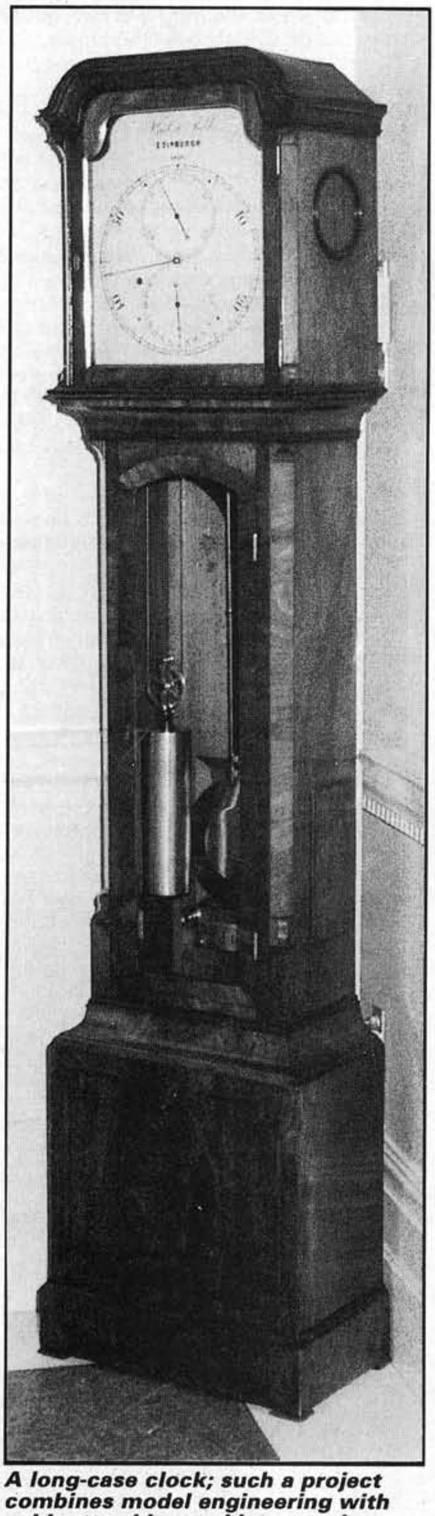
LET'S MAKE A CLOCK

Clockmaking, with its own specific challenges, is a fascinating and rewarding branch of the model engineering hobby. An understanding of the basic principles is all important...



A long-case clock; such a project combines model engineering with cabinet making and is a popular subject with amateurs.

Whilst horology is a science and hobby in itself, the fascination of clockmaking has, since early days, been allied to model engineering. A very large number of model engineers who basically work in other fields, at one time or another will build a clock just for the satisfaction of doing so. The normal workshop equipment will suffice for this although the dedicated enthusiast will have specialist equipment. Quite a large number of designs for clocks have been published in the model engineering press over the years and all are well within the scope of the average model engineer.

Keeping it simple

First thoughts are that a clock is a highly complicated piece of machinery with lots of gear wheels, some of which would seem to serve no useful purpose. Of course this is not so and, if we give it a little thought, we can soon see what is required to complete a working clock. In early days all sorts of ideas were used as a means of telling the time. Nobody knows when timekeeping devices were first used; the average person in those far off times would probably keep time by using the hours of daylight – go to bed when it got dark, and get up when it was light. Sunset and sunrise are nature's own clock in the same way that the seasons are a calendar.

It is possible that more accurate timekeeping would have been used in religious establishments where it was thought necessary to pray several times a day. The timekeeping device might be a mark on a candle, or, as the Chinese were known to do, a burning string which released weights on to a gong at given intervals. Then there were water clocks. A slow release of water from a reservoir raised the level in a tube, marked to correspond with given periods of time. Mechanical clocks on similar lines to those in use today have been in use now for many hundreds of years, the principle of construction basically remaining the same throughout all this period.

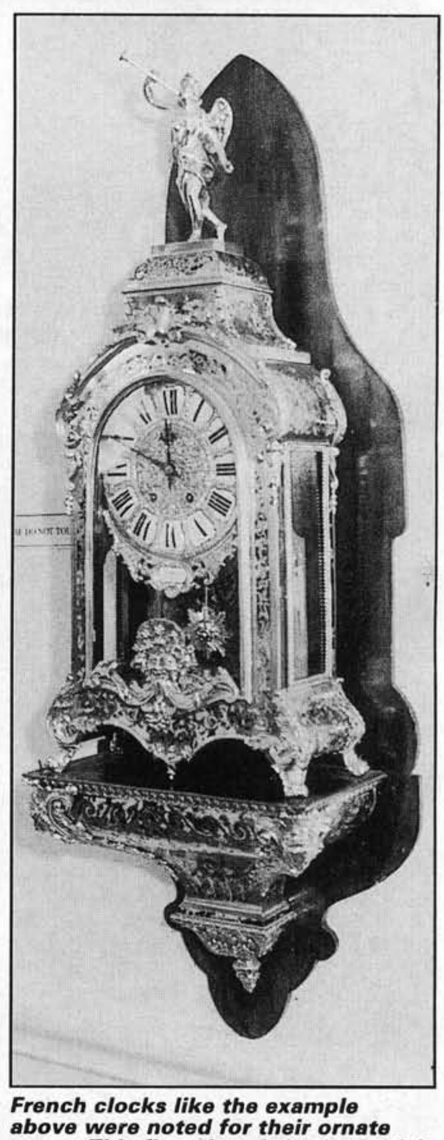
The principle of clocks

As model engineers we are concerned with mechanical devices and these work on a fairly simple principle. A driving force is connected via gears to a hand or hands which generally will be situated on a dial. All those gears that are apparently doing nothing are, in fact, serving one of two purposes. Many are there purely to slow down the driving force. Others are to gear down the hand which indicates the hour so that it will only rotate at a sixtieth of that showing the minutes.

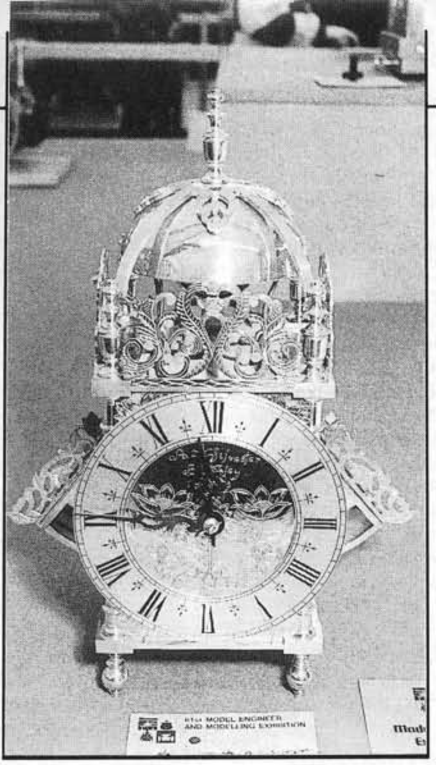
If our driving force is a weight on a string, wound round a bobbin as it frequently is, then if it is allowed to fall free it will only take a second or so to complete the fall. If the bobbin was connected directly to a hand, that hand would only show a second or two of time, and so the weight must be slowed down. This is done in two ways. Firstly with our friends the gears. Readers will, I am sure, all know that if a small gear wheel is connected to a large one, the spindle of the large gear when driven will rotate at a slower pace, in proportion to the number of teeth in the gears.

So if we have a twenty tooth gear driving one with eighty, the spindle of the one with eighty teeth will only rotate at a quarter of the speed of the spindle of the one containing twenty teeth. That is fine, but it would be impossible to slow the weight down sufficiently with a single meshing gear. The spindle holding the large gear therefore also holds another small one, which is connected to yet another large one, thus giving us a further spindle travelling at a slower speed still.

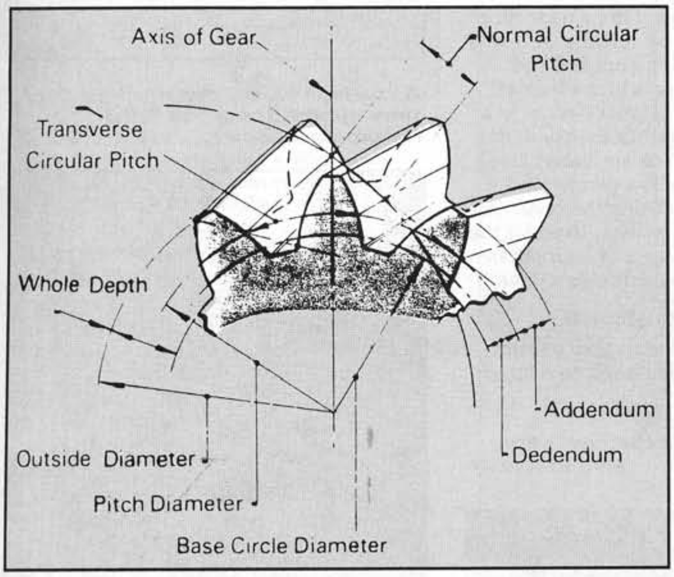
It may require several such gears in a train before the correct speed can be reached, and it will also require another two or three spindles to convert the speed of the minute hand into the required speed of the hour. It must be a reduction of sixty to one. If we had, say, a small gear with only ten teeth, then to slow it down in one jump would need a large gear of six hundred teeth, which of course is nonsense. And so, once again, a suitable train of gears is set up.



French clocks like the example above were noted for their ornate cases. This fine piece is in the British Horological Society's collection.

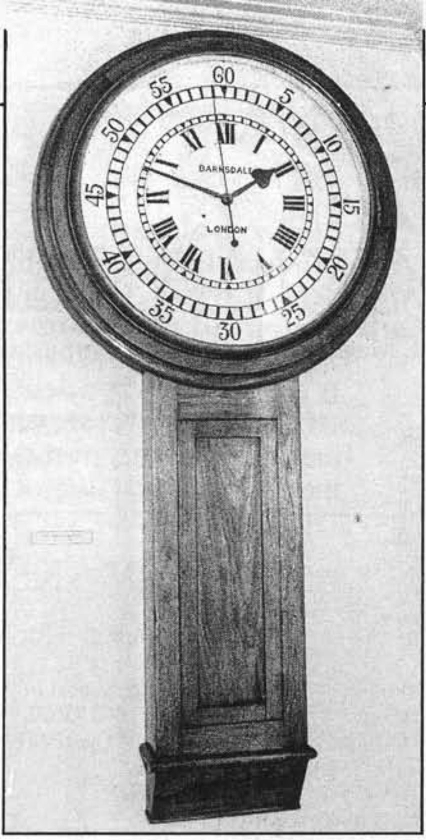


This is a striking clock, a popular subject for the model engineer. Just look at all that lovely intricate brasswork! It was one of numerous clocks on display at the 1993 Model Engineer Exhibition at Olympia in London.



