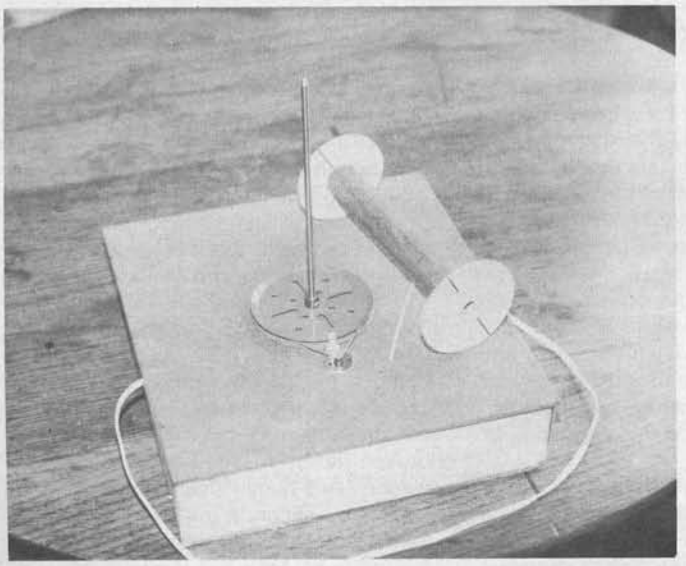


Fig 3 Base and centre column assembly

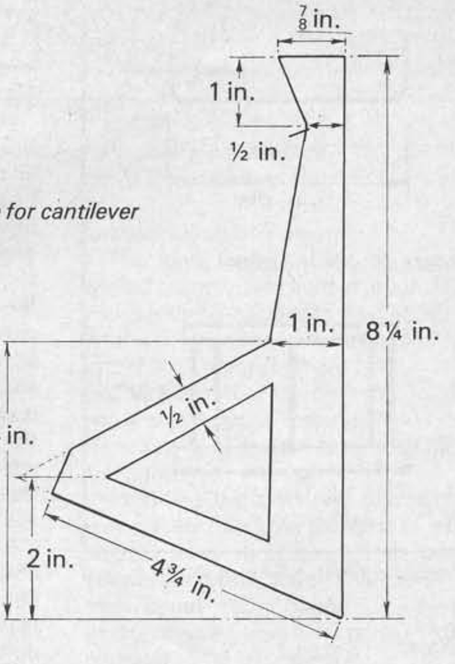
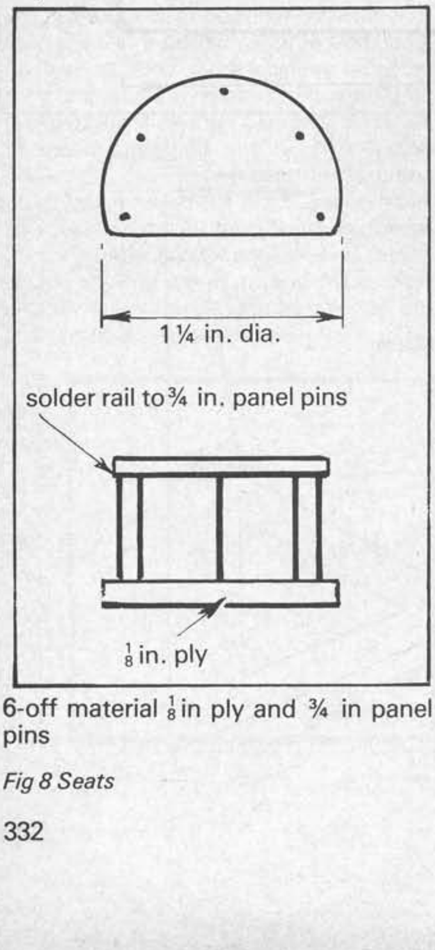


Fig 4 Template for cantilever

more artistic flair than I could paint them with typical fairground scenes and motifs.

None of the components of the revolving portion have to be made accurately to the shapes indicated but it *is* vital that they are all alike and card templates make achieving this very much easier.

Not surprisingly the chairoplane has chairs and in the originals these were of very uncomfortable metal bars springing from wooden seats. They were suspended from three chains and you will see from the photographs and Fig 8 that I have followed the original plan fairly closely. The wooden seats, from $\frac{1}{8}$ in plywood can be made by hand or on the lathe. I glued six circles of ply together, roughly cut, with paper between and in turn glued the sandwich on to the end of a bit of the $\frac{7}{8}$ in dowel. When all was dry, with the dowel in the chuck and the tailstock centre pushed in to the end of the outside 'seat', I turned the sandwich to 1¼ in dia., sawed off a segment to form a flat front to the seats and separated them by soaking in water and easing them apart with a knife. I used ¾ in steel panel pins for the uprights and, after driving them in equally, offered each seat up to the grindstone to level off the tops (and clean them up) before soldering a short length of wire to form the arm rest. The three chains are then fitted, attached with fine wire and a touch of Araldite. The chain I have used has about 14 links to the inch and is sold by Ripmax. Its a bit on the fiddly side but chain with bigger links looks a bit ungainly and is well out of scale. Each chair needs three lengths of 4¼ in the tops popped on to a wire pothook (made from pins) which are hooked through the holes in each cantilever. Make sure that the seats all face the same way when at rest.



6-off material $\frac{1}{8}$ in ply and ¾ in panel pins

Fig 8 Seats

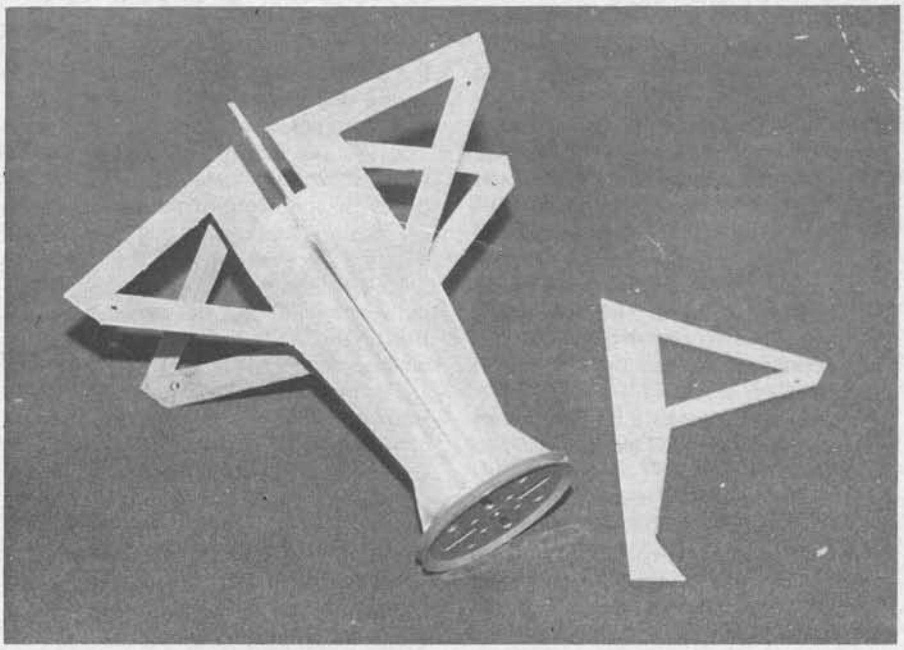


Fig 7 Assembly of cantilever arms to the centre column with the template

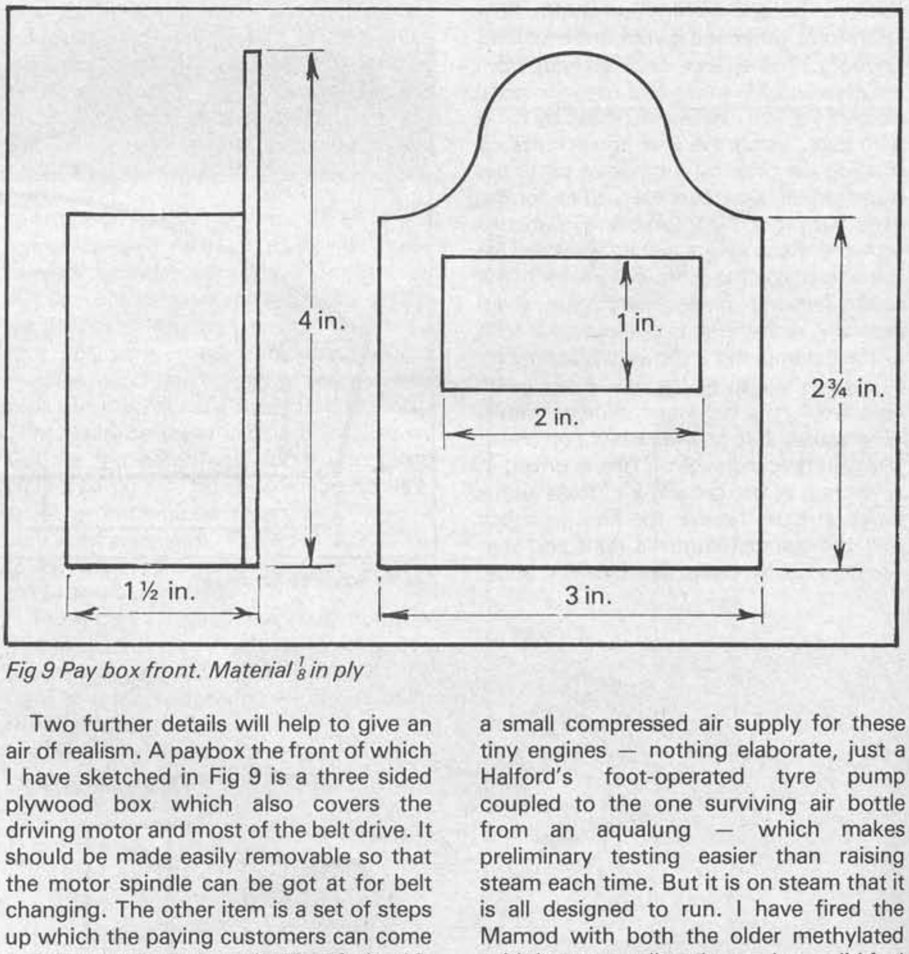


Fig 9 Pay box front. Material $\frac{1}{8}$ in ply

Two further details will help to give an air of realism. A paybox the front of which I have sketched in Fig 9 is a three sided plywood box which also covers the driving motor and most of the belt drive. It should be made easily removable so that the motor spindle can be got at for belt changing. The other item is a set of steps up which the paying customers can come and this I have shown in Fig 10. In this case $\frac{1}{8}$ in plywood was used. The steps and the seats I have treated with linseed oil which gives a nice natural wood finish, less staring than a shiny conventional varnish.

You will already have checked with a battery that the model runs — probably a little too fast on a fresh battery for realism. Now comes the time to couple it up to the Mamod tractor generator. I have a small compressed air supply for these tiny engines — nothing elaborate, just a Halford's foot-operated tyre pump coupled to the one surviving air bottle from an aqualung — which makes preliminary testing easier than raising steam each time. But it is on steam that it is all designed to run. I have fired the Mamod with both the older methylated spirit lamp as well as the modern solid fuel one. Both work well but the latter is perhaps the slightly hotter flame. Some control of the heat is desirable, such as can be achieved by careful feeding of broken pellets of solid fuel, to keep the engine (and hence the chairoplane) at a reasonable speed. If it is all going too fast then a few blasts on the whistle will slow things down a bit but the engine has to work fairly hard to keep the ride going at a

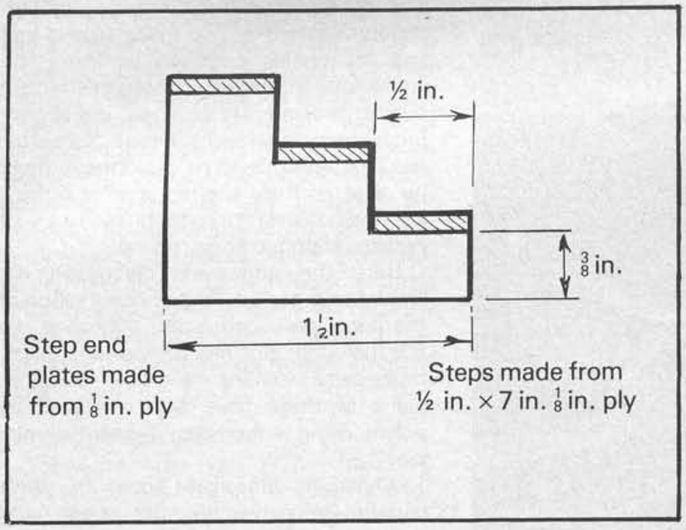
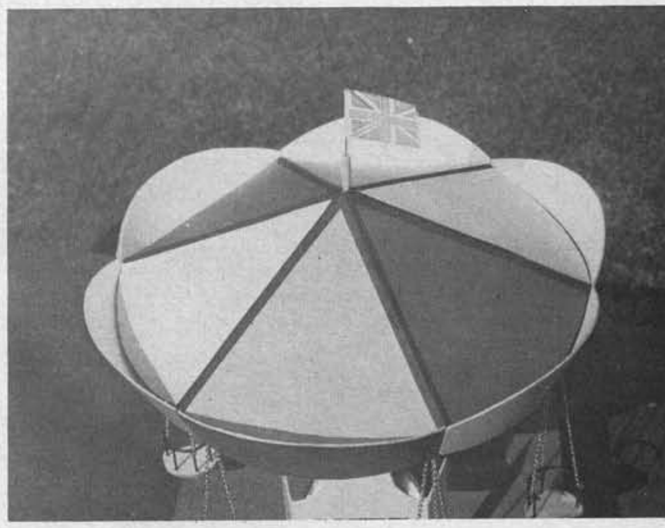


Fig 10 Steps



Showing segments of the tilt and facia boards

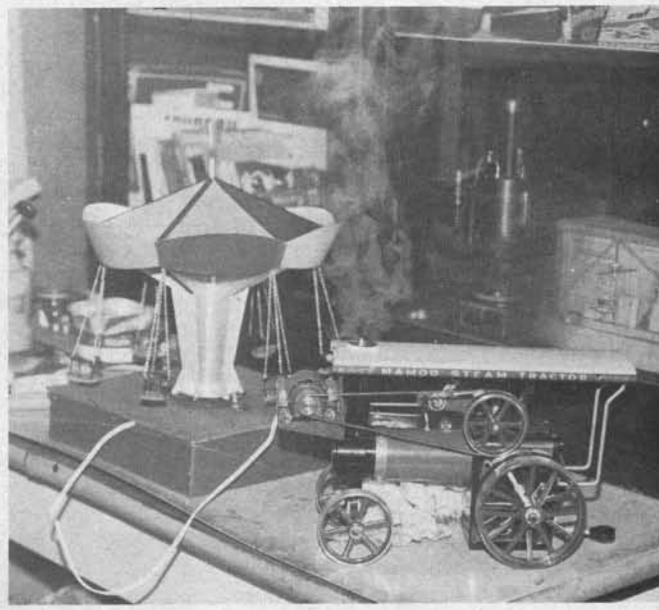
realistic speed so this probably won't be necessary.

It is most important to make sure that friction is reduced to the minimum in both engine and generator and in the chairoplane. We are dealing with very small powers indeed but with care the system works beautifully — as the photos indicate. Perhaps the following brief hints and tips will be helpful.

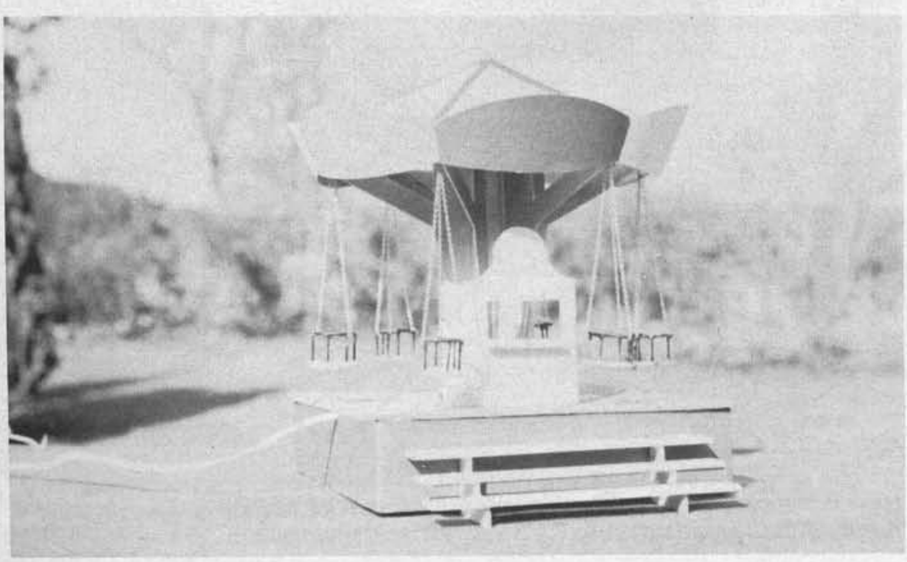
Remember that both steam engine and motor will probably work more effectively runing in one direction than the other. Check which is best for each.