Gears: Formulae and definitions

Term	Definition	Spur Gear formulae
Addendum A	The radial distance between the PCD and the OCD	$A = \frac{1}{DP}$
Dedendum D	The radial distance between the PCD and the tooth root	D= htt - A
Whole Depth ht	The whole tooth depth i.e. the addendum plus dedendum	20 DP (1.25mod) & coarser $ht=\frac{2.25}{DP}$ BS.436; Finer than 20 DP (1.25 mod) $ht=\frac{2.4}{DP}$ BS.978
Working Depth hw	The depth of engagement of two mating gears	$hw=\frac{2}{DP}$
Backlash Bl	The amount at the pitch line by which the tooth space exceeds the mating tooth thickness	Bl=CR x 2 tan PA
Normal Tooth Thickness Tn	The distance at the pitch cylinder between opposite and normal faces of the same tooth	$Tn=\frac{1.5708}{DP}$
Number of Teeth N	The number of teeth round the PCD of either the pinion or gear	N=PCD x DP



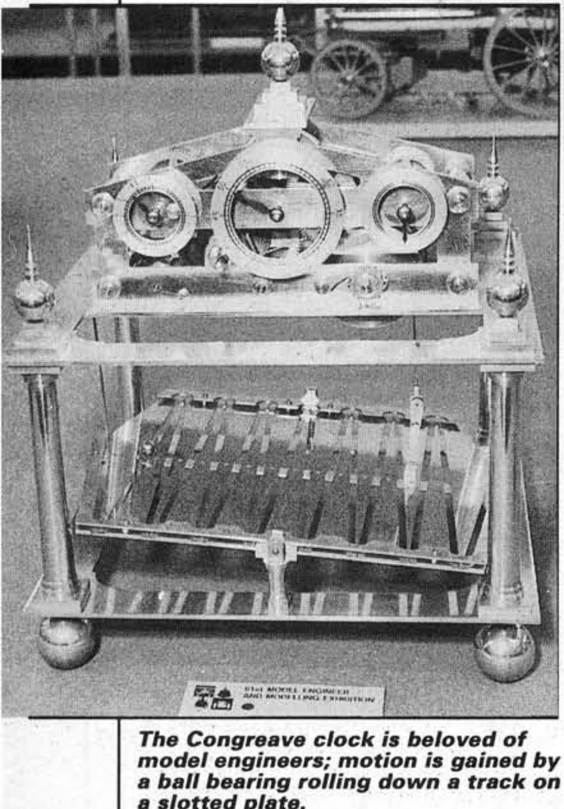
A wall clock, regulated by a pendulum and spring wound. This one is by Barnsdale of London.

The escapement

Even with our driving force and gear train (and, incidentally, the driving force could equally be a spring), the clock will hardly keep accurate time and so a balancing device is included. In some cases it is actually a spring balance, but as far as model engineers are concerned it is more likely to be an escapement, which is a sort of rocking device. The escapement itself will have some form of weight which can be moved to allow adjustment of the speed at which the movement will travel. Probably the most common example of this would be a pendulum.

It follows from the preceding paragraph that the majority of work involved in clock making is gears and pivots, and then laying them out accurately. An understanding of gears and how they mesh will help, but fortunately in the case of simple clocks, we are, with very few exceptions, limited to spur gears and that makes life considerably easier. Whilst generally for gear cutting special cutters are used it is quite possible to use simple home made tools and would be clock makers are advised to refer to the Argus book in the workshop series entitled *gears and gear cutting*, by Ivan Law which explains things in the simplest possible way.

Possibly the easiest way to make simple spur gears is to use a cutter in the tool post of the lathe and slide it along the metal being used. The gear can then easily be parted off when the teeth have been cut.



The Congreave clock is beloved of model engineers; motion is gained by a ball bearing rolling down a track on a slotted plate.

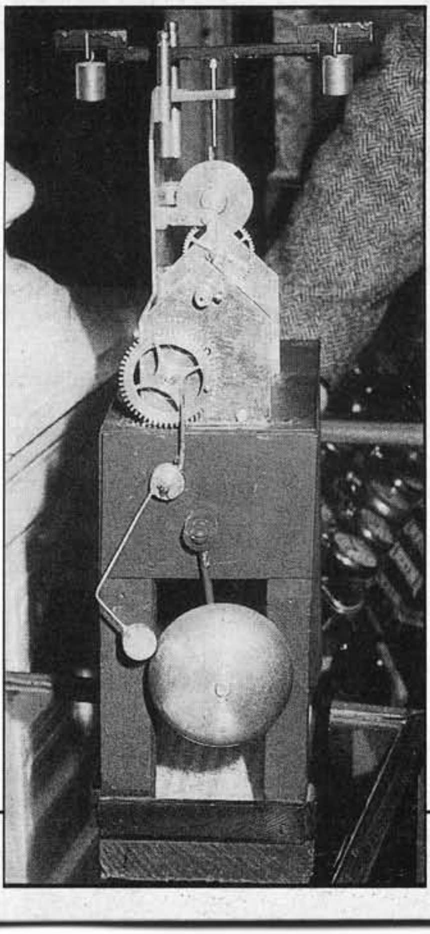
Pivots and bearings

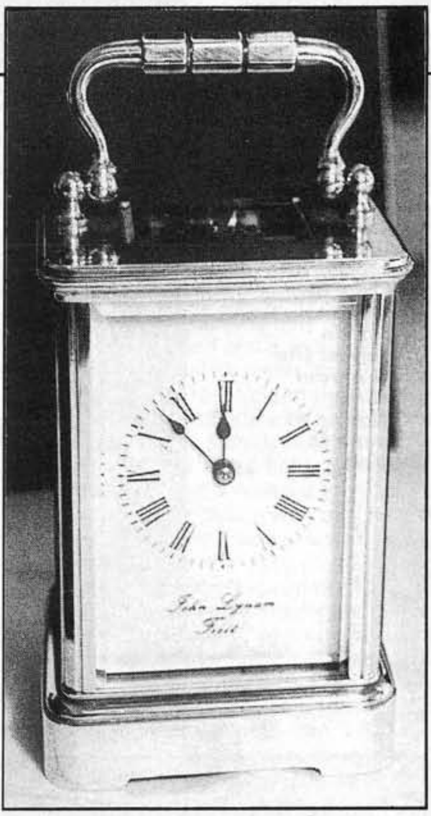
Pivots and bearings need to be as friction-free as possible and possibly the best way will be to make needle points and run them in tiny centre marks in the frame. The clock maker does a great deal of this sort of work by hand rather than with the use of a tool slide, but care must be taken when doing it as there is a danger of the hands slipping and catching the revolving chuck. If a large lathe is being used for the work there is more chance of injury than when using a small watchmaker's lathe.

Meshing gears

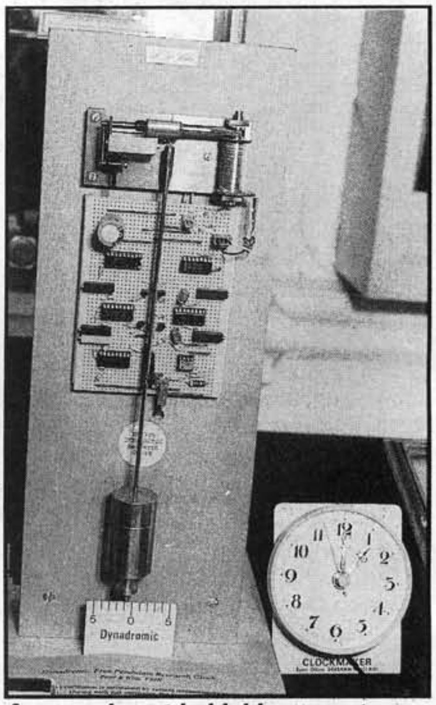
It is also necessary to learn how to mesh the gears properly. They must be neither too tight nor too loose. A rough guide is to put a piece of cooking foil between them and rotate them. A tool known as a depthing tool is used for spacing them and this is simple enough to make. It consists of two pieces of steel bar pivoted together; at the end of each piece is a round piece of steel with a hardened point.

A demonstration escapement very similar to the simple design drawn on the opposite page.





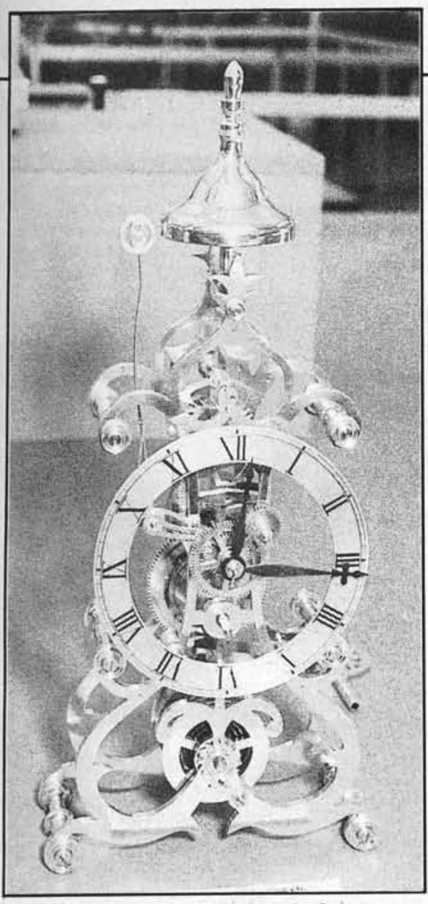
A carriage clock, this one by a third term apprentice at the British Horological Society



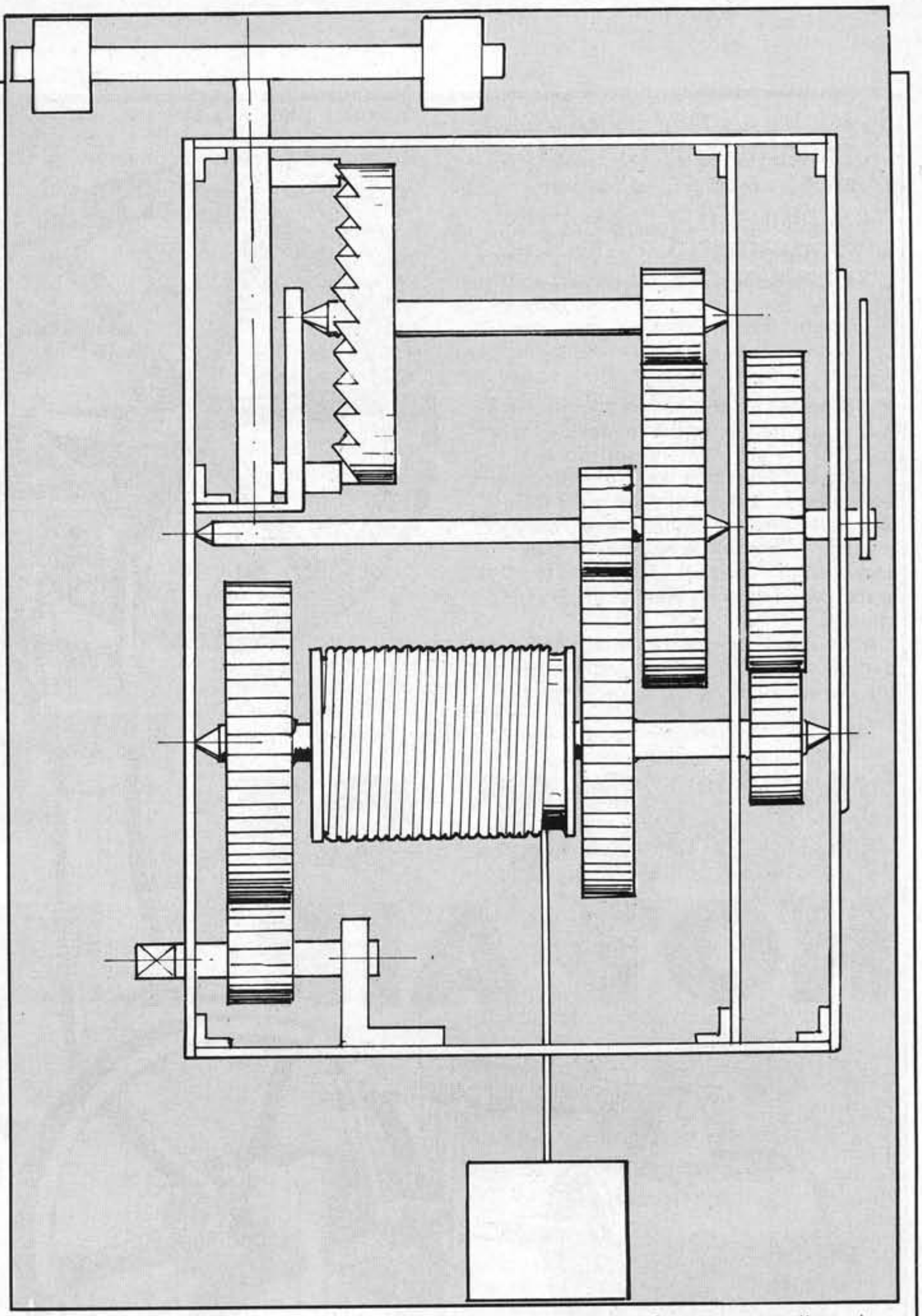
An experiment in highly accurate timekeeping; the electronic clock operates by vertical displacement.

Making a start

The frame on which the set-up is laid can be made of mild steel, and generally the gears will either be all brass or steel meshing with brass, which is the more



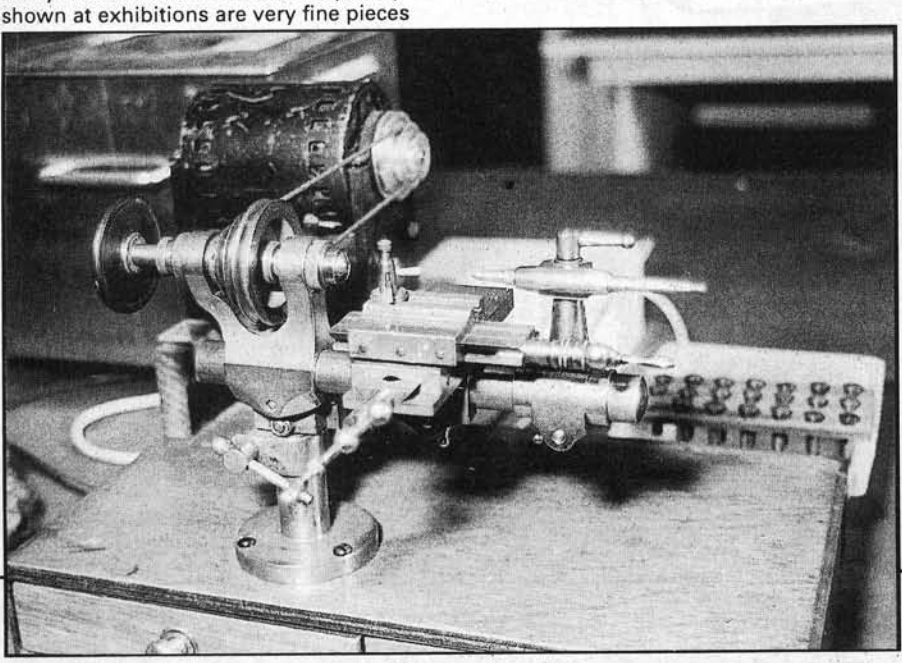
A very fine example of a skeleton clock (so called for obvious reasons) at the '93 ME Exhibition



Drawing above illustrates use of Foliot balance to regulate a clock; a simple single-handed clock could be built from this diagram. Below, a typical watchmaker's lathe; smaller than the normal type found in the workshop, it also offers the operator a greater variety of movements.

correct form. Pivots should be made of silver steel and the points hardened to prevent too rapid wear taking place. As a first exercise it is an idea for those interested in developing into this side of the hobby to make a clock with a single train of gears, giving a single hand movement.

All that is needed is an escapement, the gear train and a weight with a piece chord. The escapement is set up and the gears are meshed on the frame using a depthing tool. The final spindle has a bobbin secured to it and this has the chord wound round it to allow the weight to drop. It will be necessary to get the weight back up again and this can be organised with a slot for a screwdriver in the final spindle. A more substantial method would be to use a square spindle and a specially made key. Many of the clocks made and frequently shown at exhibitions are very fine pieces of work. They are far more complicated than the basic apparatus explained above but that is an idea for the beginner to experiment with and from there to pass on to higher things. Whilst clocks are frequently housed in cases many are left with the works showing, and possibly protected with a glass or perspex dome. This arrangement gives one the opportunity to see the craftsmanship which has gone into making the apparatus.



Courses available

Courses for would be clock makers are regularly run by the British Horological Institute. They also have open days when the workshops can be seen and offer apprenticeships as well. They will be glad to accept into membership novices as well as advanced horologists and a regular journal is issued to all members. Whilst basically the interest amongst members would seem to be traditional clock and watch-making, there is also an interest in more modern methods and this too is catered for. The address for those interested is:- British Horological Institute, Upton Hall, Newark, Notts. NG23 5TE.. Telephone 0636 813795.

The simplicity of the hot air engine has made it a firm favourite with modellers for years. It's a recommended choice for beginners, too . . .

A LOT OF HOT AIR

The Rider hot air engine achieved reasonable success and was made in considerable numbers.

The hot air engine has always had a fascination for the model engineer. There are many reasons for this probably the fact that, as a rule, they can be built from almost any old material is one. They are also comparatively easy to make and little skill is required in their construction. They are fascinating to watch when running with an uncanny silence.

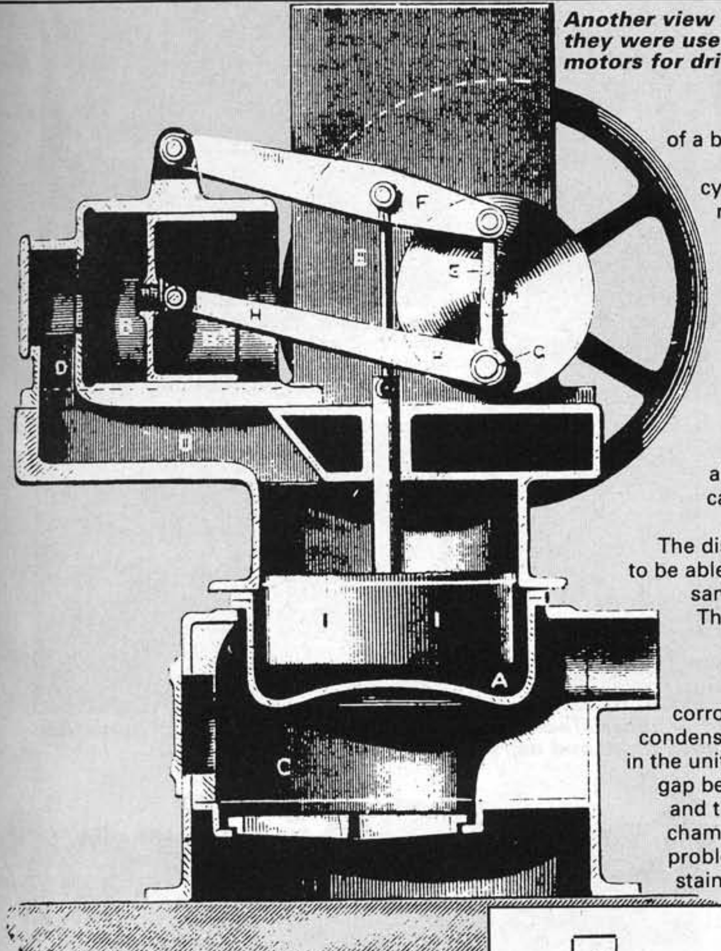
Although designs have varied to some degree over the years, generally speaking the hot air engine is based on what is known as the 'Stirling Cycle'. This is a cycle of events devised by the Reverend Robert Stirling who, with his brother James, an engineer by trade, developed the machine. The patent for the engine was taken out in 1816 and, as at the time there was little in the way of power machinery other than wind and water, it proved a revelation. In spite of its limited power, output was quite a success. Engines were used to drive pumps, and fans and the like and some were fairly big machines.

This version was known as the Robinson Patent Motor; it saw widespread domestic use.

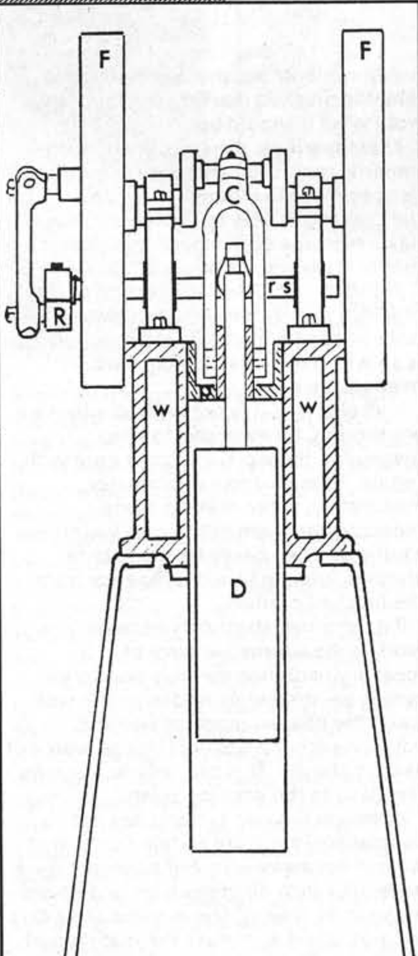
The early engines were usually quite large and were generally far more complicated than the models made today. Later on, several engineers were to design engines based on similar principles but it is largely the Stirling engine that is remembered.

The method of working is very simple; air is heated in a closed unit and this causes a piston (known as a 'displacer') to move. As the title suggests, this is not a true piston and so a gap is left between the walls of the cylinder and the piston to allow air displacement. The hot air which is displaced is replaced by cold air, re-heated and the cycle of events starts again. The same air is used to push a power piston, this time a good fit in a cylinder, and this also helps cool the air even more.

The two units are connected at ninety degrees to cranks and also connected to a flywheel which is necessary to keep the



Another view of the Robinson; they were used as low power motors for driving fans, etc.



This design, also by Rider, was an attempt to gain extra power by the use of twin pistons.

engine going. As the air is to be constantly transposed from one end of the system to the other, it follows that the unit must be airtight throughout – but, because of the limited power, this must be done with as little friction as possible.

Proportions

When it comes to making models of the engine, the main thing is to know the best proportions and materials to be used:-

1. The length of the displacer cylinder or chamber should be about three times its diameter.
2. The hot end should be about two thirds of the length of the chamber and the cold end the other third.
3. The displacer should be two thirds the length of the chamber.
4. The stroke of the displacer should be about one third of the length of the chamber.
5. The diameter of the displacer generally should be about ninety five percent of the internal diameter of the chamber.
6. The power cylinder internal diameter can be about three quarters of the bore of the hot air chamber. However, this is somewhat flexible as sometimes engines are made in a tandem configuration and, in such cases, the power cylinder has a diameter which is relatively larger than three quarters of the air chamber.

Materials

Aluminium is a popular material for displacer cylinders although it is certainly not the most efficient. Steel is quite good and is more efficient than aluminium. Remembering that we are trying to heat one end and cool the other, then the use of a brass or copper end to the displacer cylinder has much to recommend it. This brings us to stainless steel, a material which is in many ways, ideal. It does not corrode and does not conduct heat very well. In conjunction with a hot cap as already suggested it can prove to be very efficient indeed.

The displacer itself needs to be able to cool and so the same material will do. The trouble with mild steel when used to make a displacer is that it will tend to corrode as considerable condensation can be set up in the unit. With only a small gap between the displace and the inner wall of the chamber this can lead to problems. Aluminium or stainless steel therefore have an advantage – even if they are less efficient than mild steel.

As with the cylinder, stainless steel is an ideal medium if it can be obtained in a suitable size and can be machined thin enough to keep the weight low. Whatever the material used, the displacer must be completely airtight and should be as light as possible.

The displacer rod can be of mild steel, but again there is a chance of corrosion. The use of stainless steel or aluminium, even though the latter wears rather rapidly, is therefore suggested.

The power cylinder can be of almost any metal, but brass and brohze tend to hold their heat and the cylinder needs to be as cool as practical. The use of steel and stainless steel is therefore recommended, although not absolutely essential. The model described in fact has a bronze power cylinder, this being the easiest available material when it was made. The bore must be absolutely smooth to get an airtight running fit, and it should be lapped for this purpose.