Use the right oil for the engine—3-in-1 is quite unsuitable for steam.

Rubber band drive and chain-hung seats



A first test run in the workshop



Left general appearance of the Chairoplane

The belt from engine to generator should be only just tight enough to drive and the same applies to the rubber band on the chairoplane—a lot of power can be lost at both points by tight belts.

Check too, that the chairoplane column revolves absolutely freely with no binding. Here a drop of sewing machine type oil is just right.

Including the tests with the battery to make sure that everything was running sweetly as work proceeded, as well as a couple of steam runs. The project took me about 20 hours — not an unreasonable time, I think, for the pleasure to be got out of it.

Adhesives Rex Tingey

Some new products plus Aruldite Rapid. Handy strip shown on the right

ADHESIVES have recently advanced rapidly from the crude compounds of the Industrial Revolution. The Second World War started the acceleration with the need for tough, reliable replacements for old-fashioned wood glue to enable strong wooden-bodied aircraft to be built, such as the Mosquito. These were the accelerated resin glues. At the same time solvent glues were being developed for "plastics" as they were being discovered. The first of these we were likely to encounter was Perspex, the acrylic sheet, for which chloroform is a solvent, and an excellent glue can be made by dissolving small pieces in the solvent. This sort of adhesive is not versatile as it will stick only one type of material.

Modern adhesives have been formulated to work with a wide range of materials and the adhesives sold in the D.I.Y. shops are made to adhere to most types of surface with great efficiency. However, within the field of engineering adhesives have become very specialist, so that selecting an adhesive to stick metal to metal from twenty to thirty products can be difficult. Before considering the subtleties the function of an adhesive should be considered.

An adhesive should not only stick two surfaces together, it must also fill any irregularities between the surfaces. An extreme example of this is putty, which, as an adhesive, is required to stick glass to a window frame, but it is in fact used mainly as a filler and a fillet. Jointing compounds used as gaskets, act in a similar way, and are never meant to dry out their linseed oil content. Modern adhesives rely more upon original viscosity for the filling element, the more viscosity giving a greater filling power for a given surface. Additional filling agents can then be used to control the strength of adhesion by "watering down" a very strong basic bond, thus a range of strengths can be made available for different uses.

Workshop Adhesives

The adhesives of today are designed with molecular structure in mind so that a particular surface of material can be matched with a particular bond structure of adhesion to give a very strong joint of the correct flexibility. Today's adhesives do not normally soak into the surface but form a bond of polymerisation upon curing. These adhesives are polymers and during solidification, or curing of the bond, chains of molecules interweave to bind the surfaces together, giving high structural strength. The initial cure is fast and the chains continue to form and interweave with time, growing in strength over several minutes or hours, dependent upon the material and adhesive. To obtain the best bond the type of adhesive must be selected from the range of anaerobic and cyanoacrylate products available, or perhaps from the epoxy resins.

Here the adhesives discussed are limited to those useful in the workshop of the lathe man, and wood adhesives are not included, nor are the solvent glues, from balsa cement to rubber solution; many of these have been replaced by polymerising adhesives. Types included are:

1. Anaerobic adhesives. These are single component poly-acrilicester resins with variations in strength and viscosity, but with a common cure—the exclusion of air. They cannot be used for surface filling, and have limited gap-filling capabilities between surfaces.
2. Cyanoacrylate adhesives. These are single component, water setting compounds. Atmospheric moisture is the catalyst for polymerisation, and they must be used with close fitting components.
3. Epoxy resin adhesives. Two components adhesives which can be used to fill surfaces and gaps. They consist of separate compounds which, when mixed together, set with heat, with the assistance of pressure.
4. Newcomers to the market. Multi-bond acrylic adhesive. Handy-strip epoxy, which will be referred under the epoxy resins. Glass-bond, an ultra-violet light setting adhesive, referred under anaerobics, and Silicone-sealants which are water-setting gasketting compounds.

Anaerobic Adhesives

Anaerobic adhesives are made in a variety of viscosities and strengths so that a thin, weak solution can be used to

Higher temperature engineering adhesives and gasketting grades in 50 ml tubes, with the recommended cyanoacrylate 20 gram size prevent a nut shaking loose with vibration, and a thicker, strong solution used to hold two surfaces together against massive torque forces. Both the weak and the strong remain fluid until they are enclosed between surfaces when, with the exclusion of air, the liquid solidifies. Some of the solutions are thixotropic and keep their shape as a gel until moved or placed under pressure, when they flow. Some makes of these adhesives use a filler additive to make the bond of weaker strength, thus a higher viscosity does not always mean a stronger bond.

Threadlocking Grades

There are three types of threadlocking adhesive. One is for locking studs, one for nuts and the third for screws. These adhesives will fill gaps up to 0.01 inch.

The stud-locking grade has the highest strength, and is meant for threads which usually do not have to be dismantled. The adhesive is used for locking studs into components from which nuts may be required to be removed without moving the studs. Holes can be tapped through into oil, steam or water space as the adhesive effectively seals against leakage.

Components should be de-greased and cleaned before assembly.

The nut-locking grade is a medium strength adhesive to secure nuts which have a limited length of thread, and where future dismantling may be required. Nuts do not need to be cleaned for the adhesion, unless they are heavily greased. I have found that it is preferable to use a controlled oiling of the threads by cleaning thoroughly, applying 3-in-1 to the threads before wiping dry with absorbent cloth, prior to applying the nut-lock and tightening down.

The screw-locking adhesive is a lower strength grade formulated for the longer lengths of screw thread which may need dismantling. It is particularly suitable for the smaller and weaker screws which may break during dismantling. Special cleaning is not advised, but 3-in-1 may be used, wiping the threads dry before applying the adhesive.

Care must be taken not to over-tighten threaded components which are emplaced with a locking adhesive as the loosening force required on dismantling may cause a head to shear off.

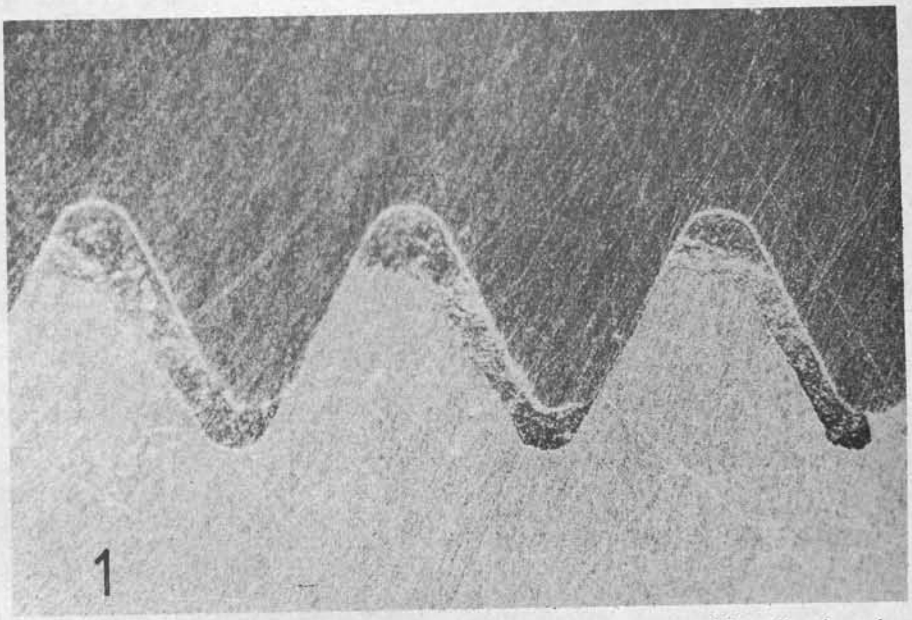
Bearing and Retaining Grades

The grades for retaining provide high strength adhesion where previously it has been necessary to use heat or interference press-fits. The bearing adhesive is the less strong of the two, for retaining ball-races, for example. The retaining grade is strong enough to retain pulleys and gears onto shafts, the components being slip-fitted before adhesion.

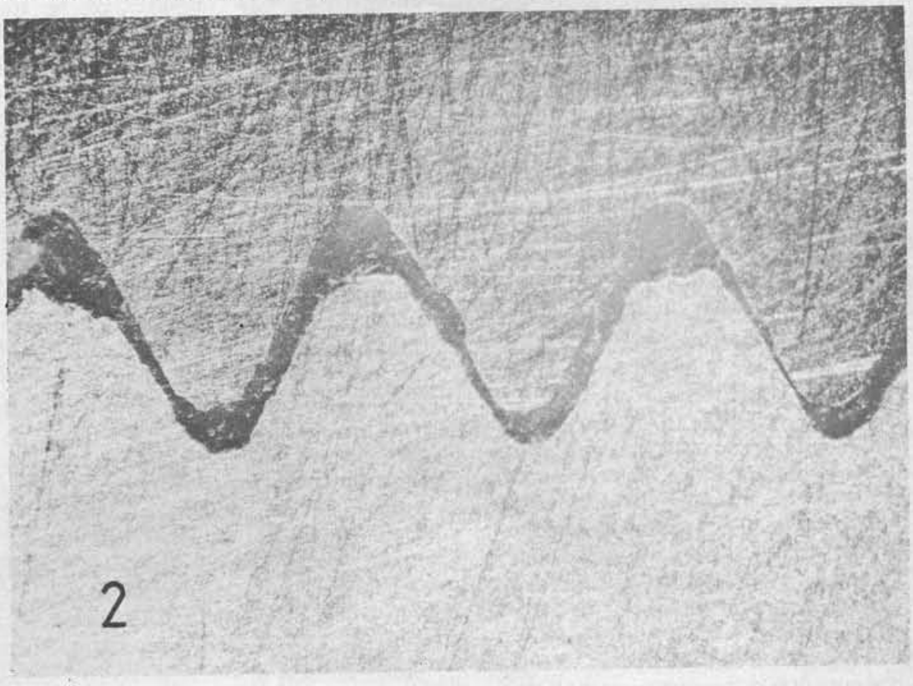
Gasket Replacement Grades

These adhesives are designed to replace the conventional gasket. They will contour and gap-fill, will not shrink with age, remain reasonably flexible and do not pressure set. The gasketting adhesive enters small holes and gaps to provide good face-to-face sealing and eliminates the need for elaborate paper gaskets. However, in my experience it is sometimes required to have a gasket which is partially insulating, such as between a feed pump and a boiler: in such cases a conventional gasket should be used, perhaps with the adhesive.

The paste type fills larger gaps than the fluid type, and both these products are thixotropic. The adhesion strength of gasketting adhesive is high, and, if small securing screws are used, the adhesive strength may cause shearing upon removal. The difficulty here is that the adhesive flows well into the screwholes when under pressure. If the screws are inserted well oiled they may be removed after the gasket has cured, and replaced after cleaning off, using the correct strength adhesive.



Photomicrographs of sectioned threads adhered with anaerobic adhesive. 1. fully tight. 2. finger tight only. The second giving better adhesion, in this case



Capillary Adhesives

Types of these adhesives are Loctite 290 and Rocol SealLock, both low viscosity, medium strength adhesives designed to "wick" into parts already assembled by being drawn into the thread or close-fitting surfaces by capillary action. Parts should have been well cleaned.

Extreme Strength Adhesive

Loctite 317 ND Rocol Fitlock are in the extreme strength class. They have very high adhesion properties, mainly for retaining purposes. I have used these adhesives successfully for "chuckless" turning, just sticking the workpiece onto the lathe backplate and machining after a curing period of 12 hours.

To remove the finished work all that is necessary is to give a sharp knock with a hammer. For more fragile jobs a sophisticated method of removal is to heat the work plus backplate to a temperature where most of the adhesion is lost. To avoid too high a temperature an indicator block of 16 gauge mild steel is used, place on the heated back, and when this goes dark yellow it will be found that the bond is almost gone, and the work will break free with a gentle tap.

The indicator block can be cleaned of the yellow oxidation and used again.

Glass Bond

A new anaerobic adhesive is Glass Bond (Loctite 358) which will bond glass to glass, and glass to metal very successfully. It utilises ultra-violet light to accelerate the cure to about 10 seconds.

An Adhesive Drawback

A major disadvantage with most of these adhesives is the ability of removal with a sharp blow as their impact strength is low. This does not matter in the case of threaded work nor in work where knocks are unlikely to be encountered, but in cases where sharp changes in direction, or where impact is likely, then a second means of securing is recommended, such as a key or grubscrew so that the adhesion break cannot be initiated.

Temperature Range

Anaerobic adhesives have a recommended temperature range from about −50°C up to +159°C. It will be the hot limit which interests us giving a maximum of use in steam application for, say, jointing and thread-locking, up to 55 p.s.i. gauge. Further to this the adhesives retain only 30 to 50 per cent of their ultimate strength at the high temperature, but regain full strength when cooled. I have used Loctites for steam applications of gasketting, sealing threaded unions, sealing fittings into the steamspace of boilers, sealing gauges and glasses without glands, and securing all the moving-part screws of engines, all up to a pressure of 60 p.s.i., with no problems.

There are ancillary Loctites, 306 Adhesive and 648 Retainer, for higher temperature, to retain approximately 50 per cent of their ultimate strength at 200°C. These have a limited outlet and may be difficult to obtain.

Superfast

Loctite call their range "Superfast" because the initial curing time is very fast, dependent on the material and ambient temperature. On copper and its alloys the adhesives cure very quickly, on iron and steel quickly, but on aluminium and stainless, less quickly. A combination of phosphor bronze and dural can cure so quickly with 601 that one on the other has to be correctly positioned within seconds. For the Rocol products the initial curing time is longer, but an accelerator spray can be used.

It is important not to move the bond during the initial curing time as the strength of the bond relies on the first polymerisation period. The time to ultimate strength of a bond varies, dependent on the type, the material, gap-size and temperature of cure. Most threaded jobs can be used after 30 minutes with safety, but smooth bonding jobs should be left for a full 12 hours before working them.

The author tested this range of anaerobic adhesives, evaluating the bond strength, using a torque wrench

Dispensing Anaerobic Adhesives

The standard bottle size (away from the bubble-pack market) is 10 cc or 10 ml, and is a plastic bottle with a removable nozzle and cap, and should be stored upright; it must always have air in the bottle or the adhesive will set. Never draw adhesive back into the container from a work surface as it will contaminate and set the contents. If the adhesive sets in the nozzle, remove the nozzle to clear it out, and, before replacing, clean it through with a chlorinated carbon, such as CTC, and allow the agent to dry before replacing the nozzle.

In use I have found that the best sequence is to first remove the cap, bottle upright, squeeze out a little air before inverting the bottle and squeezing to eject some of the contents, as required. Return the bottle upright and allow the ingress of air to clear the nozzle, wiping the neck with clean rag before replacing the cap.

Safety Precautions

Always wash the hands after using the adhesives, and if you have cuts, bruises or abrasions on the hands wear rubber or polythene gloves when handling these adhesives.

Cyanoacrylate Adhesives

These are now made in twelve grades by Loctite, but I have only tested two. IS415 is a high viscosity grade with reasonable gap-filling properties, and IS495, a low viscosity adhesive for rubber and plastic, used for extremely close bonds. hey both bond in seconds in a relative humidity of 40 to 60 per cent, speed of cure being dependent on the material joined, and full strength of bond is attained in three hours. Both the cyanoacrylates have a high temperature use limited to 80°C, and so are unsuitable for many model engineering purposes, but I have used the IS415 to great effect as an "invisible chuck" in the workshop.

Safety Precautions

Safety problems with the cyanoacrylate cannot be over-emphasised. It will bond body tissue in seconds, before you can think about it. If a piece of metal with this adhesive on its surface is picked up it will be bonded to the fingers; do not attempt to pull the skin surface off, but carefully peel apart. Wear gloves when applying this adhesive. Most chemists sell throwaway polythene gloves which are ideal. Remember not to scratch or rub when wearing contaminated gloves, particularly the eyes. If the adhesive gets onto the skin do not attempt to wipe it off, but flush it off. Keep a bottle, with a dropper, full of acetone for this purpose.

Keep the adhesives and contaminated material out of the reach of children. Use the adhesive in a well-ventilated area. In the case of spillage add water, which will cure the adhesive to a film which can be peeled.

IS415 in the Workshop

This adhesive has a greater potential in the workshop as a chucking medium, being faster setting than th anaerobics. A workpiece can be clamped in a vice after adhering to the backplate, and be ready in an hour for turning. On the hotplate the indicator plate need only be taken to the first yellow, and the adhesive bond will have liquefied, enabling the work to be lifted off; make sure the room is well ventilated and avoid breathing the hot fumes. When cool the film of adhesive can be pulled off quite easily.