The power piston has been the subject of much experimentation. Friction should be kept to the minimum whilst the unit must remain airtight; ordinary brass or bronze will suffice as will cast iron. Recently the use of PTFE and similar plastics have been successful and one reader of *Model Engineer* even found that the leather washer from a cycle pump worked for him, so experiments are worth trying!

The main bearing can be of brass or bronze but small ball races will reduce friction if they are available. The longitudinal bearing for the displacer rod can again be of brass or bronze but experiments with PTFE have proved that this can provide both an airtight seal and little friction.

Cooling

Cooling of the engines can be carried out either with cooling fins or by means of a water jacket. The latter has much to recommend it and if it can be replenished from time to time with cold water, so much the better. If cooling fins are used they should be spaced about an eighth of an inch apart maximum and the material used should be a sixteenth of an inch thick. Care should be taken that they are large enough in area to allow good cooling properties.

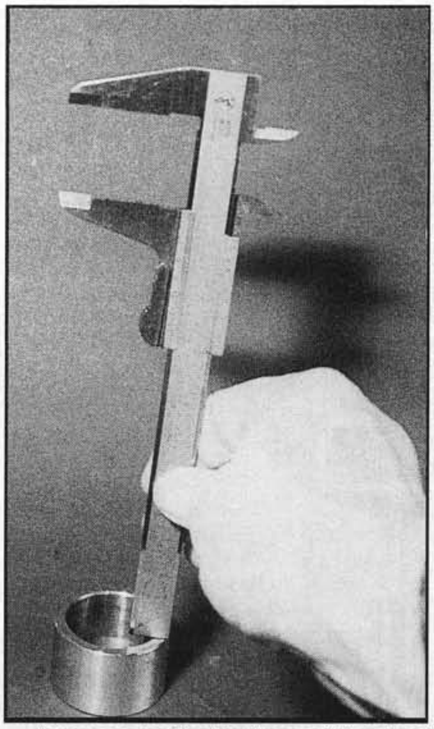
Configuration

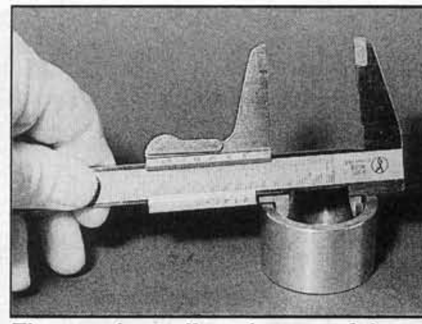
As long as the displacer and power pistons work at ninety degrees to each other, then, generally speaking, the engine can take the form of having the power cylinder placed in line with the displacer or it can be at an angle. The engines will work whichever way they are made. The arrangements of the crank at ninety degrees can therefore be made by setting the power piston at that angle. Alternatively two individual cranks can be used, or the motion transferred through a system of levers.

Heating

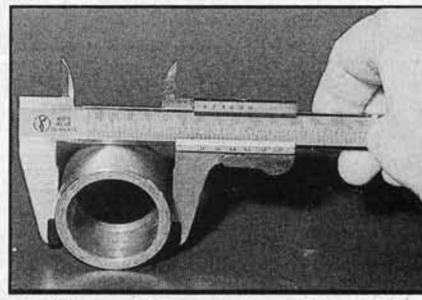
A methylated spirit burner will generally work the engine quite well. If a small gas unit is available with a suitable burner, this can be used to advantage. The original full-sized engines had a fire lit beneath them but this is hardly practical with a small engine.

Whether we like it or not, metrication is here to stay! In model engineering there is an increasing mixture of both Imperial and metric values and this is often a source of confusion to newcomers to the hobby. The solution lies in accepting both systems and taking full advantage of their individual benefits . . .





The vernier caliper is a useful tool where both Imperial and metric measurements are employed in the same modelling operation . . .



. . . because most offer Imperial and metric readings and can measure internal (top right), external (above right) and depth dimensions (above left).

mm is not for "Mickey

Although metric measurement is the only form now taught in our schools and used extensively in industry in this country, the hobby of model engineering does not seem entirely convinced of the system. It is not proposed here to go into the question of whether or not there are any advantages in the metric system as this is a matter for the individual. Older people still do not generally like the idea of working in millimetres, preferring feet and inches – younger people probably feel different. What then is the position of the two systems as far as the model engineer is concerned?

The vast majority of drawings available from suppliers are in Imperial measurements, and it is unlikely that these will ever be converted to metric. Attempting to convert directly, whether metric to Imperial or Imperial to metric, is virtually impossible. The majority of those involved in the hobby work by marking out and then machining or handworking the material. The engineer, more often than not these days, does not mark out, but works from graduations on machines, or digital read-outs – a far more accurate way, but not always practical for the model engineer.

If we try and convert, say, Imperial measurements to metric when marking out some very odd figures are the result. Millimetres to several decimal points are quite usual. Of course there is no possible way that these can be marked off, even using a vernier height gauge, let alone a rule and scriber. Rounding the figures up or down to the nearest half millimetre or so is not possible either as the altered measurements accumulate and, in the end, the finished marking is a long way from what it should be.

Therefore if we have a drawing with Imperial measurements they should be used to make the model, or whatever else the drawing relates to. The fact that one has a machine or machines graduated in metric measurements is not that much of a problem. Individual conversion of dial readings is easy enough, particularly if done in conjunction with a calculator. This is so which ever way the conversion needs to be done.

If all else fails it is not difficult when we are turning, for example, to keep measuring the work and get it right with regular reference to a micrometer. Fortunately, when making models, measurements are not always too critical as one part can easily be made to fit another, with no loss of efficiency from the finished product.

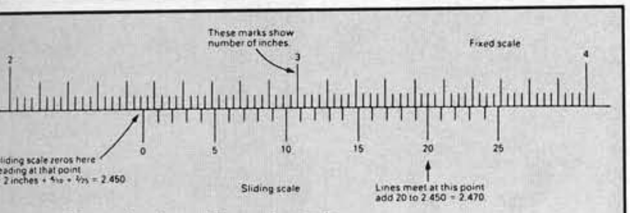
If it becomes absolutely necessary to work in the alternative form of measurement then the only way to be sure is to completely re-design the work using the nearest practical size and adjusting other parts until things work out as they should. This can only be done by resorting to the drawing board.

Although the two systems are not compatible, there are certain things that we can get away with. For example, if we have a 1/4 inch diameter hole to drill with a part to fit, then, if the only available drill is 6mm, use it and make the mating part 6mm also. The same can be applied to some milling and fitting operations. It is largely a matter of commonsense.

Take drills as an example. Many drawings specify number and letter drills to be used. Such drills were nearly always only used as tapping and clearing sizes for threads and the metric range does the job equally well if not better. There is certainly a wider range of drills in metric sizes than there were in the number series. It is difficult to buy number drills now, and they are twice the price of the metric series so it makes sense to think metric when it comes to small drills.

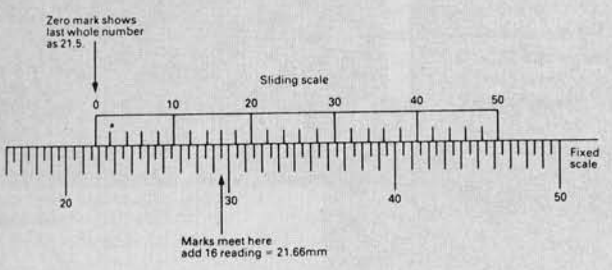
It is quite common anyway if one goes to a tool stockist and asks for number drills; the assistant will go and look up the metric equivalent and supply that, without saying what has happened. Some of the DIY stores have drills on display that are given in dual figures, for example 1/4 inch/6mm. This is taking things a bit too far – it might work when drilling holes in wood to put up shelves, but the model engineer needs more precision than this! However, the Imperial measurement range is still easily available at tool stores, it is only the number and letter series that are scarce.

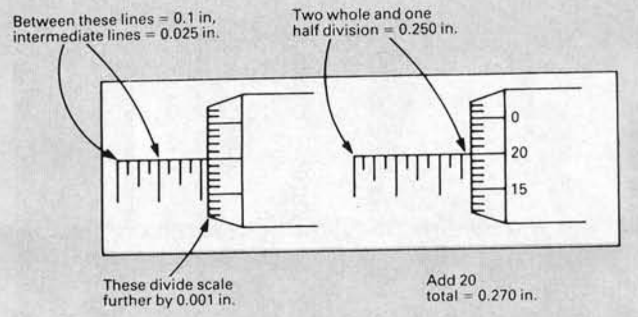
Nuts and bolts can be something of a problem. Drawings that are purely metric will specify metric threads and this is fine, the range being considerable. One problem however is that small metric nuts and bolts are very hard to get except at a specialist dealer while the BA series is, at present, comparatively easy to obtain. It is not difficult to get metric threads from 3mm upwards but it is below this that problems start. Small threads like 8 and 10 BA are frequently used in our hobby and so, when it comes to these sizes, it will be necessary to think Imperial. Many model engineer suppliers will also supply these small bolts with a head that is a size



Above — To read an imperial vernier scale
The fixed scale is the same as in the case of a micrometer, tenths, divided into four. The sliding scale is divided into 25 as is the thimble on the micrometer. The reading is obtained by seeing which of the divisions on the sliding scale is exactly opposite a line on the fixed scale — sometimes a magnifying glass will be needed to decide this. The one that is, is the one giving the required reading.

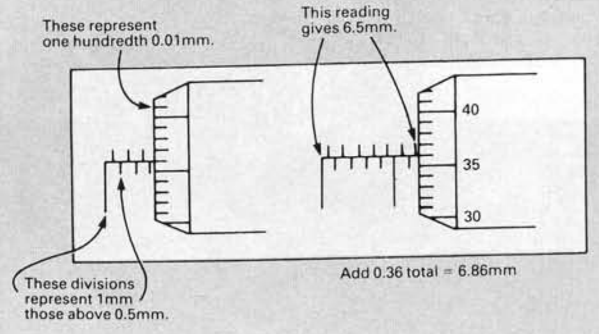
Below — To read a metric vernier scale
The fixed scale will contain whole and half millimetres as on the micrometer. The moving scale will have a reading of 50, again parallel to the readings on the thimble on the micrometer. The reading that is adjacent to a line on the fixed scale is the one taken.
In the illustration, for the sake of clarity, the sliding scale has divisions in 1/50 mm instead of 1/100 mm so there are only 25 divisions instead of 50.





Above — To read an imperial micrometer
The scale on the sleeve or barrel is divided into tenths of an inch, and these tenths are sub-divided into four. This means that the large divisions represent 0.1 in and the four sub-divisions each measure 0.025 in. If the zero on the thimble meets at a point just after the first large division, on the first of the smaller divisions we have a reading of 0.125 in. The second small division would give us 0.150 in, the third 0.175 in, and so on. This measurement can be further sub-divided by the 25 divisions on the thimble. If then, instead of being on zero, the thimble reading was 14, we would now have readings of 0.139, 0.164 and 0.189. In other words 0.014 would be added to the original measurements.

Below — To read a metric micrometer
The scale on the sleeve or barrel is divided into millimetres and half millimetres. Unlike the imperial micrometer, these two measurements usually are placed above and below a line, for convenience. Which way round they are will depend on the make of the micrometer. This makes reading somewhat easier than with the imperial micrometer as we now have a simple case of just counting the number of large divisions and adding just one small division if need be. Let us say then that the thimble reading is zero and seven whole divisions and one half are exposed, the reading therefore is 7.5 mm. The thimble is divided into 50 parts, giving us readings of one hundredth of a millimetre. If instead of being at zero the thimble had been at 32 the reading would have been 7.82 mm. If the half millimetre division had not been uncovered then the reading would have been 7.32 mm.



Mouse"!