For Best Adhesion

Cyanoacrylate adhesives are water setting and rely on moisture upon the surfaces, obtained from moisture in the air. In the British Isles the relative humidity is such that there should always be an ideal curing atmosphere. In conditions of low humidity it should be found sufficient to have a kettle boliling in the workshop before using the adhesive, to quickly supply the right conditions for cure.

For a good bond both surfaces to be joined must be very clean, and a light abrasion of surface helps.

Epoxy resin adhesives S

These adhesives consist of two solutions, and adhesive and a hardener, which, when mixed together, set from a sticky substance to a hard resin by forming its own heat of curing. Brands most easily obtained are Bostic and Araldite both in normal and quick-set versions, and they all set more quickly if both heat and pressure are applied. The standard pack consists of two tubes with different colour codes so that the correct cap can be replaced on the right tube and contamination avoided.

The two solutions are very viscous, and required to be expelled from the tubes in equal amounts to be thoroughly mixed before being applied to the work. The adhesive will bond to most clean surfaces and can be useful for filling gaps and irregularities, and for levelling contours before gasketting surfaces not quite mating with each other. It has excellent high temperature properties up to 250°C and even past this temperature remains quite firmly adhered while browning and smoking. It can, for example, be used to secure a smokebox onto the front end of a boiler with far less fuss than with other methods, and will only burn if the boiler runs dry.

Slight variations in the amount of hardener added can cause the resultant resin to become harded, or more flexible if slightly less adhesive than hardener is used, for different jobs.

A Quick Setting Method

The setting of the epoxy resins can vary considerably when mixed cold. The answer is to mix them hot. Use a piece of 18 gauge brass on the hot-plate, turned down low; as soon as water spits when applied, remove the brass from the hot-plate and squeeze onto the brass the required amount of the two solutions, slightly apart to avoid nozzle contamination. The two solutions will flow together and become far less viscous. Mix together well and the adhesive will become transparent and flowing. The workpiece should be cold and the adhesive applied accurately and quickly: the rapid grade will be half-cured within a few seconds, using this technique.

Handy Strip

Handy Strip is a plastic putty based on the epoxy resin adhesive, very useful as a non-run filler. It is first a two-coloured strip of material from which a piece is cut and kneaded until it is one-coloured, then it can be applied, setting in 24 hours. Its main advantage is that it retains its shape after application, until set.

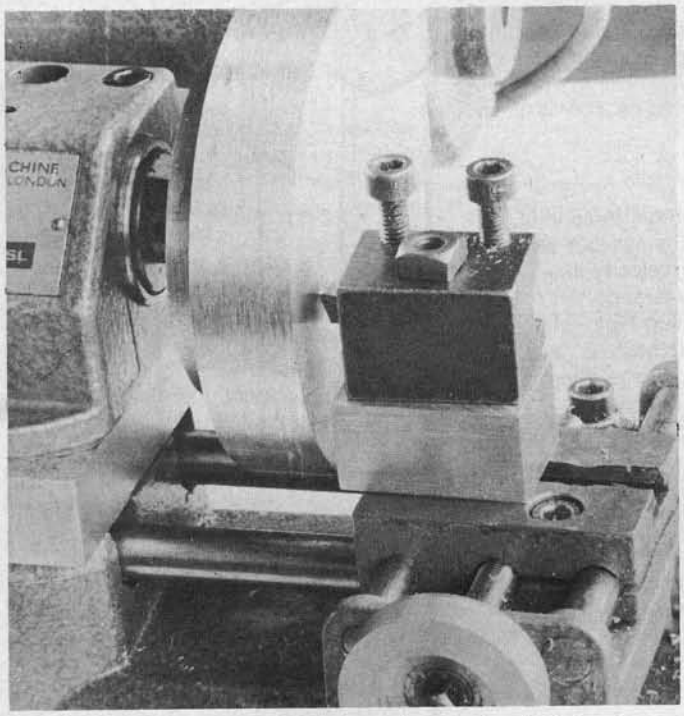
Safety Precautions

The epoxy resin adhesives can cause skin problems, and those prone to skin complaints should wear polythene gloves when handling. The rapid setting resins contain a peroxide which can irritate; a barrier cream applied to the hands before using the adhesives will help the removal of adhesives as well as protecting the hands.

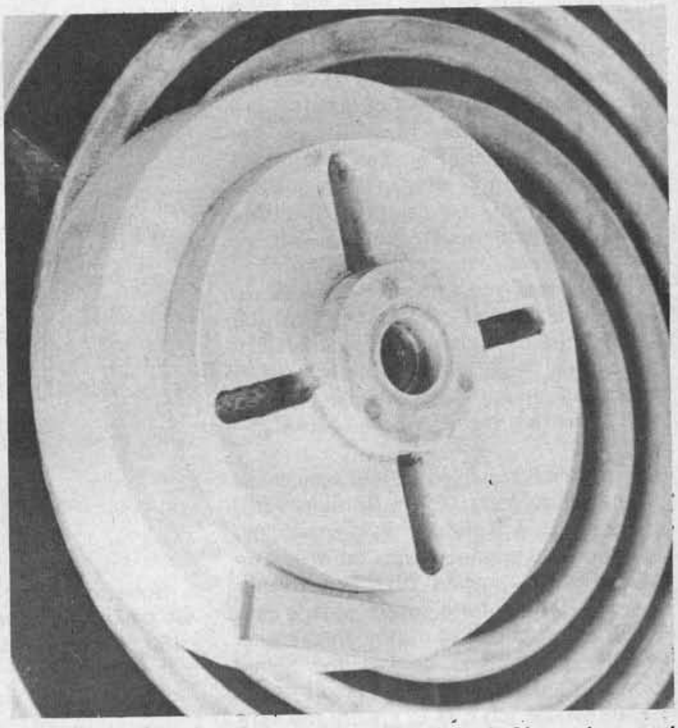
New Products

Silicone Sealants are a new silicone rubber product for mainly gasketting, and are water setting thixotropic paste adhesives. They remain more flexible than the anaerobic gasketting products, when cured, and can be used to higher temperatures.

Multi Bond is an acrylic adhesive, fast-curing with a very strong peel resistance bond; surfaces need no special cleaning. Unlike the epoxies it is a one solution adhesive, but it must be used with a special activator which does not require to be mixed in. The activator is applied to one surface and the adhesive to the other before bringing the bond together. Unlike the epoxies it is not suitable for use in temperatures above 100°C.



Turning a large workpiece adhered to the backplate



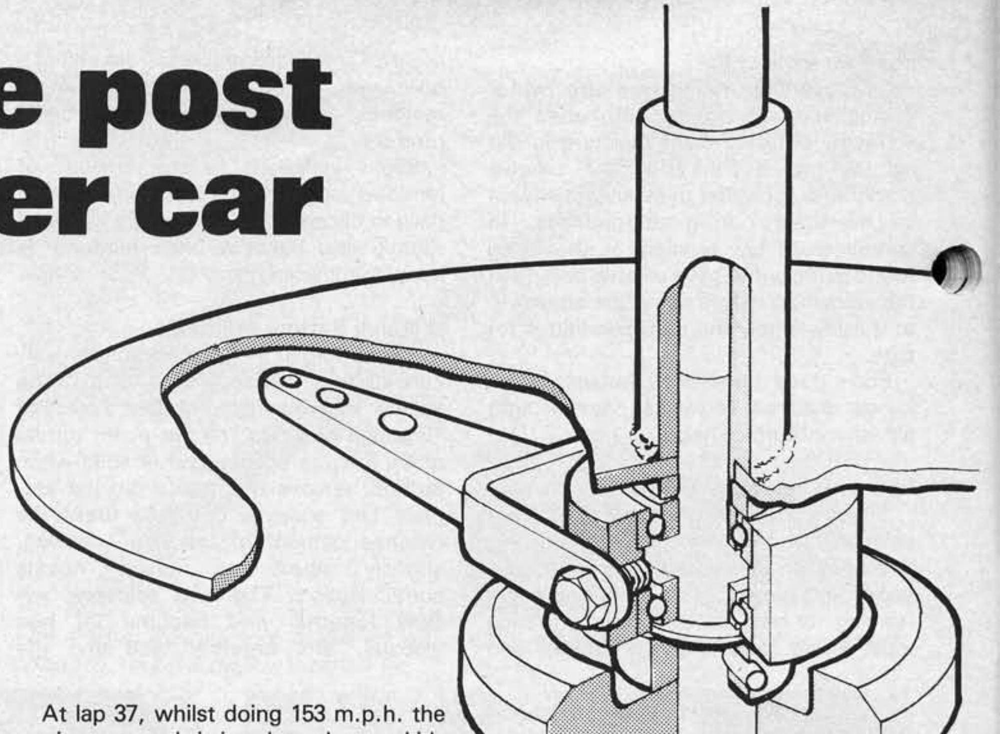
Heating up to weaken the adhesive bond. Note the steel indicator

Recommendations

For the sake of economy it is advised that the 10ml bottles of adhesive be purchased, rather than the bubble-packs. The following assortment of products should be sufficient for the average workshop:

Cyanoacrylate 415	General adhesive
Loctite 601	Bushing and studding
Loctite 222	Thread locking
Loctite 504	Thin gaskets
Rapid Aruldite	Filling adhesive

A centre post for tether car racing



THIS IS THE actual unit made and used at the model engineering symposium held in Pontins Holiday Village at Brean Sands, last October. I have since amended the post slightly to comply with specifications laid down by F.E.M.A. the European body governing tether car racing.

A major problem for people intending to run these cars in this country is availability of a suitable track and since none of the original tracks survive (with the possible exception of Mote Park, Maidstone) we must improvise and the employment of a Tennis Court to this end may be an answer. Most of the net support posts are, or can be made, removable and this device is designed to fit into one of the centre post holes, which at Pontins is an iron pipe 3½ in. inside diameter, let into the ground.

For those of you who have never heard, or seen a 10 c.c. car at speed on the tether, the pivot construction may seem excessively heavy. So let's go through an imaginary run with a car weighing 5½ lb. and powered by a Yellow Jacket 61 engine.

The model is fuelled up and connected to the 35 foot long .059 in. diameter wire, the ends are carefully inspected, the starting pole engaged with the rear axle and the car pushed off. The pusher watches the car for a couple of laps as it circulates at about 30 m.p.h. then leaves the circle to stand outside the heavy diamond link fencing. The person in the centre whose job it is to ensure the wire does not drag and bring the car into the circle, has accomplished this and is now safely on the platform watching the car. A few curious onlookers have drifted over and stand leaning on the fence. The car starts picking up speed and the front wheels dance over irregularities in the track. A couple of car types walk over to the timer and wait for timing to begin.

By lap 10 the engine is running evenly at 10,000 r.p.m. the car is perfectly visible at 80 m.p.h. and noise is around 95 dB. All conversation has stopped and the tourists are no longer leaning against the fencing. At lap 14 the car begins to lose definition, the enthusiasts stop trying to watch it and instead concentrate on engine note fluctuations.

At lap 18 the engine is beginning to howl, the car is a coloured blur, speed has jumped dramatically to 140 m.p.h. and noise is 104 dB. At 155 m.p.h. the timer is started.

At lap 37, whilst doing 153 m.p.h. the engine cuts and six laps later the car skids to a halt.

Now the force exerted by a car is given by the expression:—

$$F = \frac{W w^2 r}{g}$$

Where F = Centrifugal force in lb.
W = Weight of the car (5½ lb.)
w = Angular velocity in radians/sec.
r = Radius in feet
g = 32 ft/sec²
(acceleration due to gravity)

since linear velocity = radius × angular velocity

$$\text{or } V = rw$$

$$\text{then } w = \frac{V}{r}$$

So with the car running at 160 m.p.h. we have a linear velocity of

$$\frac{160 \times 1760 \times 3}{60^2} \text{ ft/sec} = 235 \text{ ft/sec}$$

$$\text{and since } w = \frac{V}{r}$$

the angular velocity w =

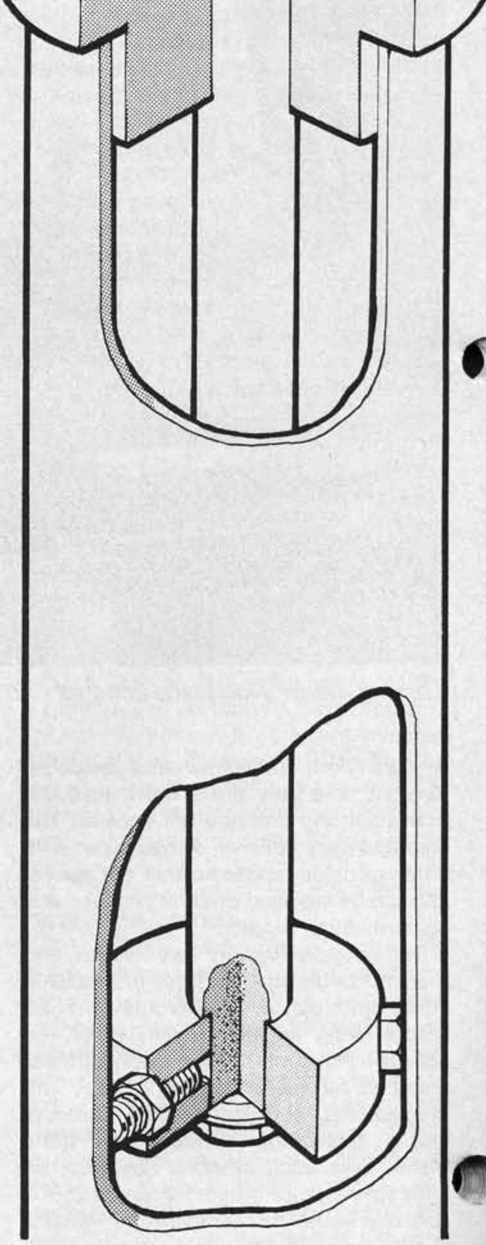
$$\frac{235}{35} = 6.7 \text{ radians/sec.}$$

therefore:—

$$F = \frac{5.5 \times (6.7)^2 \times 35 \text{ lb.}}{32}$$

= 270 lb. this was the mean tension in the cable at 160 m.p.h. Shock loading can effectively double this figure to 540 lb. so even with no safety factor we are talking about fairly major loads and bear in mind the top OPS powered streamliners are approaching 190 m.p.h.

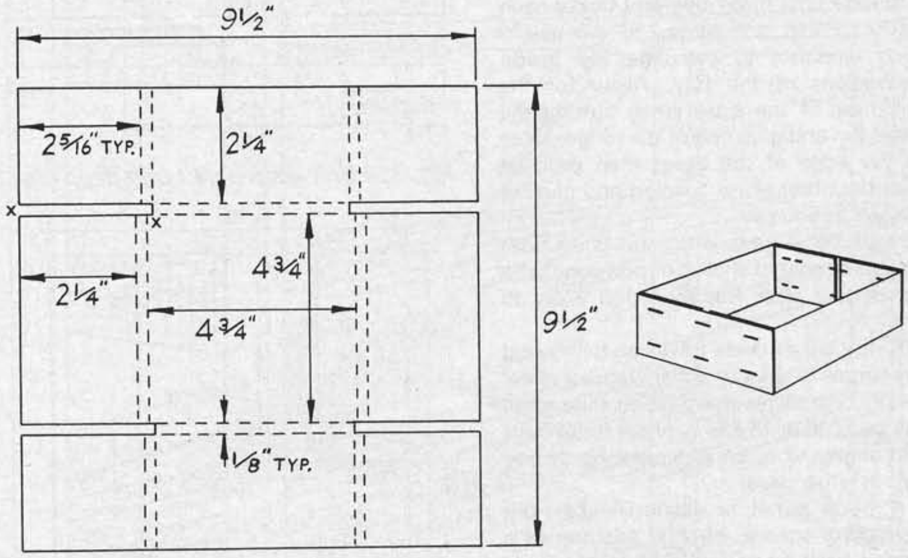
However, to be practical, it is extremely unlikely that a tennis court surface will allow much in excess of 100 m.p.h. although the pivot shown is O.K. for any 10 c.c car currently being run. A permanent installation with a flat surface could dispense with the swining arm weld an arm directly to the bearing housing.