The ultimate confusion? Many DIY stores offer perfectly good drills in combined sizes. Both dimensions can't be correct . . .

smaller than specified. Whilst this makes a mess of the sizes shown on spanners, such bolts can enhance a model.

Most of the model engineer suppliers can still sell us metal bars in Imperial sizes, indeed few stock metric sizes. They also stock copper tube in Imperial sizes. It is quite possible that a visit to a metal stockist would result in only metric sizes being available, although some are still stocking Imperial as well.

When it comes to sheet metal the old standard wire gauge sizes are now nearly extinct. They will, of course, be specified on drawings and the nearest metric size will have to be used. The difference in the sizes is not all that great and generally will make little difference. However, it could cause a certain amount of weakening, if, for example, 1/8th inch plate was specified for a five inch gauge locomotive frame and only 3mm could be obtained. Taking the two frames sides the difference in thickness would be nearly half a millimetre which is quite a percentage of the original specification.

It is therefore as well to estimate how much spare space there is between the frames, if possible, and to get 4mm instead of 3. The amount of thinning required on other components to make up the difference is unlikely to affect a model, and the result would be a great deal more overall strength.

Many older model makers dislike the idea of metric measurement, probably younger ones equally dislike Imperial sizes. It is largely a matter of what we are used to; my grandchildren have not the faintest idea what I am talking about when I speak of inches, feet or yards, they only know metric measurement. The hobby therefore to a large extent will need to look towards metrication before too long. In the meantime there is no need to worry about either system, both are easy enough to use.

The usual argument is that with metric measurement it is not possible to halve, quarter, or divide into eighths, etc. This is true, but one must not think in that fashion. (Neither is it easy to divide an inch into five or twenty.) The basic measurement of a millimetre means that such things are not necessary. We can add as many of those together as we wish and a half millimetre on the end will not be difficult either. Incidentally, the use of the centimetre is never considered in the engineering world, everything being calculated in the basic unit. This in fact makes life very easy.

Those who are brought up on the metric system find it hard to work in a large unit such as an inch. It is not practical to use a fraction as a basic because if we used, say, 1/32nd inch and tried to quote in numbers of that, things would rapidly get out of hand. It is therefore a case of dividing a single large unit into convenient pieces and so we get the more common fractions. To the person who is metric minded this seems the wrong way of going about things, it being easier to add than to divide. There is no reason to worry about either, since, once mastered, both are easy.

I was forced into dealing with metric measurements and must say that at first I found them confusing. However, with a little practice they became as easy as the other way, and I now use whichever is the most convenient. The advantage of converting full-size prototypes into metric models was long ago discovered by the makers of small model railways. Take gauge one, for example. At one time it was modelled to a scale of 3/8ths inch to the foot but it is now found more convenient to use 10mm to the foot as the scale.

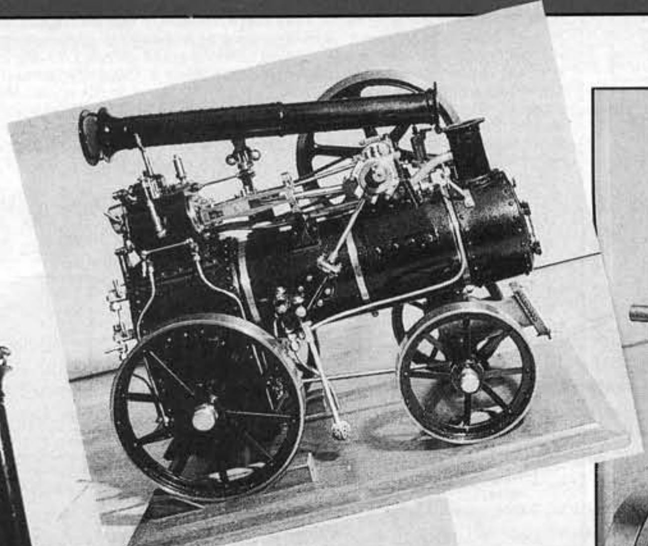
The lesson to be learned is to accept both systems for what they are worth and to make use of the advantage they offer. In this way we can have the best of both worlds!

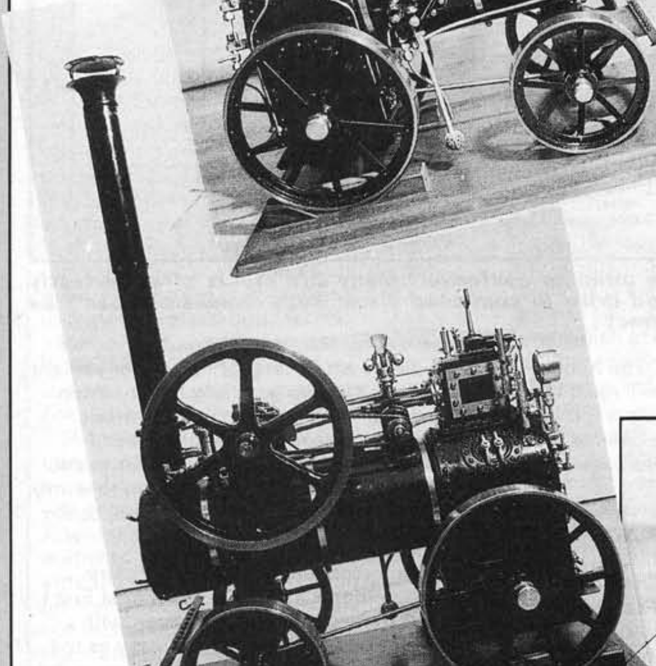
TAKING A CLOSER LOOK

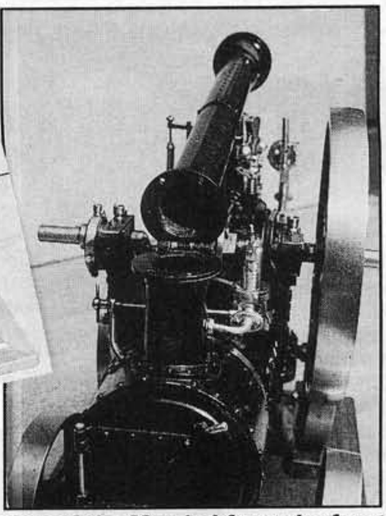
The outstanding model engineering of Louis Harling wins competitions and admiring comment wherever it is shown. So let's take a closer look...

It is always worth a close look at how the high class model maker sets about things and the difference it makes to the appearance of a model. In these photographs, some of the work of Louis Harling is featured. No apologies are made for the fact that his work has been shown before; he works with the minimum of equipment and yet continually produces models of an exceptional standard. The photographs and captions show the reason for this...

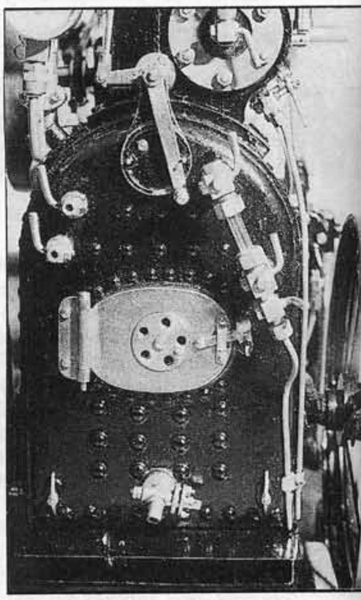
The crankshaft would have been forged – in this scale a carefully disguised fabrication has been made.



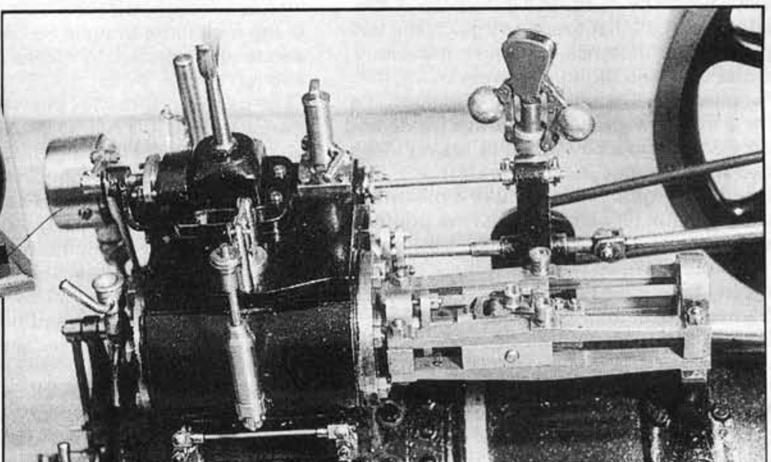




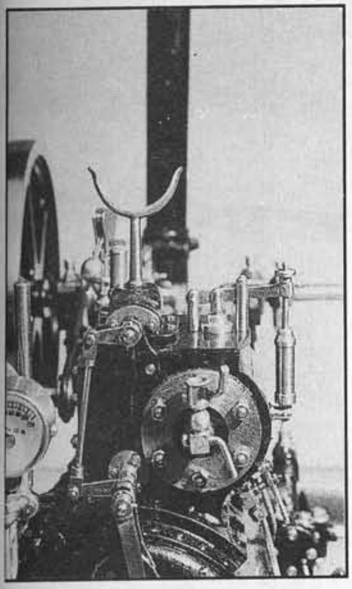
A view of the Marshal from the front showing the folded chimney and flywheel; chimney has been correctly rolled and riveted along the seam.



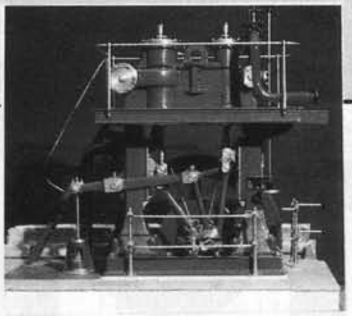
Illustrations on this page are devoted to Louis Harling's magnificent 1" scale Marshal Portable Engine. The model is completely fabricated (ie, no castings were used) and it is based on an original full-size vehicle. It will have been enjoyed by many thousands of visitors to the 1993 Model Engineer Exhibition, on display in the Loan Section; if entered in the competitions it would certainly have come away with an award. Some of the illustrations show the model in its transportable form with chimney lowered.



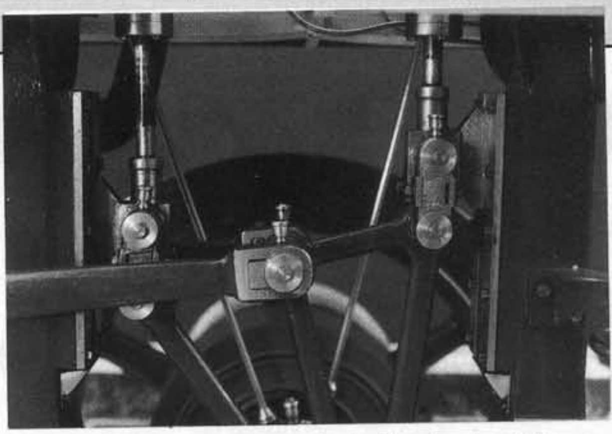
On this side of the Marshal we can see the minute drain cocks and get a close-up view of the slide bars. Above right, superb firebox detail.



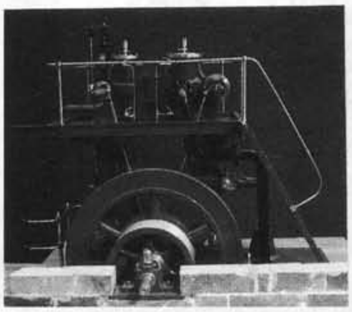
The firebox end from the side; note superb little governor, wash out hole cover and other fittings.