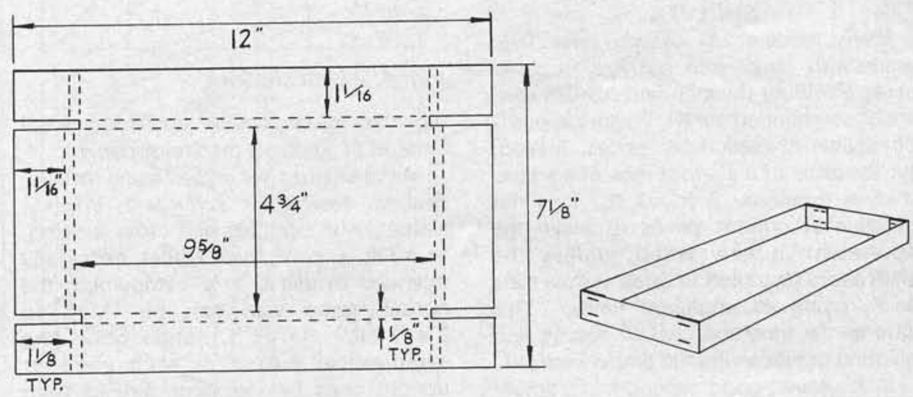


STORAGE SYSTEM FROM SCRAP

By L. Balderstone

HOW TO construct a cheap and versatile storage box system from mostly waste materials. In the previous article I described the techniques of working fibreboard with simple hand tools, and gave constructional details of a small open box in thin card, intended for use as a dividing container within a large tray or drawer. The ways in which this box can fit in with other sizes to give versatility in the use of storage space was described, so now I shall go on to give constructional details for the other sizes of box, and some details of suitable cabinets and shelves to house them.





THE CONSTRUCTION OF BOXES IN THICK CARD

Working in $\frac{1}{16}$ in. thick fibreboard differs from the thin boxes in that all the bends must be scored with double lines, and that double fold-over end flaps are not usually required.

In all the dimensional drawings for boxes, solid lines indicate outlines or slots to be cut, and dotted lines indicate lines to be scored for bending. Dimensions designated 'TYP' mean that the size is typical of all the symmetrical or similar locations on that particular drawing.

1. Mark out your material in accordance with the appropriate drawing, on the inside face of the fibreboard.
2. Cut around the outside edge, and cut out the four slots, as X-X. Score along all the dotted line.
3. Fold all bends up to 90° in turn, as described under Bending in the first article.
4. Fold sides and corner flaps up to 90°, then fold up ends, align corners carefully and staple as shown in the drawings.
5. Clinch all staples down flat.

The types of box and their relevant figure numbers are given in the table, together with the size and thickness of material required for each.

Box Size	Figure No.	Material Size	Thickness
1 unit shallow	5*	6½″ × 4⅜″	0.020″
2 unit shallow	9	8¾″ × 4⅜″	0.020″
1 unit deep	8	12″ × 7⅛″	0.020″
2 unit deep	8	12″ × 9½″	0.020″
4 unit deep	6	9½″ × 9½″	0.060″
Dividing Tray	7	12″ × 7⅛″	0.060″

New readers

For the benefit of any readers who may have missed the first article, the construction of boxes in thin card (i.e. cereal packet thickness, 0.016″ to 0.025″) is similar, except that bends are scored as single lines, bent to 180° and pressed down flat as a preliminary to assembly and stapling as shown in the drawings.

The one-unit deep box is not shown as a separate drawing, as it is similar to the two-unit box, Figure 3. The 9½″ dimension (marked *) is reduced to 7⅛″, and the 4¾″ dimension (marked *) is reduced to 2⅜″: otherwise proceed as for the two-unit deep box.

CABINETS AND TRAYS

The selection of boxes described were designed initially to fit into a drawer of the dimensions given in British Standard 826, Adjustable Steel Shelving.

However, for many purposes simple wooden trays and cabinets are equally suitable or even superior.

Figure 5 shows the type of construction and the finished result. Straight-grained planed softwood or plywood ⅜″ or ½″ thick is suitable for sides, 1¼" wide if for shallow boxes only or 2½" wide to accommodate both deep and shallow. Hardboard or ply ⅛" thick is ideal for bottoms. Panel pins and waterproof wood glue complete the material requirements. Simple butt-jointed corners are quite sufficient, though of course if you have the time, enthusiasm, skill and facilities for proper comb-joints, then so much the better!

Decide how many one-unit boxes each tray is to hold, and allow 2½" per unit in each direction to calculate the inside dimensions of the tray. Allow for the thickness of the sides when cutting the base! Pin and glue one of the longer sides to the edge of the base, then proceed with the other sides, pinning and glueing corners as you go.

Wipe off surplus glue, and finish with one quick coat of shellac or polyeurethane varnish, or clear Cuprinol, and allow to dry.

A number of these trays can be housed in a simple cabinet of either wood or sheet metal. Ledges for the trays to slide upon can be of 16 or 18 s.w.g. sheet metal bent into angle, or of small square hardwood strip in either case.

A back panel is essential, to hold everything square, but the addition of a hinged front cover and a carrying handle will make the whole cabinet portable, if desired. See Figure 7.

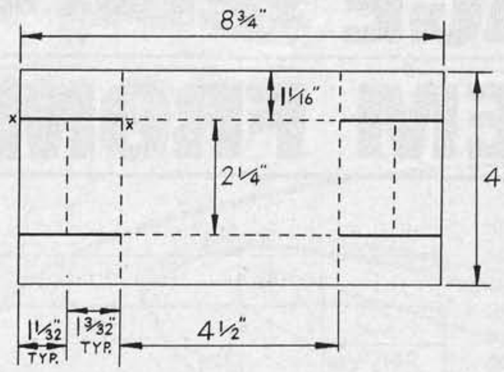
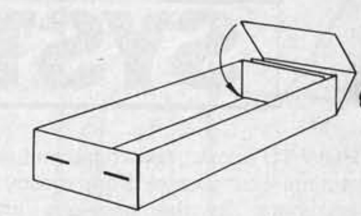


Fig. 3. 2 Unit deep plus 1 unit deep (see text)



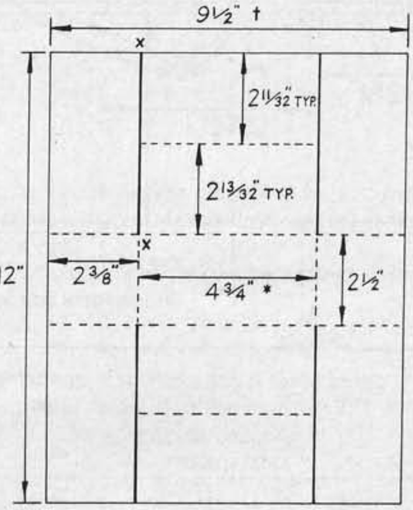
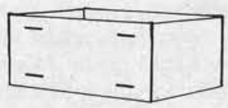
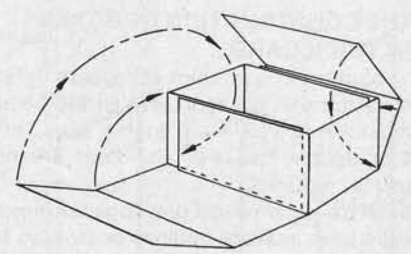


Fig. 4. 2 Unit shallow.





SHELVES

Many readers will already have their workshops lined with shelves, in some cases no doubt the standard BS 826 steel shelvesmentioned earlier, which are easily obtainable at reasonable prices. Indeed, for the price of a six-foot rack of six steel shelves nominally 3 ft. × 1 ft., it is not possible at current prices to make the equivalent in new wood, unless the shelves are restricted to three narrow slats each, using all unplaned timber. This ignores the time and cost of cutting and painting or preserving the timber version.

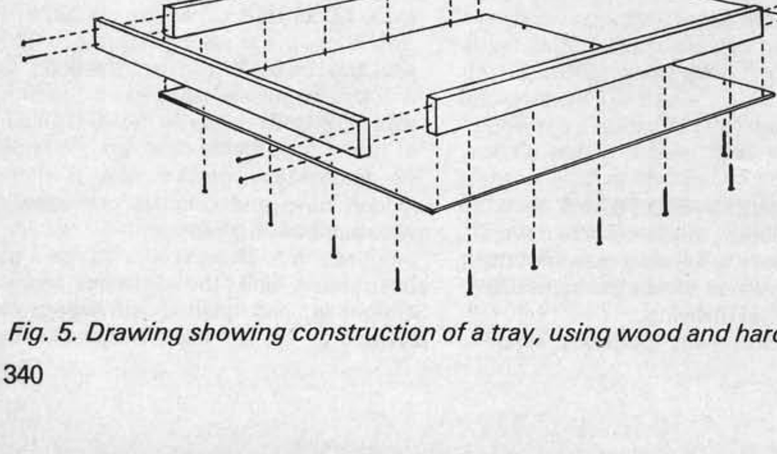
If, however, good second-hand timber is available, such as old packing cases, then it well may be worth setting to work to make your own. Unless space is very tight indeed and only a few shelves are needed, it is worthwhile to make sets of shelves to some standard and repeatable pattern. It saves time and trouble in repeated measurement, and some small amount of jigging is then reasonable.

I have dsigned for myself some racks of shelves, each shelf 3 ft × 1 ft. in area, slatted, with uprights and cross bracing, in such a way that whilst nominally intended to use 2" × ¾" stripwood, the actual wood size can be (1½" to 2¼") × (⅝" to 1"), and only the symmetrical pieces in each shelf or upright need be the same size as each other. This enables me to use any odd pieces of plank, batten or board which I may have around, and cut them into one or other of the five standard pieces required. One simple assembly jig is used both for shelves and the upright frames, to eliminate variation; and a stack of shelves may be dismantled or re-erected in about three minutes. See Figure 6.

To return to our storage boxes, cabinets of trays as in Figure 7 can be made to fit on or in place of existing shelves, of if you already have some of the BS826 steel drawers, the fibreboard boxes can be used in them. Wooden, or wood and hardboard drawers to the same internal dimensions can easily be made, similar to the trays. I have designed and made for own use replicas of the steel drawers in 1/16" fibreboard, which are cheap and serviceable.

FURTHER IDEAS

A tray full of the small dividing boxes lends itself to a number of other very useful purposes. It can be used when



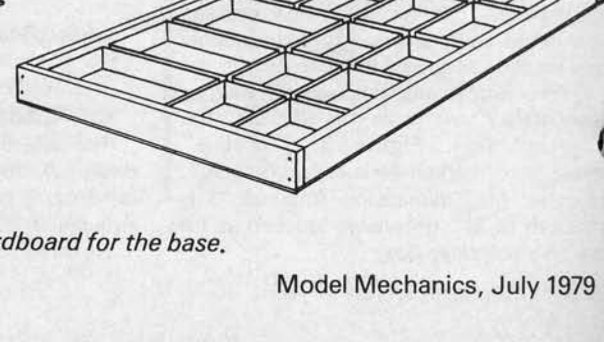


Fig. 5. Drawing showing construction of a tray, using wood and hardboard for the base.

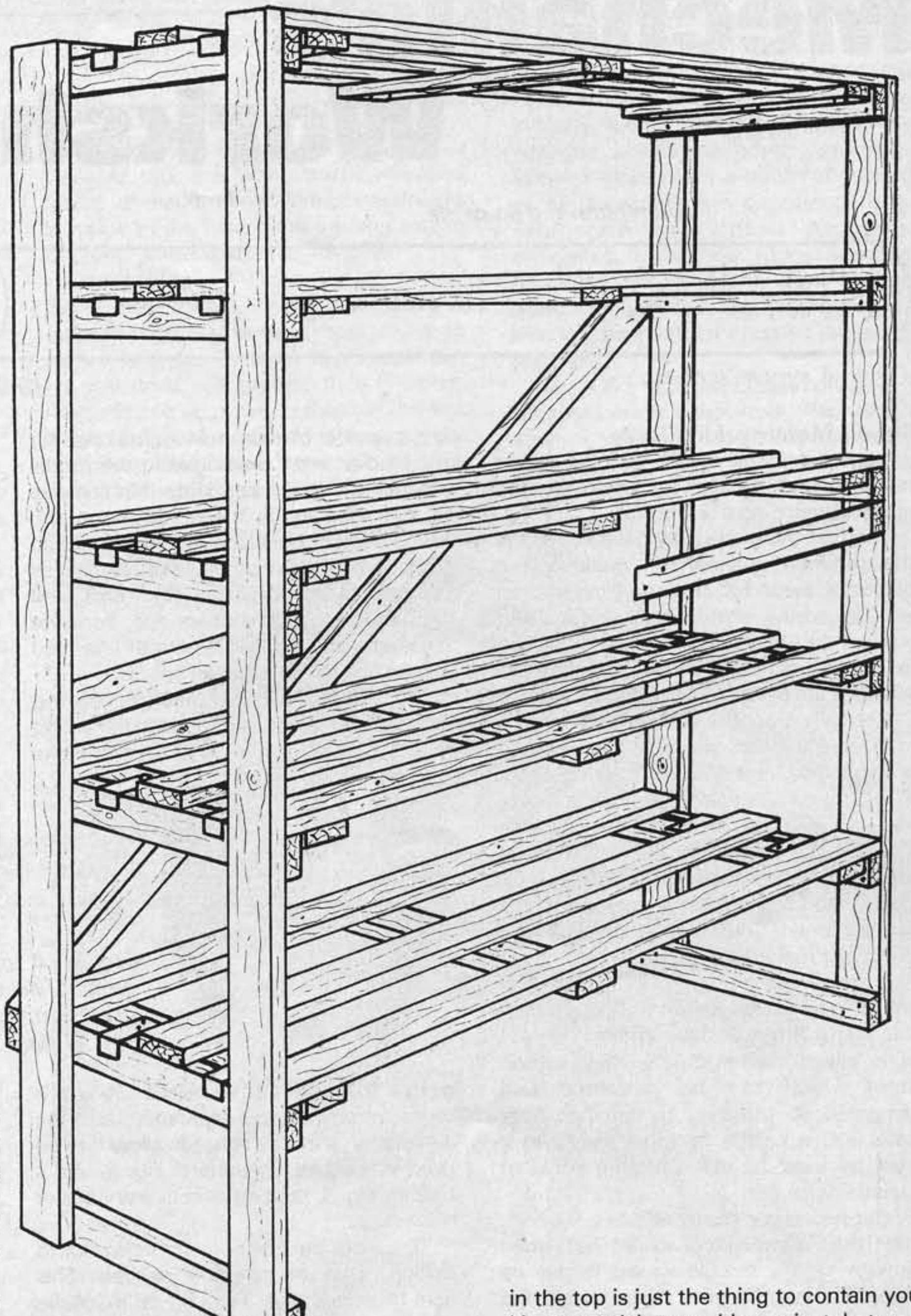


Fig. 6. A rack of shelves, note the metal bracket locking shelf to the upright.

sorting out those random collections of 'mixed fixing items' which one often accumulates, and is also very useful to contain the various screws or parts of any working model, domestic machine or car engine which is being dismantled for repair or maintenance.

A stout wooden or fibreboard box with a tray of the small boxes resting on ledges in the top is just the thing to contain your kit or model assembly project between spells of work. The same sort of box can hold the kit of tools or materials for a particular hobby activity or craft. For example, one of my workmates whose hobby is printing has made himself some type trays on exactly the same principle, working out his own division sizes to suit the pieces of type, after seeing the small boxes described here. Similar shallow boxes have been made, covered with decorative paper, to hold some of my wife's home-made sweets, etc., for fetes and bazaars, covered overall with cling-film wrap for hygiene!

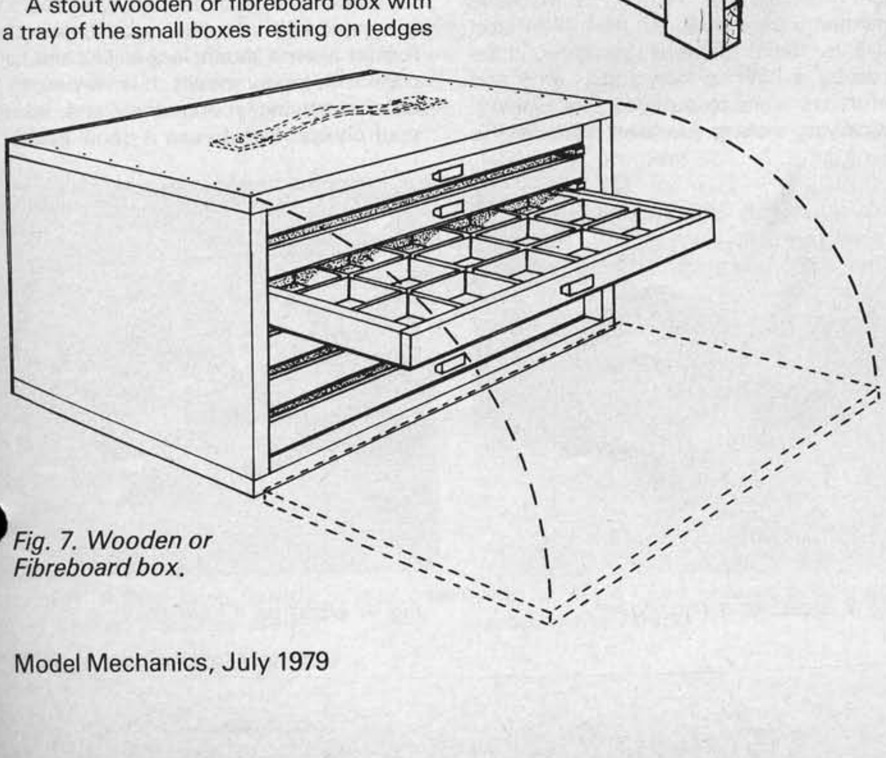


Fig. 7. Wooden or Fibreboard box.

You may find that once you get going your main difficulty is the supply of material, and that you may encounter some surprise as you snatch empty boxes from hands hovering over dustbins, but nevertheless "Round one — come out boxing!", even if the rules owe nothing to the Marquis of Queensbury!

Mechanic's Workshop

By Andrew Smith

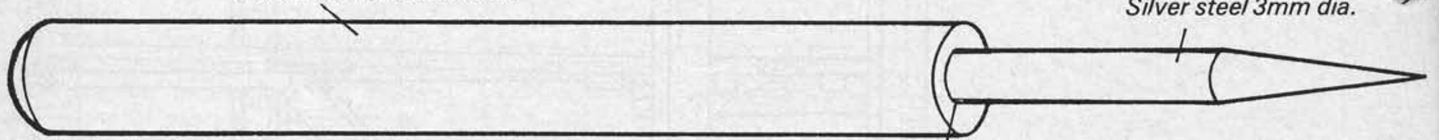


Fig 1. A simple scriber .

Simple Metalworking Tools

We will deal this month with the simple metalworking tools most useful to the reader developing a workshop.

The first thing you may have noticed is the different manner of marking out pieces of metal for cutting, filing and so on. The scaley, shiny or oily surface that we find on a metal does not lend itself to taking or retaining a pencil line; although felt pens are useful for rough marking out.

Normally a scriber is used to scratch a mark on the metal, which will show up as a bright line, easily seen in good light. Although commercially available, scribers may be wuickly made to the scheme shown in the sketch Fig. 1. Drill the end of the rod to accept the point and press it in. Years ago I made such scribers from the old-fashioned gramophone needles and they were marvellous.

A brief explanation about the stuff called "silver steel" might not be amiss at this point. It has nothing whatever to do with "silver", being actually a high carbon steel which can be hardened and tempered to provide, in this particular case, a sharp point. In other examples it may be used to make cutting tools of various types.

The necessary heat-treatment is, first, heat the "silver" steel to red heat then quench rapidly in cold water. It may be that for your scriber this is all the treatment required and will give you an exceptionaly hard point that may be ground and oilstoned down to needle fineness. If the point is too brittle and tends to break under light hand pressure, the steel needs to be tempered. This is carried out by first polishing the steel bright with some emery cloth, then gently heating (really gently), until a straw colouled oxide layer begins to form on the steel's surface. This needs to be viewed in a subdued light. Whn the colour appears, quench the steel again in cold water.

Different degrees of hardness are required for different tools and, with care, can be accomplished using "silver" steel and these simple heat treatments. About this interesting activity, more anon.

Along with the scriber we will need a steel rule for measuring and a try-square to get things at right angles. The former would ideally be 150mm (6 inches) long and the latter of 100mm (4 inches) size for the kind of work envisaged in the model mechanic's workshop. Note that the size of a try-square is measured along the inside edge of the blade, the inside leg, so to speak. Such other instruments as dividers to mark circles and arcs and micrometers and verniers for accurate measurement, we will deal with later and can be bought as the need arises.

In terms of simple measuring equipment, the rule fitted with sliding heads, shown in Fig. 2, is a very useful device. It contains an excellent rule which saves us buying one separately, and the adjustable caliper type heads allow it to be used as a simple try-square, Fig. 3, and a caliper, Fig. 4, reading directly in inches or millimetres.

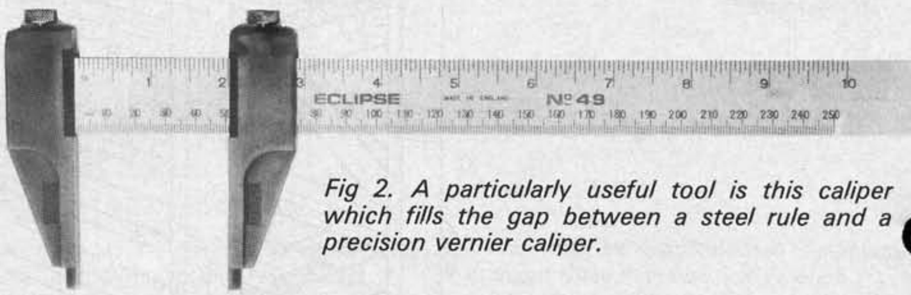


Fig 2. A particularly useful tool is this caliper which fills the gap between a steel rule and a precision vernier caliper.

To set out the position of a hole prior to drilling, a centre-punch is needed. This can be made see Fig. 5, in a similar manner to the scriber, but from silver steel of 5 to 10mm diameter, however, there may be a limit to how much time and effort we want to put into tool making. Mind you, making your own equipment is a very praiseworthy pastime. It can be carried to excess, but every man to his own taste.

Now we can measure and mark out the size and shape of the metal required, we must be able to cut the same. For this a metal-cutting hacksaw, Fig. 6, is used. Note that the demonstrator in this picture is left-handed. Whether you choose a file- or pistol-type handle is up to you, but the frame must be adjustable to accept different lengths of blade.

The choice of a blade is important. They are available made either in "high-speed" steel or "carbon" steel and as "all hard" or "flexible". The "hard" type, in the hands of a skilled user are highly efficient metal cutters, but the "flexible" is likely to give a considerably longer working life if the user's actions are less skilful. Whether you choose "high speed" or "carbon" may depend to some extent on the depth of your pocket, but the former have a much longer life and will cope with harder metals. It is very much a case of paying your money and taking your choice. But do use a good make.

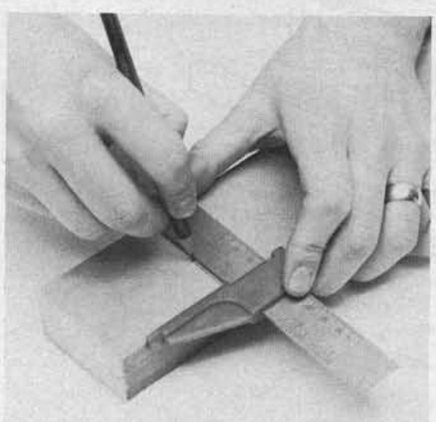


Fig 3. used as a try-square.

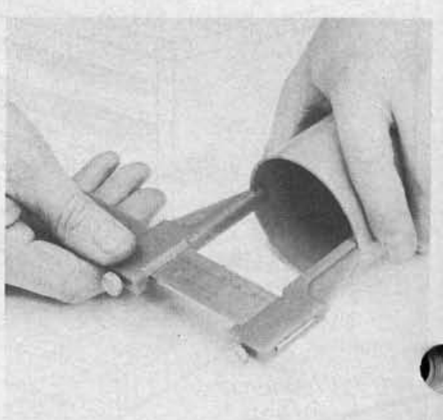


Fig 4. Used as a caliper.

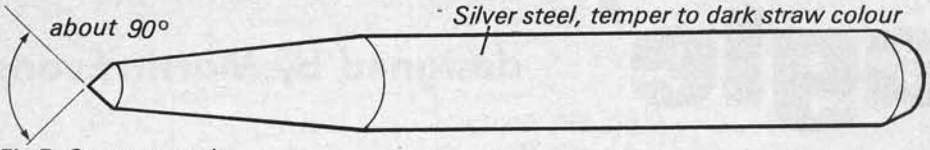


Fig 5. Centre-punch

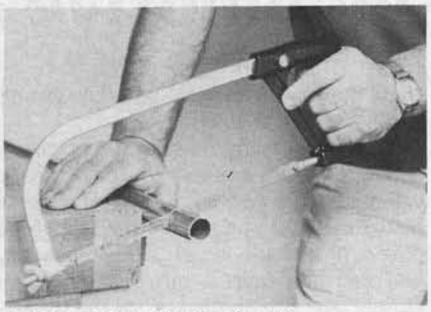


Fig 6. Using the hacksaw.

In addition you will need to choose a particular tooth size, or number of teeth per inch. Generally 18, 24, and 32 teeth per inch are standard, although others are available. For cutting steel and cast iron use 24 tpi, for aluminium and copper alloys the coarser 18 tpi will reduce clogging, while for sheet and tube 32 tpi will be about right. If choosing one grade, go for the middle one.

Breaking of hacksaw blades is generally the result o them being twisted or wrenched in the cut. Loss or rapid wear of the teeth is invariably due to them straddling thin work with the result that the tips of the teeth are broken off. There should always be at least three teeth in contact with the metal in the cut.

The two other tyhpes of saw will be useful in the workshop. For fine work, the so-called "Junior" hacksaw, Fig. 7,

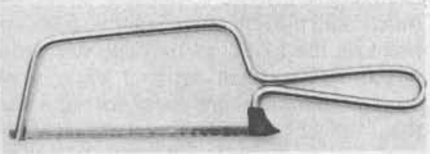


Fig 7. The Junior hacksaw.

consisting of a simple frame with a miniature blade is ideal; while to use up the blades inadvertently broken, we can obtain a simple handle into which the broken remains can be clamped for those occasional awkward to get at places, see Fig. 8.

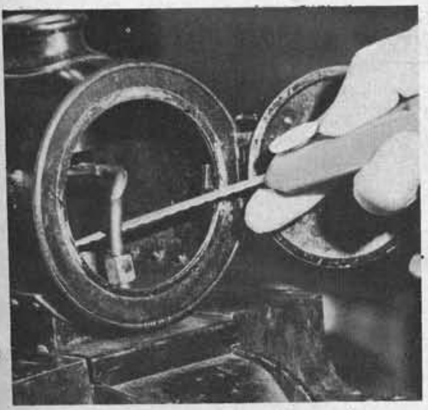


Fig 8. A pad-saw, handle makes use of broken hacksaw blades.

The ability to hacksaw accurately in a valuable skill and when learnt will save hours of hand filing. Which seems to bring us to the next metalworking tool in our mechanic's workshop—the file.

These come in a wide range of shapes, Fig. 9. Flat, square, round, triangular and taper section and in sizes from about 16 inches long downwards. It is rarely that we will need any greater than 8 inches long and as a start two or three of this size should suit us for the odd jobs about the workshop and house that will give us some practice in their use.

Without exception we are sure to be using twist drills. They are available in a wide range of sizes and it is more economical to buy them as required rather than bothering with a set. At the moment industry is changing over to metric and I suppose I shnould advise you to do likewise—but! With a hobby that is still, as far as screws are concerned, largely Whitworth and British Association orientated, I can only suggest that you proceed slowly and only purchase what you actually need. This is another topic that will be enlarged upon as the months progress.

Again like hacksaw blades, drills can be obtained made either from "high-speed" steel or "carbon" steel. Buy the former, they will be more expensive, but last longer.

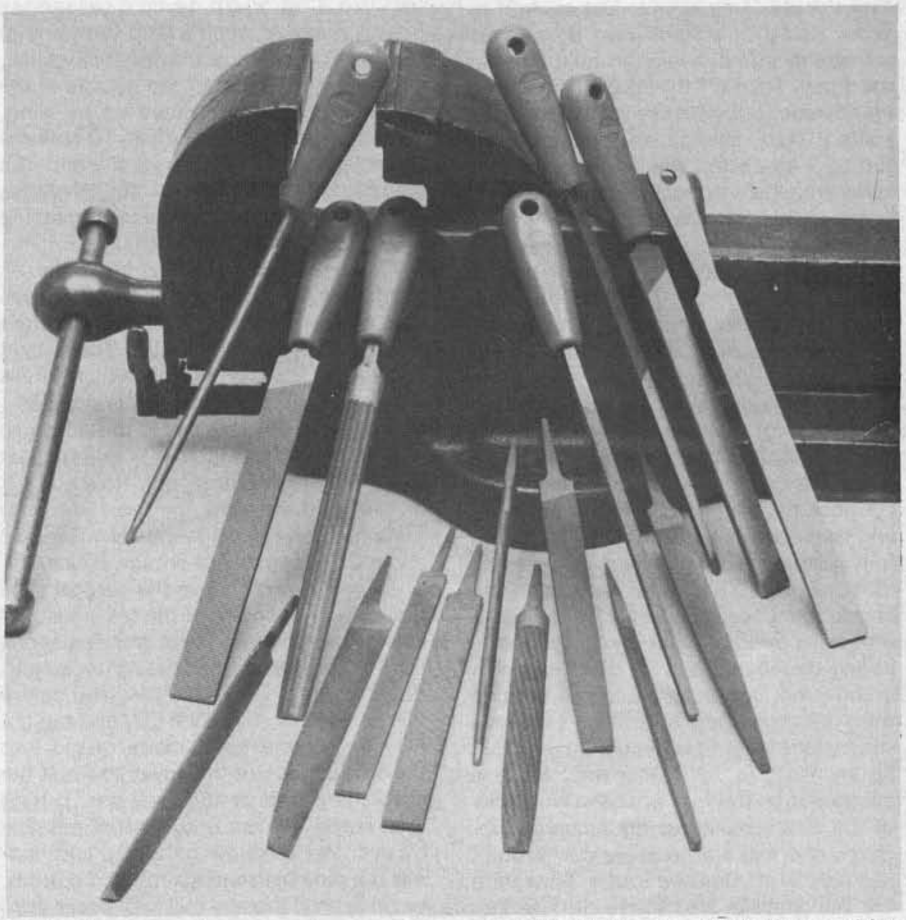


Fig 9. Files come in many shapes, sizes and cuts: Choose carefully those which will be of greatest use. A substantial vice is a must.

Figure 10 illustrate the method of handling files. If you happen to be left-handed, hold the pictures up to a mirror.

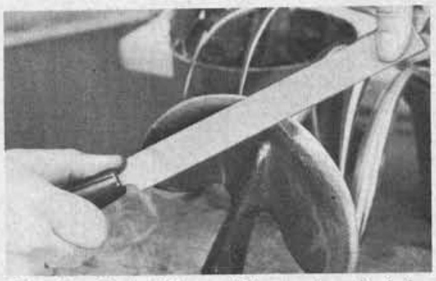


Fig 10. Gain filing skill on simple jobs around the house.

It is said that a picture is worth a thousand words, but in learning to use tools, a simple five-minute demonstration is worth a hundred pictures. So may I suggest that you join an evening class in workshop practice at your local Technical College or Evening Institute.

Now a postscript. The final paragraph of the April Mechanic's Workshop about simple lathe building has not been forgotten. Our Editor suggested that this interesting activity be held over for a period until readers, new to the workshop, had the opportunity to organise the hand-tool side of their facilities—a sensible observation.

The 'Eagle' designed by Martin Evans

A simple 2½ in gauge 4·4·0 locomotive

CONTINUING with the cylinders for our G.N.R. (I) 4-4-0, the next items to be tackled are the end covers and steam chests. Gunmetal castings will be available for these and they are quite easy to machine.

End coveres

To deal with the end covers first. Chuck the castings by the outside and take a cut over the chucking spigot, just enough to leave "clean" metal. We now have something true by which to hold them in the 3-jaw. Face off the rough skin with a round-nose tool set cross-wise in the tool-holder, then change to a knife tool, setting it at a slight slant to the job; turn very carefully to a good fit in the bore for a length of 1/32 in. The flange part, that makes contact with the cylinder body, is carefully machined off, followed by the outside diameter to 1⅛ in. To hold the covers to face off the outside, a home-made step-chuck is used. To make this, we need a brass blank or another gunmetal end cover casting from a locomotive of the next larger scale would do nicely if no brass blank is available, in which case, turn this all over first.

Chuck the blank or casting in the 3-jaw and turn down a shade under ⅜ in. length to a little over 1 in. diameter — the exact diameter doesn't matter. Reverse in the chuck, face, centre deeply, drill a pilot hole right through and open it out with a boring tool to about ¾ in. dia. Next, with a knife tool set cross-wise, and starting from the edge of the hole, form a recess a shade under 3/32 in. deep in the face, this to be an exact fit for the covers. Make a centre-dot on the face opposite No. 1 jaw of the chuck, take out the embryo step-chuck and make a hacksaw cut through one side of it. Replace in the 3-jaw with the dot opposite No. 1 jaw, put the first cover in the recess and tighten the chuck jaws, when the cover will be gripped firmly and should run true. Saw off the chucking piece before facing off the outside.