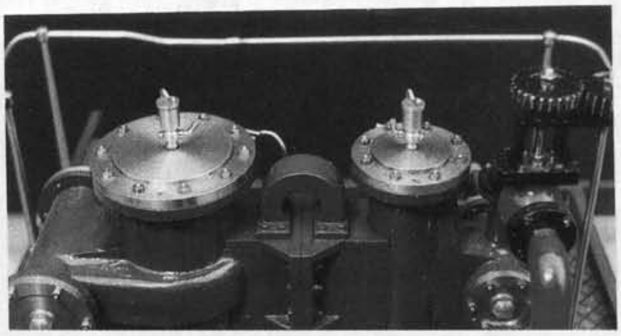
This second model by Louis is of a non-dead centre compound steam engine, the full-size version of which is preserved by the Northern Mill engine Society. It won a Silver Medal and the Tom Nevins Memorial Trophy at the 1993 ME Exhibition - the highest award made to any model stationary engine. Look at the quality of work and the attention to detail that makes this such an outstanding model.



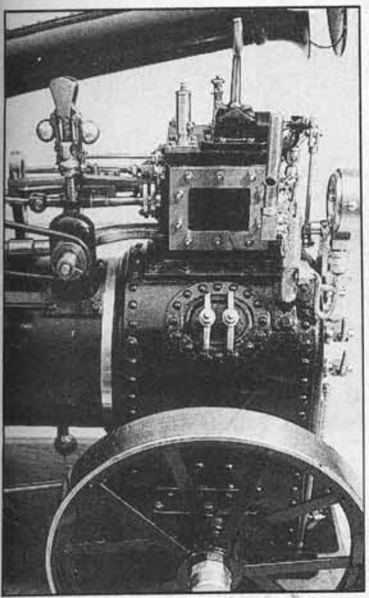
As the camera moves up a little the glands of the cylinder comes into view. They are from steel as in the full-size and bolted on. Note the slide bar on the right bolted to the frame.

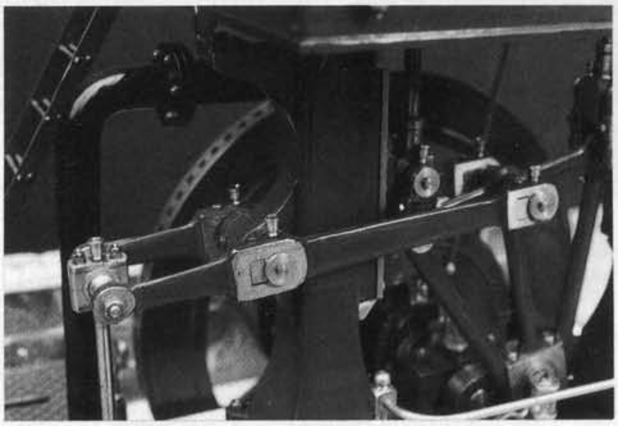


Model sits on a foundation which uses real stone for the walls.

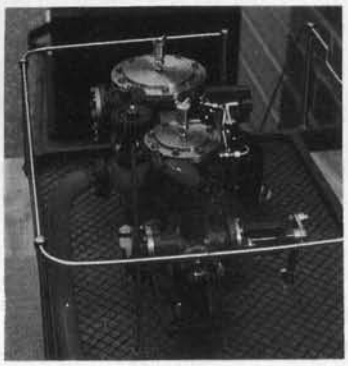


Cylinder covers have correctly spaced and sized studs, one half of the thread showing above the nuts as in full-size practice. Note the flanged pipe fittings, lubricators with hinged lids and taps. Complicated cylinder block is completely fabricated.

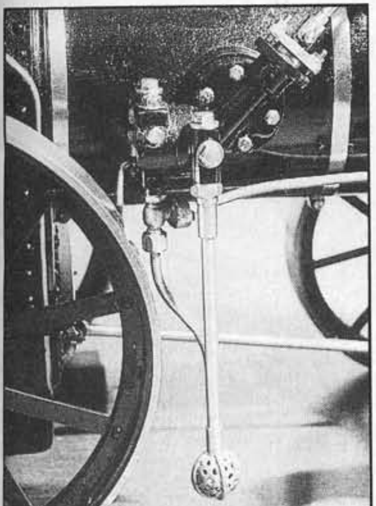




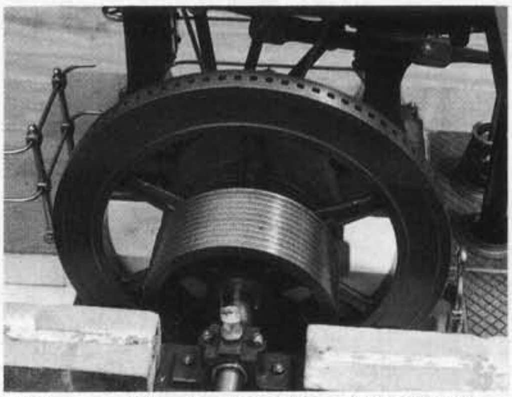
Note correct use of lock nuts on bearings and minute lubrications, also double bars forming rungs of ladder in background and flanged steam pipe joints.



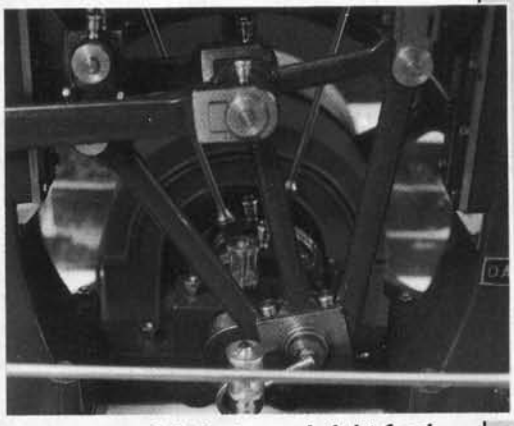
Overhead views offer a general idea of layout of engine.



On the Marshal, the pump, like the rest of the model, is fabricated, right down to the water strainer.



Fabricated flywheel and rope drum; note rectangular holes for the pinch bars to turn the engine over and hand-cut chequer plate for the base.



Bango type lubricator and sight feed lubricator on main bearings. Just visible, nameplate at right is shim brass stamped in reverse on a lead block.

TAKE TO THE ROAD

Left, a three inch scale tractor makes a nice sized model, although help would probably be needed to turn the wheel rims. Above, a very nice example of a four inch scale Fowler seen at the Primrose Valley Modellers Festival.

You don't necessarily need rails to enjoy the pleasure of miniature live steam operation. Traction engines are probably the most popular of all model road vehicles . . .

One disadvantage of making models of locomotives, be they steam powered or otherwise, is that a track is required for their use. Many people make models of road vehicles of one sort or another, some to be able to use them without the need to have the use of a track, some purely because they find that such vehicles are fascinating in their own right and frequently colourful.

Probably the most popular type of road vehicle modelled is the traction engine, the name being a generalisation as such vehicles were, in fact, called by a variety of names – including sometimes those given them on the spur of the moment by the driver when things did not go quite right...

Design

The type of engine would depend on the form of construction and sometimes its size. Very small engines were, more often than not, tractors. These were used in much the same way as the modern farm tractor and were maids of all work. Heavier engines were used for road haulage purposes, and these would be fitted with solid rubber tyres to avoid too much damage to the roads.

Sometimes tractors were also fitted with rubber tyres for use on the road. The ploughing engines were heavy machines distinguishable by the drum underneath which was used to pull the plough across the field. Two engines were used, the plough being passed on the cable from one to the other, (the engines were too heavy to actually tow the plough along and this would have defeated the very purpose for which they were designed.) Then there were the specialist engines which came in many forms. The most common of these was the Showman's Engine which was used both to haul fairground equipment along the roads as well as to power it on site and provide lighting.

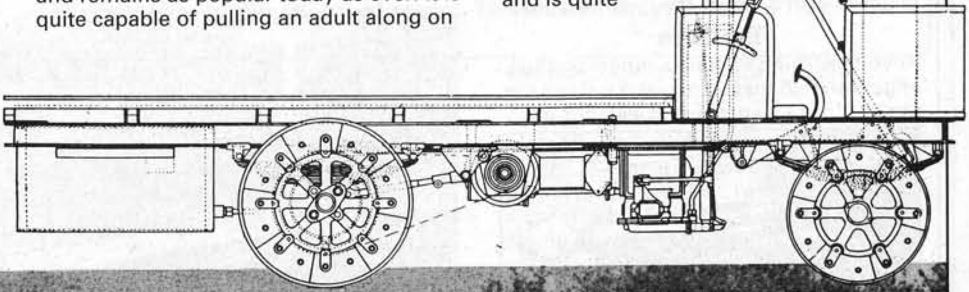
'Minnie'

There are many designs of such road vehicles available for the modeller. As with model locomotives, scale against size of prototype will, to some extent, be the deciding factor for many. One of the smallest is 'Minnie' which is actually a freelance design and does not follow any prototype. It is, nevertheless, a very attractive model and has a close resemblance to several full-size originals.

It was designed by the late Len Mason, a master craftsman if ever there was one. It is described as being to a scale of one inch to the foot, and is approximately that. We cannot say exactly, of course, because, unless it is a model of a particular full-size design, there can be no scale! It has been built in the hundreds and remains as popular today as ever. It is quite capable of pulling an adult along on a properly designed truck in spite of its size. A number of modellers have scaled it up and examples are seen in two and three inch scale.

Larger scale

We come now to slightly larger engines and the scale of 1.1/2 inches to the foot is the next one generally used. Possibly the most popular design in this scale is the model of an Allchin design by the late Bill Hughes. It is a very fine design which closely follows the prototype and, like 'Minnie', has been built by hundreds of people. It is a convenient size and is quite



Drawing above shows a popular model choice — a Sentinel Waggon. Above, a line-up of traction engines at a rally held by The Steam Road Vehicle Society.

capable of pulling a couple of adults.

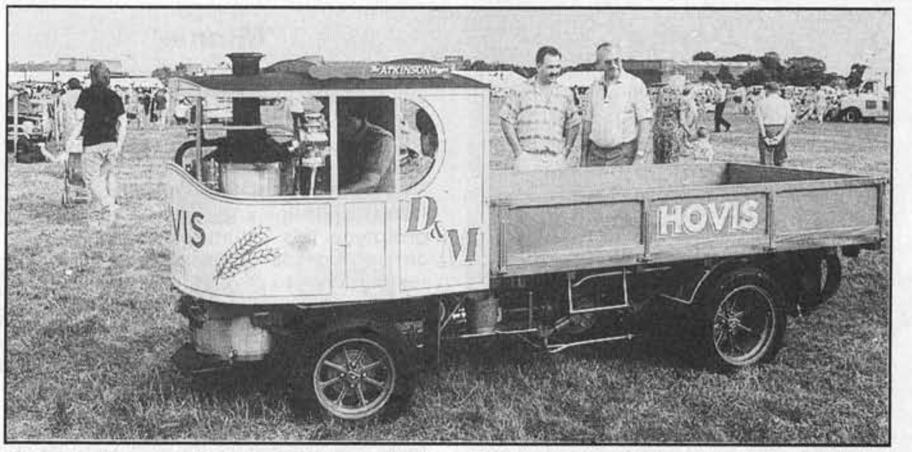
The next scale used is 2 inches to the foot and there are many suitable designs for this, too. One of the smallest is a Ruston Proctor Tractor designed by John Haining, and, one of the largest, a Durham and North Yorkshire traction engine by the same designer.

The scale of 3 inches to the foot is also popular and here we are getting into quite large models – certainly such models cannot be lifted singlehandedly by the average person. They are, of course, very powerful and will pull several people along. There are quite a few designs available in this scale but the same cannot be said for the larger scales like 4, 4.1/2 and 6 inches to the foot. There *are* designs available for such models but these are fewer than in the smaller scales. Generally speaking, outside help will be required with building the large engines.