Rear covers

The rear covers are a little more work as they incorporate the gland and stuffing box and also carry the slide bars. Deal with the "register" side first, exactly as for the front covers, but before removing from the chuck, centre deeply, and drill right through 5/32 in. dia. Reverse, and set up again in the "step-chuck". Saw off the chucking piece, if any. We now have to open out for the stuffing box, with a 9/32 in. drill, for tapping 5/16 in. × 40t. However, it is very difficult to ensure that the larger drill follows the 5/32 in. drill concentrically, so I would strongly advise making, or purchasing, a pin-drill. We want a pin-drill of 9/32 in. diameter with a guide pin 5/32 in. dia., obtainable from Reeves or Kennions (Incidentally, a 9/32 in. pin-drill with a ⅛ in. dia. guide pin would be fine, provided the cover is only drilled ⅛ in. dia. at first. It can always be opened out afterwards).

Open out the hole to a depth of 9/32 in. then tap 5/16 in. × 40t, using a second tap first, if available, then a plug (bottoming) tap, holding them in the tailstock chuck.

The unturned part of the outside of the rear covers can be cleaned up by filing, though it isn't really essential. To hold the covers for doing this, screw the end of a length of brass rod 5/16 in. × 40, screw this into the cover, then you have something to hold it by.

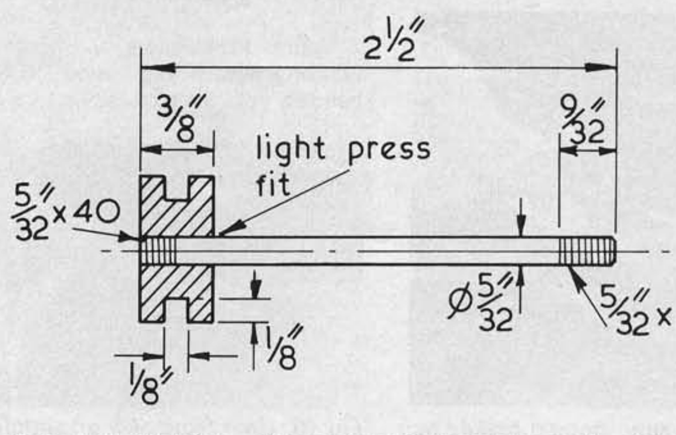
The next job is a little bit tricky — machining the flats or steps to carry the slide bars. These must be equidistant from the piston rod hole. The way I usually do this is as follows: A short length of silver-steel ⅝ in. dia. and about 7/16 in. long is taken and this is turned down to 5/16 in. dia. for a length of ¼ in., this part being threaded 5/16 in. × 40t. Now put a 5/32 in. drill right through.

Next, take a short length of mild steel about 3 in. long and of section about 1 in. × ¼ in.; clamp this to the vertical slide horizontally over one of the tee-slots, and adjust the slide so that the horizontal centre-line of this is at lathe centre height. Put a centre drill in the 3-jaw, and centre this bar deeply, then drill (32) and tap it 4 BA. Screw the home-made gauge into the stuffing box of the cover and bolt the cover hard against the steel bar, setting the "steps" as near horizontal as possible by eye. We can now go ahead and end-mill the slide bar seatings top and bottom, working until the end mill just grazes the ⅝ in. dia. of the gauge, with the knowledge that the two seatings will be exactly parallel to one another.

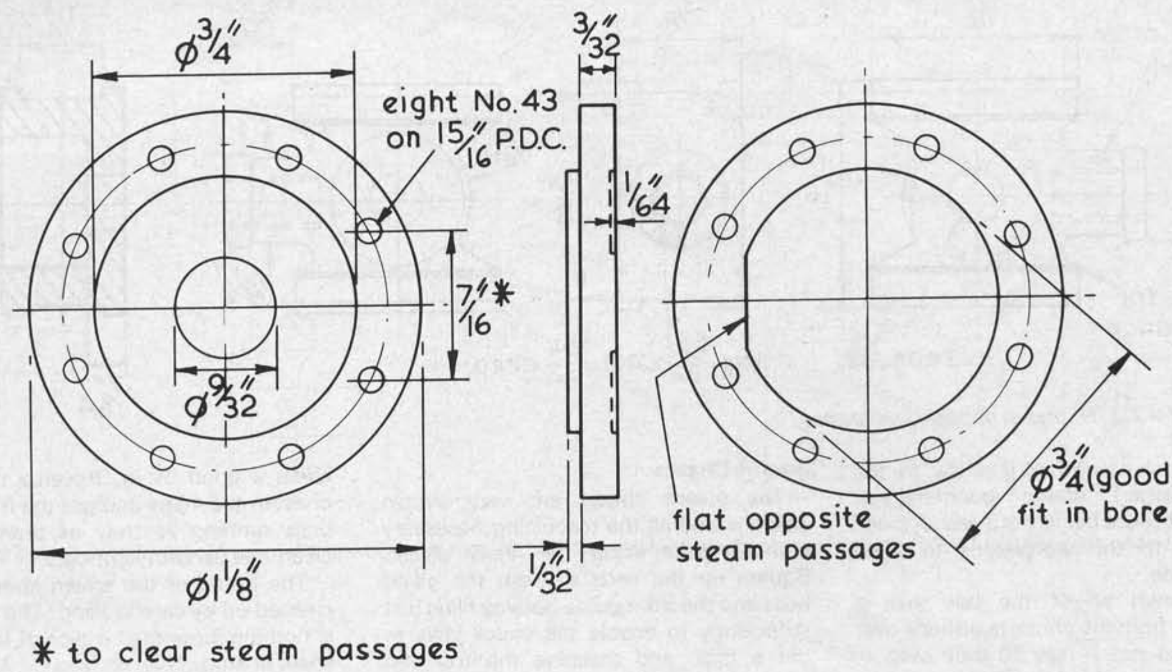
To drill the fixing holes in the covers, it is worth making a simple jig, for which we will need a big washer, or a steel or brass blank (steel for preference) the size of the covers or a shade larger. Chuck this truly and drill and bore it out until it will fit closely over the "registers" of the covers. Set out the location of the fixing screws on this, drilling them No. 50 (tapping size for 8 BA), also noting that the spacing is not regular all the way round, due to the proximity of the steam passages. Put the jig over the covers in turn, clamping them in place with a small toolmaker's clamp, then run the No. 50 drill through, into the cylinder block. Remove the jig, and drill the block to a depth of ¼ in. or a shade more, then tap 8 BA, using taper or second tap to start with, completing with a plug tap. Note as the spacing of the holes is irregular, the covers will be "handed", so the drilling jig will have to be reversed between drilling for the front and rear covers. Incidentally, when drilling for the rear covers, make sure that the slide bar seatings are "square", in other words at right-angles to the bolting face of the cylinder block. Don't forget, also, to make a little identification mark on each cover, where it doesn't show too much, and also on some suitable adjacent point on the block, so that you will know which cover goes where. Very small number punches are ideal for jobs like this.

Pistons

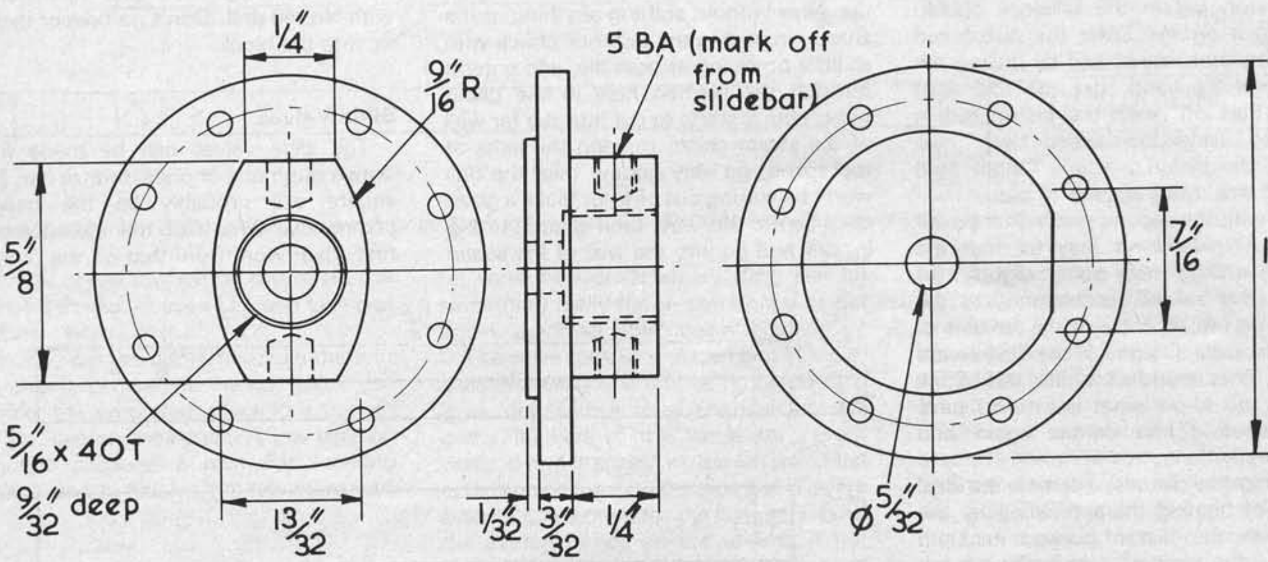
Make the piston rods first. These are 2½ in. lengths of 5/32 in. dia. stainless steel. At the piston end, put 3/16 in. of 5/32 in. × 40t. thread on, leaving the threads a shade on the large side. At the other end, 9/32 in. of similar thread.



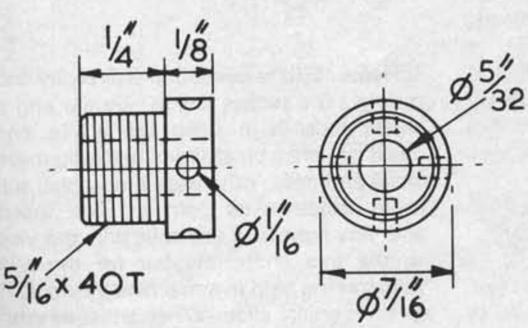
Piston & Rod: 2 off piston — drawn phosphorus bronze rod — stainless steel



FRONT CYLINDER COVER (x2) 2 off gunmetal
(R.H. drawn)

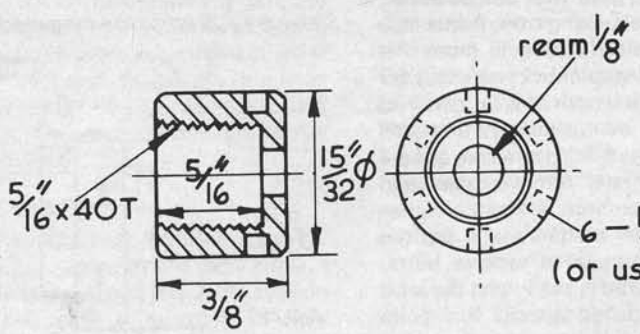


REAR CYLINDER COVER (x2) 2off gunmetal (RH drawn)



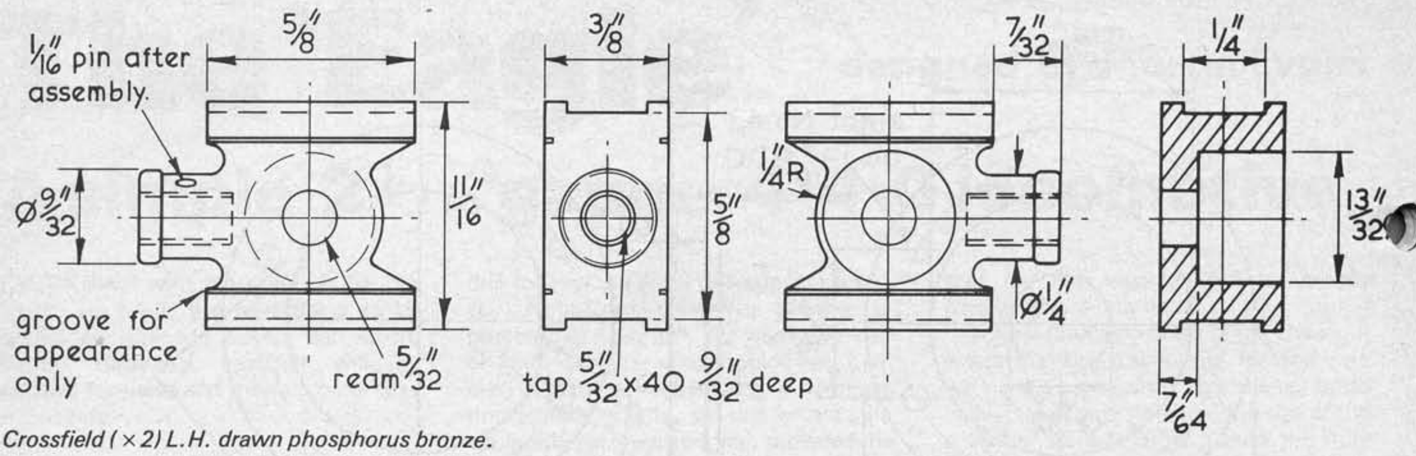
PISTON ROD GLAND (x2)

2 off gunmetal



VALVE SPINDLE GLAND (x2)

2off gunmetal



Crossfield (× 2) L.H. drawn phosphorus bronze.

Now chuck a length of 11/32 in. dia. (or the nearest larger) drawn gunmetal or phosphor-bronze bar in the 3-jaw. A piece 1⅜ in. long for the two pistons, to be on the safe side.

Turn down all of the bar that is protruding from the chuck to a shade over the finished size — say 10 thou over — face the end, centre deeply, then drill 1/8 in. dia. to a depth of 7/16 in. full. Tap 5/32 in. × 40t. with the tap in the tailstock chuck. Then open out with No. 23 drill to a depth of 3/16 in. Put the packing groove in for the first piston only at this stage, and put the first piston rod in the tailstock chuck, gripping it *tightly*. Enter the piston rod into the piston blank, and by pulling the lathe bolt by hand, get the rod right home. Part off, with the piston rod in position, using low speed here, also leaving the piston a shade longer than finished size, say 3/8 in. plus 10 thou.

Deal with the second piston in a similar manner. However, it may be that the original drilling has gone slightly off centre (this sometimes happens to the best of us!). If so, face off the remains of the blank until all signs of the "off-centre centre" (that sound a bit Irish, but I think readers will know what is meant!) have disappeared. Then centre again and repeat operations.

To finish the pistons, a collet is the ideal means of holding them, holding by the rod, with the piston pushed hard up against the collet. However, many builders will not have collets, so they could try the old dodge of packing out the offending jaw or jaws with bits of paper, until the piston is running true. Better still, make an improvised collet, in much the same way as the step-chuck was made for the covers. Use a length of 5/16 in. dia. mild steel, face this, centre deeply, then drill No. 23, and ream 5/16 in. dia. Make a mark opposite No. 1 jaw, remove collet and split it lengthwise with a fine saw. Re-chuck, aligning by the jaw mark, put the reamer through again to remove burrs, and if the piston rod is put in and the jaws tightened, the piston should run quite true.

Take very fine cuts with a sharp tool, until the piston will just slide in the bore of the cylinder, with no signs of shake, using each cylinder in turn as a gauge.

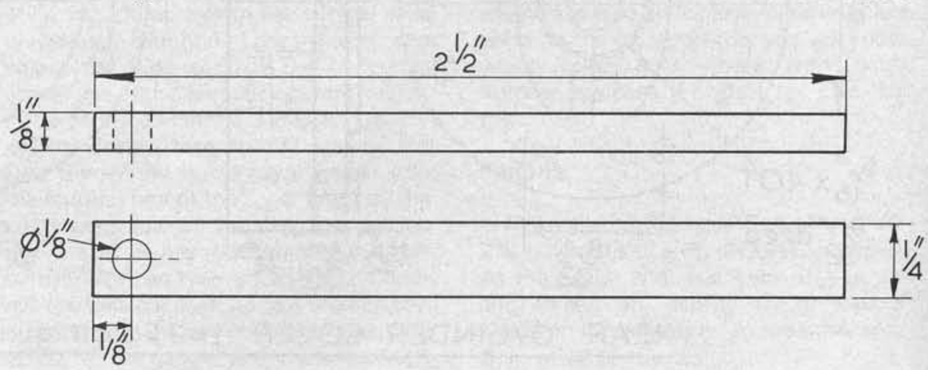
Steam Chests

The steam chests are very simple castings and all the machining necessary can be done using the 4-jaw chuck. Square up the ends of both the gland boss and the front guide boss by filing just sufficiently to enable the chuck jaws to get a grip, and machine the top and bottom faces right across, using a tool set cross-wise in the lathe toolholder. Re-chuck to turn the gland boss, making sure that the centre of this is offset as shown on the drawing. Thread the outside 5/16 in. × 40t, centre deeply, drill and ream 1/8 in. dia. Now without shifting anything, put a sharp 1/8 in. drill in the tailstock chuck with as little overhang as possible, and enter it through the reamed hole in the gland boss, until it starts to cut into the far wall of the steam chest, running the lathe at top speed, go very gently, then the drill won't be sprung out of true. Make a good deep centre this way, then change to a 3/32 in. drill and go into the wall of the steam chest a good ½ in. Reverse the steam chest in the 4-jaw and get the front guide boss running as truly as possible, and clean this up with light cuts.

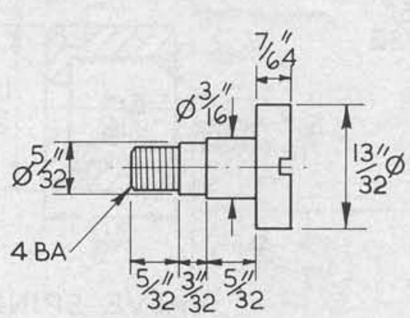
The inside of the steam chest can be cleaned up by careful filing. The top cover is nothing more than a slice of hard brass sheet or strip, 1⅝ in. × 1⅛ in. × 3/32 in. thick. Mark out the screw holes in this, then use it as a drilling jig for the steam chest, which itself can then be used as a drilling jig for the cylinder block. Use No. 48 drill, tap the block 7 BA, then open out the holes in the top cover and steam chest with No. 40 drill. Don't go deeper than 3/16 in. into the block.

Slide Valves

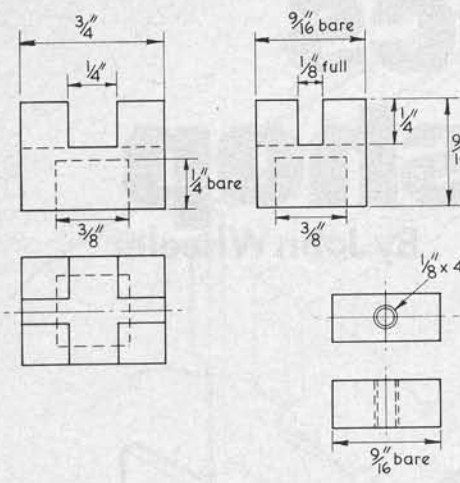
The slide valves can be made from drawn gunmetal or phos/bronze bar. 5/8 in. square will probably be the nearest commercial size. Cut the steam recess first, then work from that on the outside surfaces. This is best done entirely by end milling. The recess is 3/8 in. square and a shade under ¼ in. deep. Use a 5/32 in. end mill if you are a bit afraid of breaking these small end mills, otherwise 1/8 in. which will leave rather neater corners. High speed and very light feed will save an extra visit to the tool shop, the bar for the two valves being held in a machine vice bolted to the vertical slide. When satisfied with the two recesses, mill or file the outsides. Turning the bar round, mill the two slots, one 1/8 in. wide for the spindle, the other ¼ in. for the driving nut. If using ordinary square brass for the nut, don't use a ¼ in.

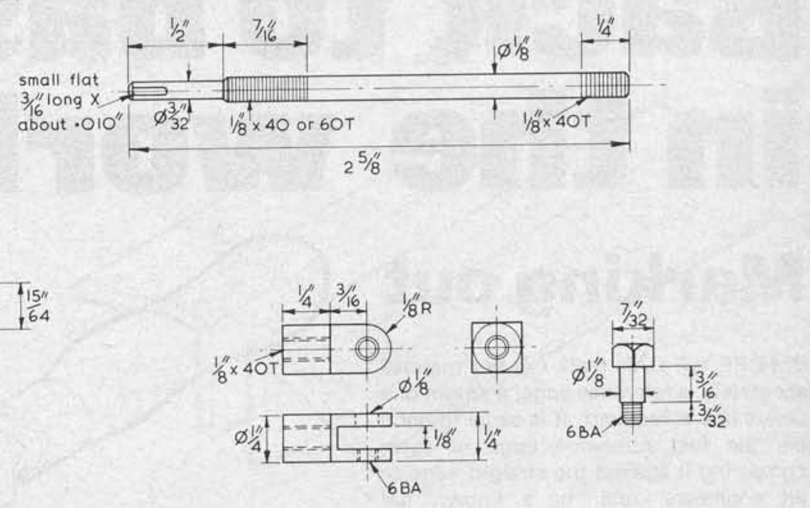


Slidebar (× 2) bms case hardened.



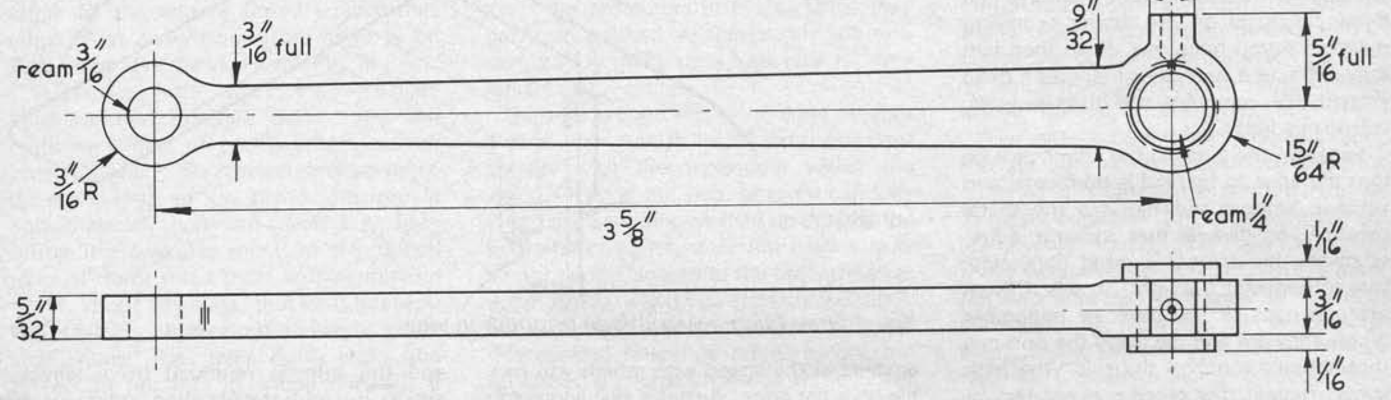
Gudgeon pin (× 2) silver steel.





Slide Valve and driving nut 2 off: valve phosphorus bronze, nut brass

Valve spindle, crosshead and pip. 2 off: bms pin case-hardened

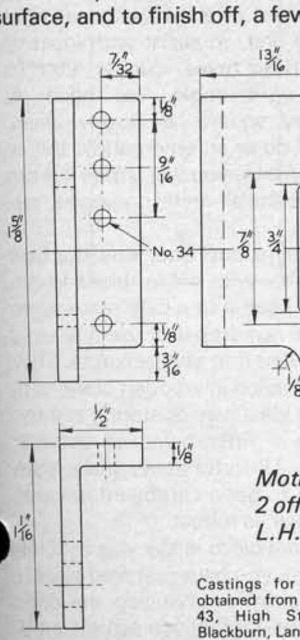


Connecting rod (× 2) bms. Phosphorus bronze bush at big end. Small end to be case-hardened (L.H. drawn).

end mill, or the nut will be too slack, use one of $\frac{3}{16}$ in. dia. or even $\frac{1}{8}$ in. and take two or three "bites" at it.

Finally, cut the bar in two, use the four jaw chuck to machine the cut ends, and transfer the separated valves to a smooth flat file, laid on the bench. A few rubs on this will produce a nice flat working surface, and to finish off, a few more rubs on some fine grade emery cloth laid on something really flat — plate glass or the drilling machine table does nicely.

The valve spindle is made from $\frac{1}{8}$ in. dia. stainless steel, one end being reduced to $\frac{3}{32}$ in. dia. with a small flat filed on this end. The idea of the flat is to prevent water being trapped in the steam chest extension. If $\frac{1}{8}$ in. × 60t. taps and dies are available, use them for the driving nut and the mating thread on the spindle, if not 40t. will do. The valve spindle crosshead is a very simple item, from ¼ in. square mild steel. Drill the cross-hole first, No. 42 for the 6 BA thread, opening out the opposite side to $\frac{1}{8}$ in. dia. Then slot out $\frac{1}{8}$ in. wide for the valve rod, using a small diameter face cutter if available or even a Woodruffe cutter of $\frac{1}{8}$ in. width. To drill and tap for the valve spindle, set to run truly in the 4-jaw.



Motion Bracket 2 off bms L.H. drawn.

Castings for Eagle can be obtained from Dave Goodwin, 43, High Street, Rishton, Blackburn, Lancs.

Motion Brackets

The motion brackets are made from 1¼ in. × 1¼ in. × $\frac{1}{8}$ in. bright steel angle. I don't think they require much description as they are really a question of very careful marking out, drilling, sawing and filing to get the recesses for the ends of the slide bars right. As the slide bars are not bolted or held positively at their outer ends, it is most important that they fit the slots in the motion bracket accurately, so make the slide bars next. They are just lengths of ¼ in. × $\frac{1}{8}$ in. bright mild steel, case-hardened for preference, with a single $\frac{1}{8}$ in. hole at the cylinder end, for a 5 BA screw.

Having completed both motion brackets and slide bars, the cylinders can be lined up and bolted to the frames. Put the first cylinder in place, noting the required position from the drawings. To get the cylinder at the right angle, take a suitable length of round silver-steel, say ¼ in. dia. and drill, accurately, a hole in one end $\frac{5}{32}$ in. dia. — a good fit over the end of the piston rod. Turn the other end to a point. Push this "lining-up rod" over the piston rod, which should be pulled out to its full extent, and line up the pointed end with the driving axle centre, with the driving axlebox at the correct working height in its horns. Having arrived at the correct position and angle, using a toolmaker's clamp to hold the cylinder firmly to the frame, run a No. 34 drill through the four fixing holes in the flanges of the cylinder, following up with 6 BA bolts and nuts. Remove the burrs on the back of the frame first!

Next month, we will deal with the crossheads, the lining up of the motion brackets and the connecting rods.

Back to basics in the workshop

By John Wheeler

Marking out

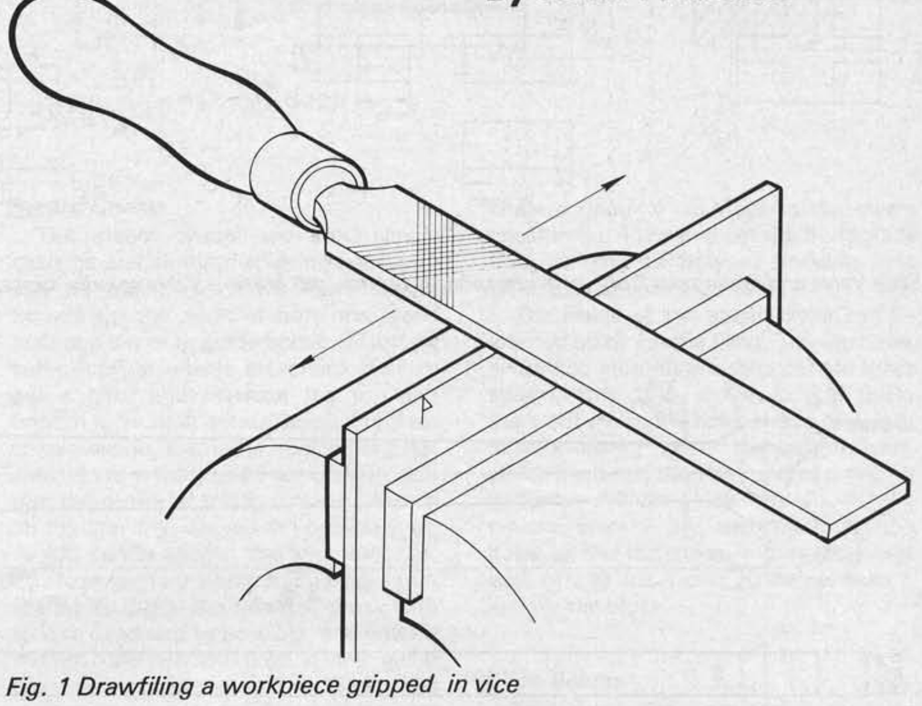


Fig. 1 Drawfiling a workpiece gripped in vice

BEFORE WE CAN mark out our material accurately, a reference edge, a datum or a centre line is required. It is usual to hand file the first reference edge or face, comparing it against the straight edge or an engineers' rule, or a known flat surface, i.e. the surface plate or a piece of plate glass supported in a felt lined tray. Sometimes, if you are lucky, it is possible to machine the first face of a casting in a 4-jaw chuck, or on the shaper or milling machine if you have one. Even then you may still find a final dressing with a dead smooth file, removing the burrs at least, will be needed.

First grip the piece in the bench vice so that the edge to be filed is horizontal and using a smooth cut file, file the metal carefully to give a true straight edge; compare this against a good engineers' rule, up against the light, to see if there are any gaps. If so, mark or remember where they are and file away the portions that actually touched the rule—the high spots. Repeat this process every two or three file strokes, aiming to reduce the visible light space to a minimum. Most persons find the centre low and the ends high, and then when correcting, the centre becomes high and the ends low. It is vital to be able to push the file forward along the metal without rocking it, one of the engineers' hard-learnt skills. Practice the process often and you will soon be amazed at the speed with which you can file up a flat edge. A useful skill acquired. But that is not quite all, before you leave any edge, remove the burrs left from the filing or machining. I find it best to smooth the edge and remove burrs using a 6 in. dead smooth file, holding it truly at right angles to the long edge and drawing it back and forth along the edge (Fig. 1). This will make the edge very smooh; do however, keep a check on its flatness; and the burr is removed by a similar action, but with the file tilted either side at 45° to the flat faces (Fig. 2) leaving a very slight chamfer along the edges or burrs can give some nasty cuts to delicate fingers.

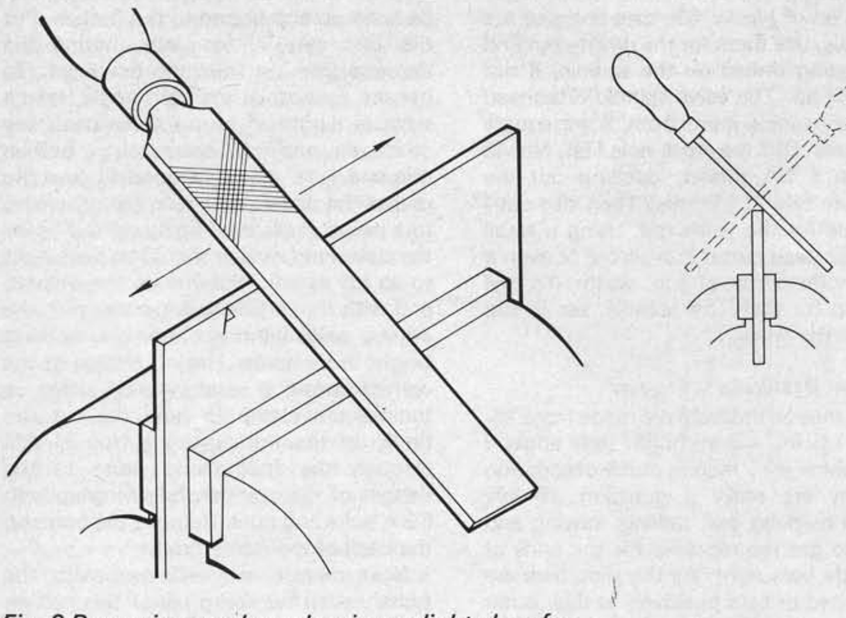


Fig. 2 Removing any burrs leaving a slight chamfer.

Once you are satisfied with the accuracy of this first edge, you should mark it in some way, with a felt tip pen using the new internationally reference edge mark.

More often than not, you will also require a second reference edge at right angles to the first, to assist with locating centres of drilled holes, curves, etc. To check this right angle, we need an engineers' try square, a woodworkers' try-suare will do in an emergency, but as your skill improves, you will realise it is not as accurate as the all-metal engineers. try-square.

If you have to buy one, buy the best you can afford—with a 4 in. blade length approx., and keep it in a safe place when not in use, do not drop it or use it to tap a nail in. You want it to stay accurate. They used to be supplied in wooden boxes with a slide lid, an ideal way of storing one try-square, with a little piece of anti-rust paper inside. Unfortunately, these days you are likely to get a cardboard box that is nowhere near as robust.