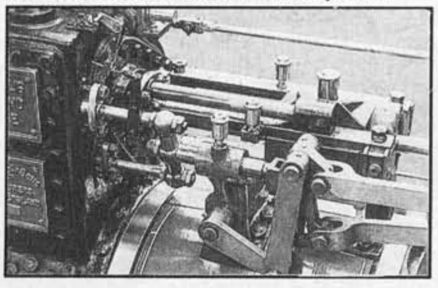
Boilers

Anyone wishing to build a model traction engine should make no mistake about the fact that it is one of the trickiest jobs in model engineering. It is also one of the most satisfying. The construction differs greatly from the construction of a model locomotive, even though there would appear to be much in common between the two.

The boiler of a traction engine acts as the frame and supports the wheels. On a locomotive there is a frame for this purpose. This means that the boiler has to be constructed differently, and in the larger scales. it is essential that the boiler is made of steel in order to give the set-up sufficient strength. The cylinder, too, is mounted directly on the boiler and the regulator is in the cylinder block rather than interspersed between the boiler and cylinders.

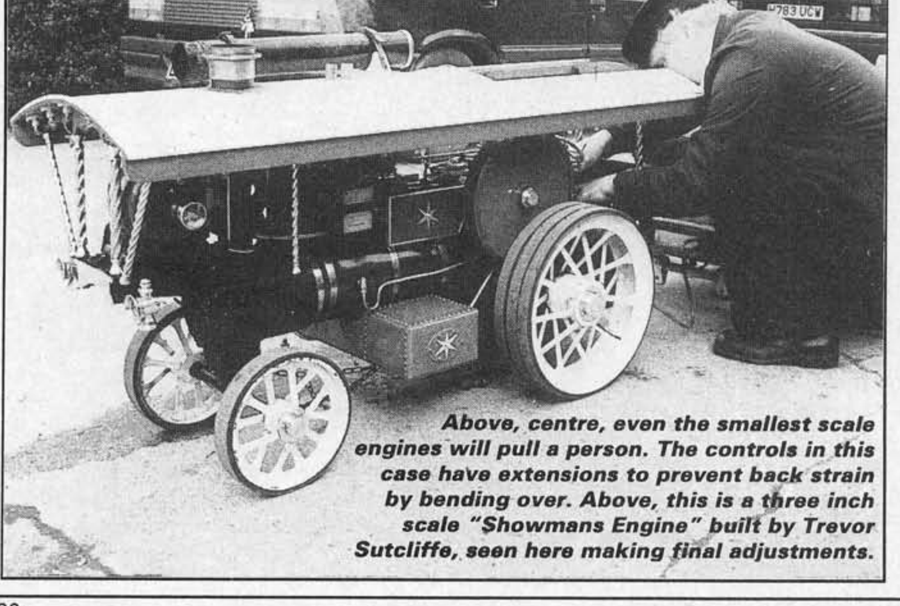


A really large vehicle is this model of an Atkinson steam lorry at a scale of 4 inches to the foot.



Unlike a railway engine, the cylinders and valve gear of a traction engine fit straight to the boiler.

An off-shoot of model traction engine building is the construction of steam lorries, the most popular design being this Clayton.



Above, centre, even the smallest scale engines will pull a person. The controls in this case have extensions to prevent back strain by bending over. Above, this is a three inch scale "Showmans Engine" built by Trevor Sutcliffe, seen here making final adjustments.

Wheels

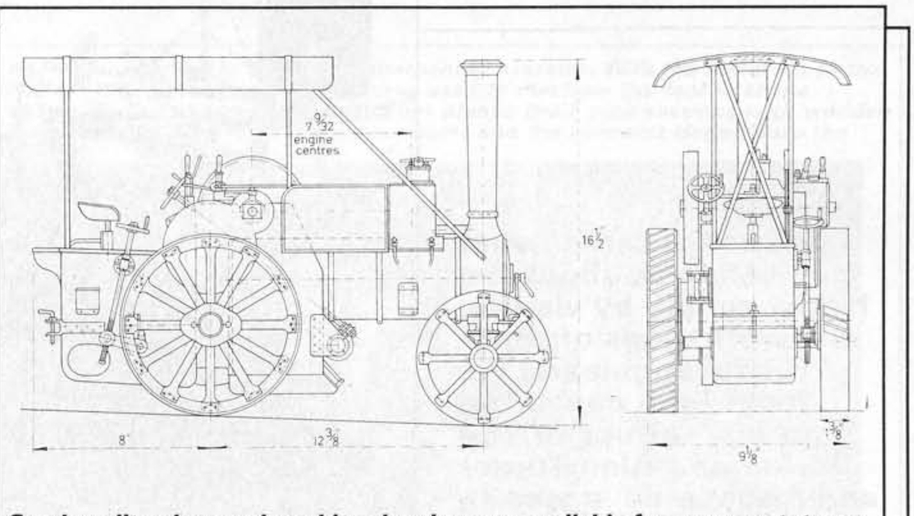
Wheels, too, are different. On a locomotive they are made from simple castings and perhaps the really fastidious modeller will put on steel tyres. On a traction engine they have to be built up using a separate hub, steel spokes and a rim. Sometimes the rim will be of steel but sometimes aluminium is used on the smaller sizes. The building is done on a simple wooden jig, but each spoke has to be riveted to both rim and hub.

Before this the rim and hub must be machined to size. On most engines there were strakes round the rear wheel rims to give a grip to the engine when used on soft ground. These are riveted individually to the rim. When it comes to large scale models, few people have lathes at home big enough to machine the rims. There are specialist firms who will do the work, and some colleges of engineering which run evening classes also have suitable equipment.

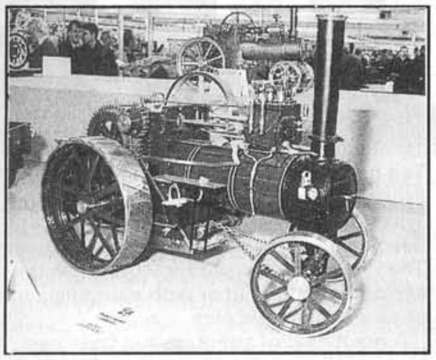
Cylinder blocks are machined in a similar way to those on a locomotive. They are slightly more complicated but not over-difficult. One problem is the need to machine an accurate curve for the cylinder block to fit on to the boiler, and this is usually done by mounting the block on a lathe saddle and machining the curve with a fly-cutter.

Hornblocks

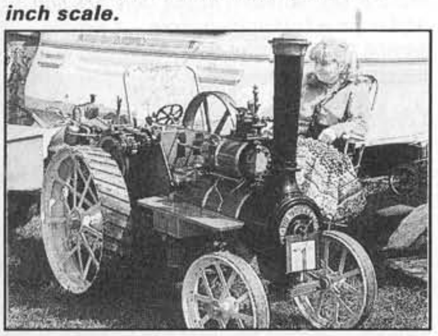
The need for strength in the boiler to allow it to support the wheels has already been mentioned. On full-sized engines the bearings for the wheels would be bolted either directly or via springs to the sides of the firebox, which were extended and acted as the hornplates. Where a small engine with a copper boiler is concerned this is not practical as the copper is not a suitable medium. The practice is to make a separate hornplate of steel which is bolted to the boiler and support the rear wheels on this. The front wheels are supported by the smokebox via the front axle.



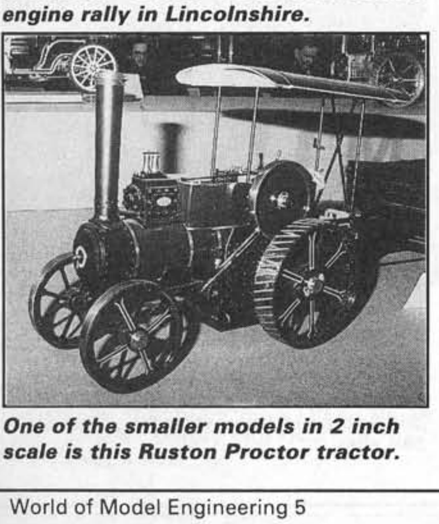
Good quality plans and working drawings are available for many prototypes in a mouthwatering choice of scales. This Ruston Proctor Steam Tractor is just one of many.



The Durham and North Yorkshire design is one of the largest in two inch scale.



Somewhat larger in scale is this 4 1/2 inch scale "Burrel" seen at a traction engine rally in Lincolnshire.



One of the smaller models in 2 inch scale is this Ruston Proctor tractor.

Gears

A locomotive wheel is connected directly to the cylinder via a rod. This did happen on some early traction engines but the practice was soon abandoned and, instead, a train of gears was used – the opportunity being taken to allow the engine to have two gear ratios as a rule. These gears are also needed for the model and they are fitted to the hornplates via shafts.

The gears can be cut in the home workshop, but it must be said that many builders prefer to purchase them. A differential gear is also used on large models to assist the engine to go round corners. There is no differential specified on , 'Minnie', one wheel only being connected to the drive and this having more or less the same effect. The same system can be adopted on other engines but it must be understood that a slight loss of power will result from the method.

Other details

Nearly all the larger types of engine incorporated a winding drum in their construction. Generally this would be fitted on one axle. Heavy flywheels were fitted for two reasons; firstly to provide a smooth motion to the cylinder, secondly to be used for driving machinery such as circular saws and threshing machines, via a flat belt. Showman's engines would, in addition, carry a small crane and a dynamo, the latter to power the fairground rides. The Showman's engines had a canopy covering the length of the engine to keep the crew dry. On some other types of engines there would also be a canopy, particularly the tractor which would have one over the driving area, but many had no protection whatever for the operators.

Steam rollers

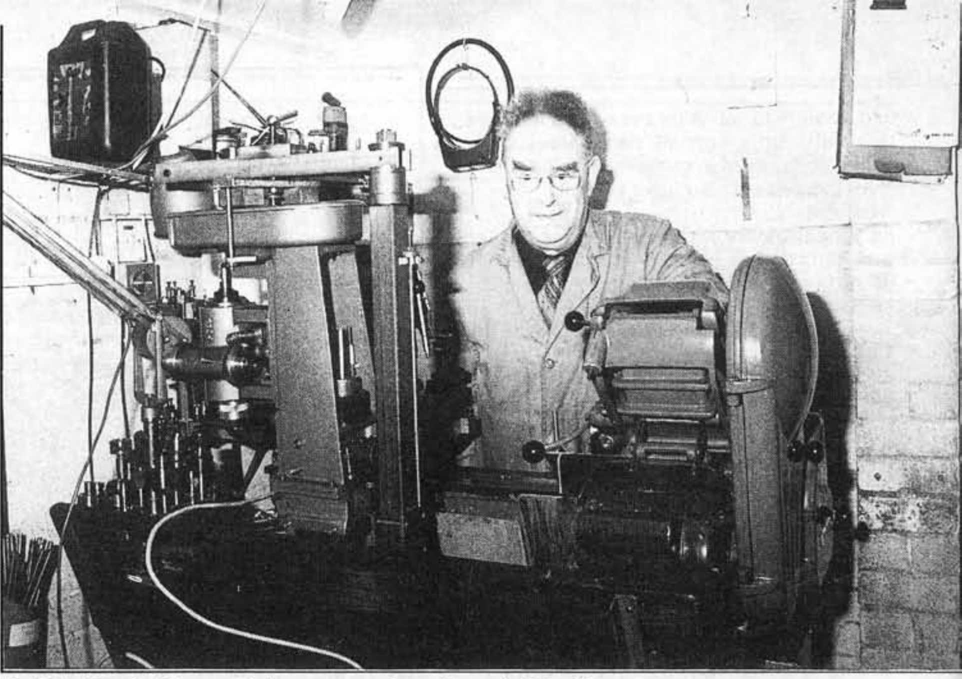
At one time the steam roller was a common sight on our roads – not as now, with long lines of cones blocking the carriageway for miles, but with a small gang of workers re-laying a section of road. So common was the machine that, even many years later when diesel rollers were used for the purpose, the name 'steam roller' still stuck.