Set the metal piece in the vice with the reference edge you have just filed placed vertically, slightly overhanging the edge of the vice jaws, so that you can place the

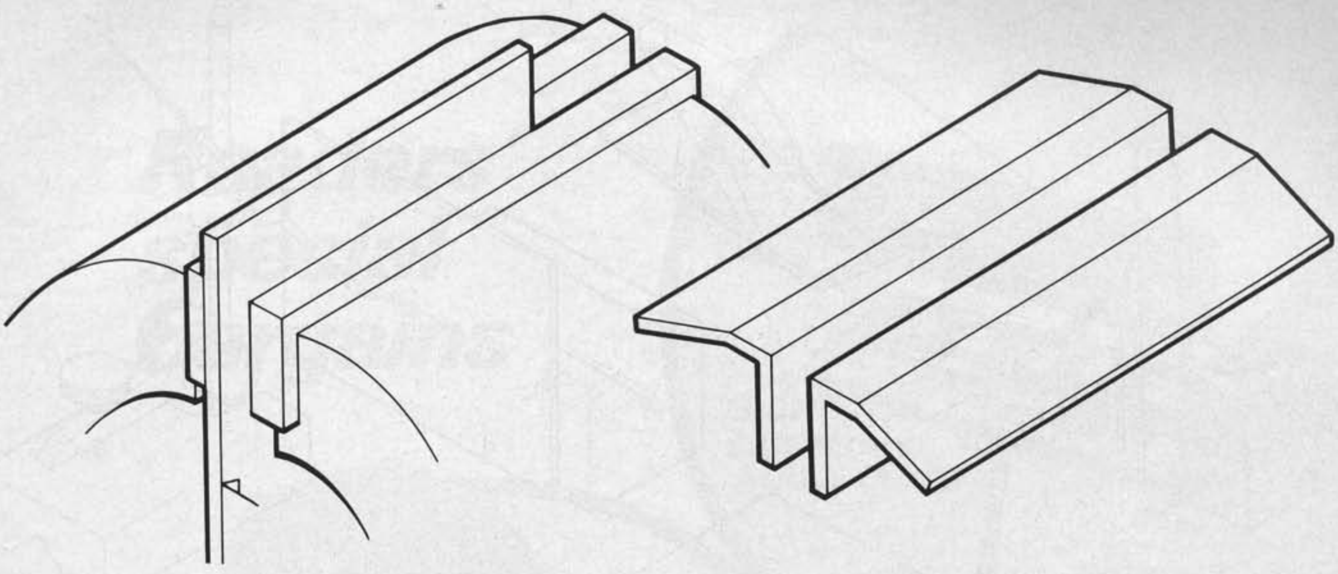


Fig. 3 Set up for filing—second reference edge and jaw protectors.

stock of the square firmly against this edge. That should bring the edge to be filed just above the vice jaws (Fig. 3).

A point to note, many vice jaws have hard serrated gripping teeth, that will mark each face of your workpiece each time you grip it. So many modellers make up some form of jaw protectors from a soft material, you can even buy fibre protecting jaws for many of the bench vices. I make mine from soft aluminium sheet, about 14 gauge, that I cut to shape with tinsnips, then grip both pieces in the vice, close the jaws tight bend the projecting uprights to shape (Fig. 3). If you add 'ears' on the ends it will help to keep the protectors in place. Once they get badly marked, as they surely will, you can quickly make up a new pair for very little cost.

File the second reference edge straight and at right angles to the first, constant checks with the try-square whilst the work is held in the vice, or more carefully when the workpiece is held up against the light and checked, until you have a truly straight edge, square to the first reference edge. Again, when you are satisfied, draw file this edge, remove the burr and mark this second reference edge. Ignore the other two edges of the piece of metal; for the moment that is, until you have completed the marking out, because in many cases metal has to be removed to shape the outline and unnecessary filing of straight edges only to remove them later is not the way of the busy engineer.

The metal is now ready to be accurately marked out, using these two reference edges in turn against the surface plate, or as guide edges for the try-square or odd ley calipers. You should note that using these datum edges you can always mark out two lines on your work to intersect accurately at right angles which can indicate the centres of holes or curves (Fig. 4). Modern drawing practice often shows the main dimensions from such a

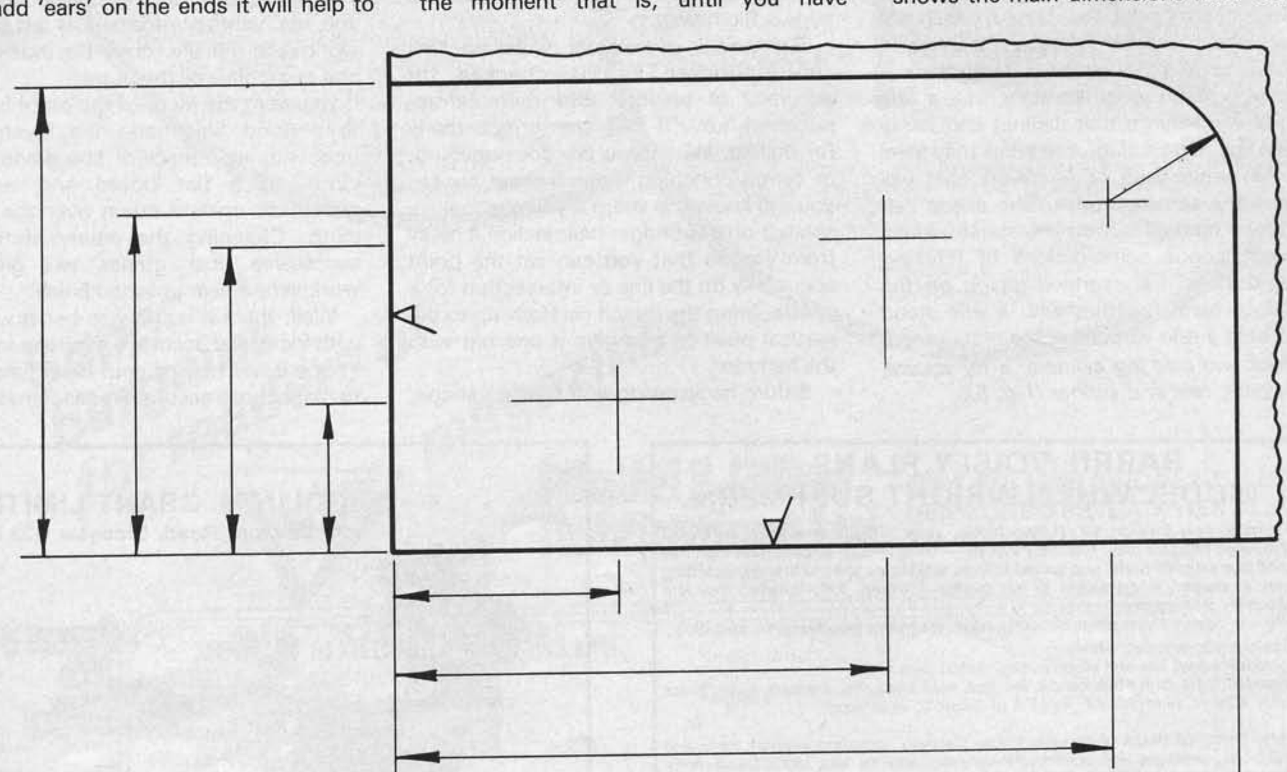


Fig. 4 Workpiece dimensioned from Datum edges.

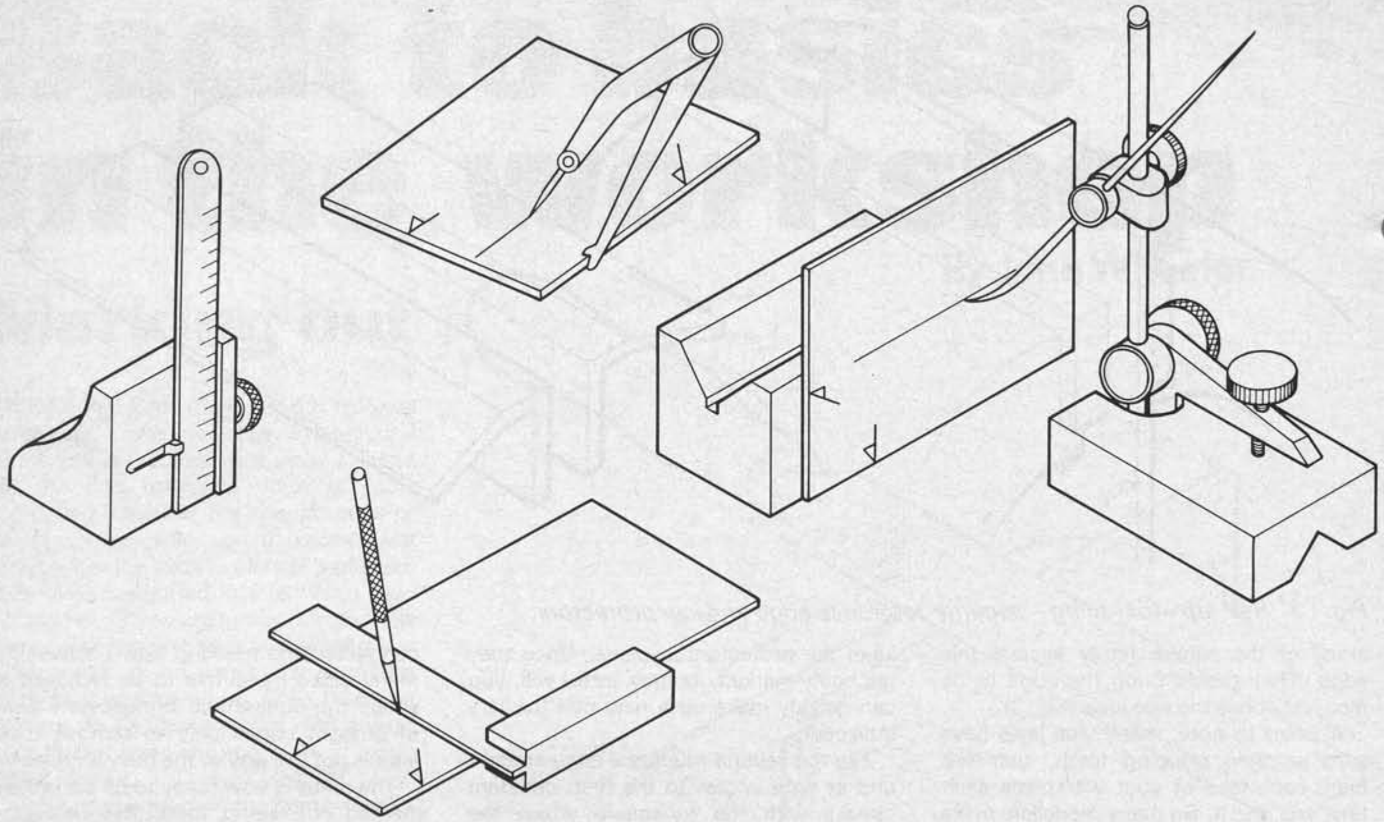


Fig. 5 Range of marking out processes.

datum edge, but for older drawings you may have to make up your own small sketch to work in this way.

Before actually marking out the metal, give it a thin coat of one of the "layout fluids" either brush or spray applied, although you can rub bright steel over with a copper sulphate solution which will deposit a thin layer of copper on the work. The idea in both cases is to provide a surface which when scratched by a fine point will leave a thin distinct and easily seen line. On castings and black mild steel a thin whitewash or emulsion coat will serve the same purpose. The shape can now be marked out on the metal surface using various combinations of marking out devices, i.e., surface gauge on the surface plate together with a rule stand (to hold a rule vertical) angle plate or vee *block and odd leg calipers, a try-square, dividers, rule and scriber (Fig. 5).*

Once the shape has been marked out, checked for accuracy, you do not want to drill holes and cut the outline and then find it incorrect. The outline is further emphasised by dot punching, producing witness marks that can be used later to indicate the position of the line as the edge is filed away.

The centres of holes or circles are first centre-punched lightly, checked for accuracy of position and then centre-punched firmly if they are correct, ready for drilling. When you are dot punching, or centre-punching, have a sharp punch; you will know it is sharp if you can make a scratch on your finger nail; incline it away from you so that you can set the point accurately on the line or intersection for a centre, bring the punch carefully up to the vertical position and give it one tap with the hammer.

Before hacksawing and filing to shape, drill out any holes or complete any internal shaping, it is easier to grip the metal while it is still in a rectangular shape, then concentrate on hacksawing off as much of the waste metal as is possible. Follow by carefully filing down to the line, which you will know you have reached when you see half the witness dots left on your workpiece. Finally, draw file those edges and do remove all the burrs.

If you want the faces of the piece brought to a good finish and the layout fluid removed, lay a piece of fine grade emery cloth on a flat board and rub the workpiece up and down over the emery cloth. Changing the emery cloth with successive finer grades will give the workpiece a near polished finish.

Well, there it is, how to begin working with increased accuracy of shape in mind. I hope it has helped you. Next time, how to make those accurate measurements.

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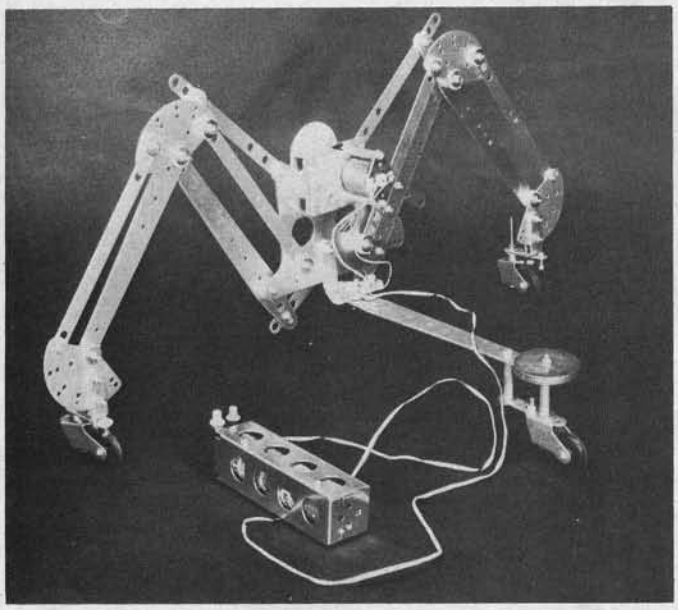

An example of one of the models that can be made from the 3-in-1 Mechanimal Kit. This is supplied by Electroni-Kit Ltd., 20 Bride Lane, Ludgate Circus, London EC4Y 8DX at £20.45 including post and packing.

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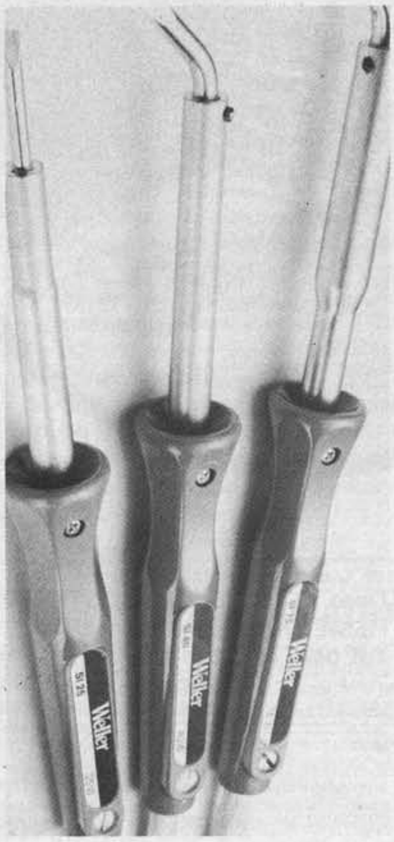

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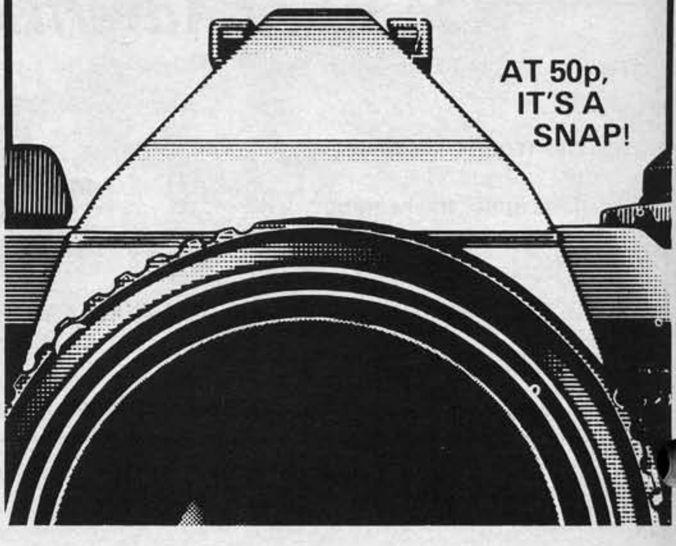

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