Designs of steam rollers for modellers are not forgotten and there are several available in various scales. Some traction engines were convertible to rollers and this applies to some model designs also. There is not a lot of difference in the construction of a model steam roller to making a traction engine. Basically the design is the same except that the support for the heavy roller at the front end extends in front of the smokebox.

There is no doubt that the building and running of model traction engines and steam rollers has a fascination all of its own and there are many advantages and a great deal of satisfaction and pleasure to be had from this side of the hobby.

Model traction engines can be a family affair — as in this case.

It's remarkable what can be learnt about the hobby simply by visiting the workshops of other model engineers. We visited the converted garage set-ups of Ted Barker and Alan Turner and discovered a wealth of clever ideas and ingenious shortcuts which we believe readers will find of value



Ted Barker in his workshop — a mine of useful tips!

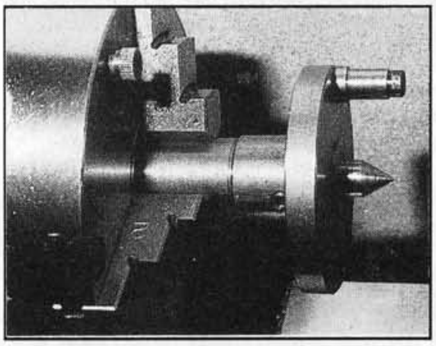
WELCOME TO T

A visit to somebody else's workshop will frequently give the visitor an idea that he or she can make use of. It is, in some ways, the passing on of knowledge that makes the hobby of model engineering so pleasant. Of course it is not always easy, particularly for the lone hobbyist, to find workshops which they can go along to.

For this issue of *World of Model Engineering* visits were made to the workshops of two model engineers. The subjects were carefully chosen for their knowledge of workshop practices and their ability to fabricate devices to help with the hobby. They kindly allowed us to photograph for the benefit of readers some of the gadgets and ideas which they make use of. Details of these are passed on here in the hope that readers will benefit from the experience of others.

Of course, workshops differ considerably as far as buildings are concerned with all sorts of places being pressed into service. Some people work in wooden garden sheds, some in rooms in houses and others take over the garage, or part of it. Both of the guinea pigs that were used have a similar set-up, each having partitioned off the end of the garage so that vehicles are separated

Ted's round parallels — simple to make and easy to store on a piece of dowel.



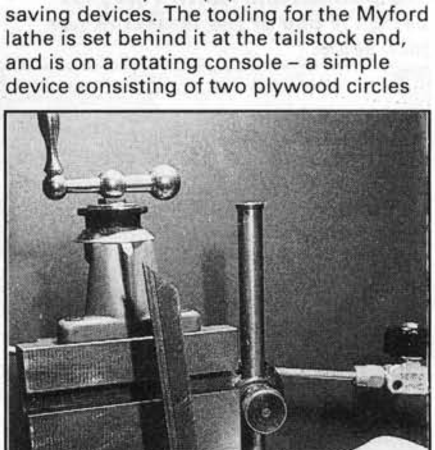
Ted's mini faceplate and dog with soft centre; simply put it in the chuck and take a quick cut across the centre. The size and fact that it is away from the headstock makes it very convenient.

from the workshop area and excessive damp avoided. Both featured insulation to keep heat in and damp out, but beyond that the resultant workshops are as different as chalk and cheese.

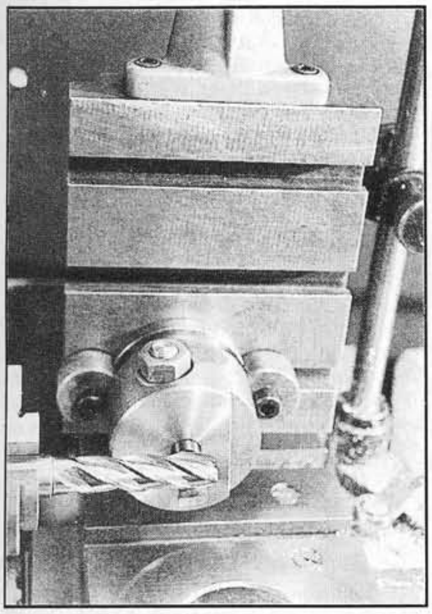
Ted Barker lives in the country and the workshop is rather in open space. One immediate feature that is noticed is the attention he has paid to security. Doors have good quality locks, and the window has home-made steel bars plus a sheet of 1/8th inch steel plate on it for good measure. Inside it is not a very large area and, as he points out, it is designed with one person in mind. Taking that into account the design permits maximum use of space.

The workshop contains two lathes, one a Hobbymat, the other a Myford Super Seven, the latter has a milling attachment. This being very heavy it is not practical to put it on and off when it is required and Ted has made a cradle which allows it to swing in and out of position as need be. This provides all the milling facilities he needs and, at the same time, saves space. The Hobbymat is used for work when the Myford is set up either with a turning job or as a milling machine.

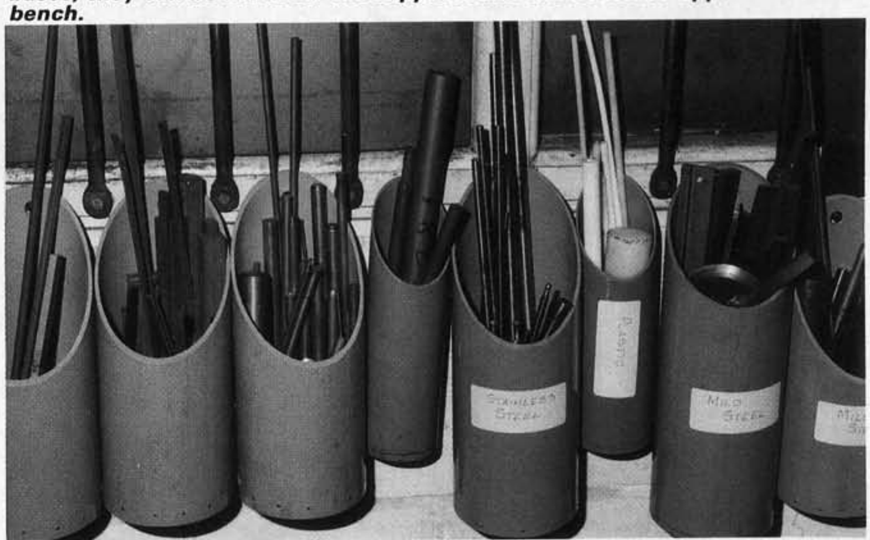
A great deal of attention has been paid to accessibility of equipment and time-saving devices. The tooling for the Myford lathe is set behind it at the tailstock end, and is on a rotating console – a simple device consisting of two plywood circles



A device for machining the correct angle on home-made cutters. It swivels on its support and the protractor is lined-up with a flat on the side.



At left, next stage in the cutter sharpening exercise. With the metal set to the correct angle a milling cutter is then used to machine the tool to shape. Below, Ted's storage method employs plastic drain pipe sections with wooden bases; they can be lifted off the supports and the contents tipped onto the bench.



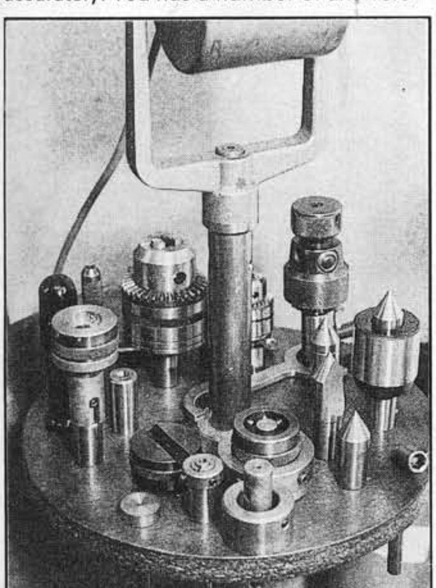
HE WORKSHOP

with a piece of tube and a spindle between them. Tapered pieces slip into holes and other bits and pieces are fitted as required. Being at the lathe end it stays clear of swarf and can be moved round easily to get at any tool that is required. A simple device set on the saddle of the lathe allows easy screw adjustment of the top slide set over, for turning tapers.

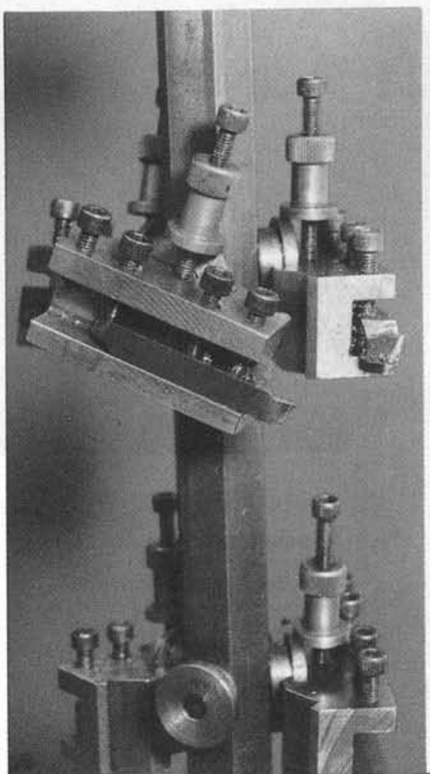
All of the work done is carried out with great care. In particular, of course, this involves setting work square and accurately. Ted has a number of answers to doing this quickly; he uses an attachment in conjunction with setting the vertical slide accurately and quickly. It is simple enough – a couple of accurately machined buttons and a bar which slips on the bed and butts to the vice jaws, the vice being bolted to the slide.

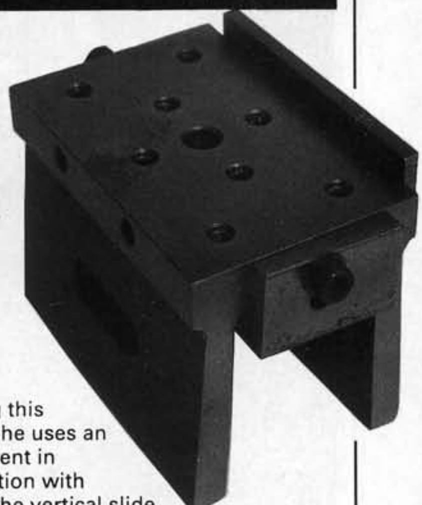
Nothing is wasted in the workshop and a broken vice was taken to evening classes and ground into a small surface plate. A number of carefully spaced tapped holes allow work to be bolted down if need be and metal strips along the edges once again ensure quick and accurate square work setting. Part of the rest of the vice has been made into a finger plate.

Low cost is very much an element that goes along with the search for accuracy and parallels which are so essential for work setting have been

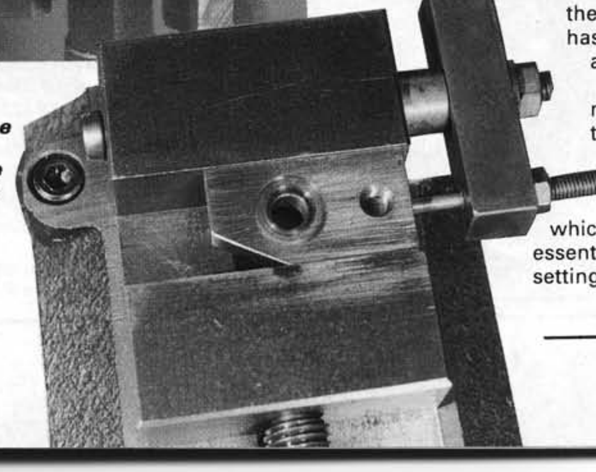


Above, a tool rack in the form of a carousel for easy tool selection. At right, Ted's ingenious method of storing tool holders for a Dixon Bates type holder; simply clip them on the round supports.

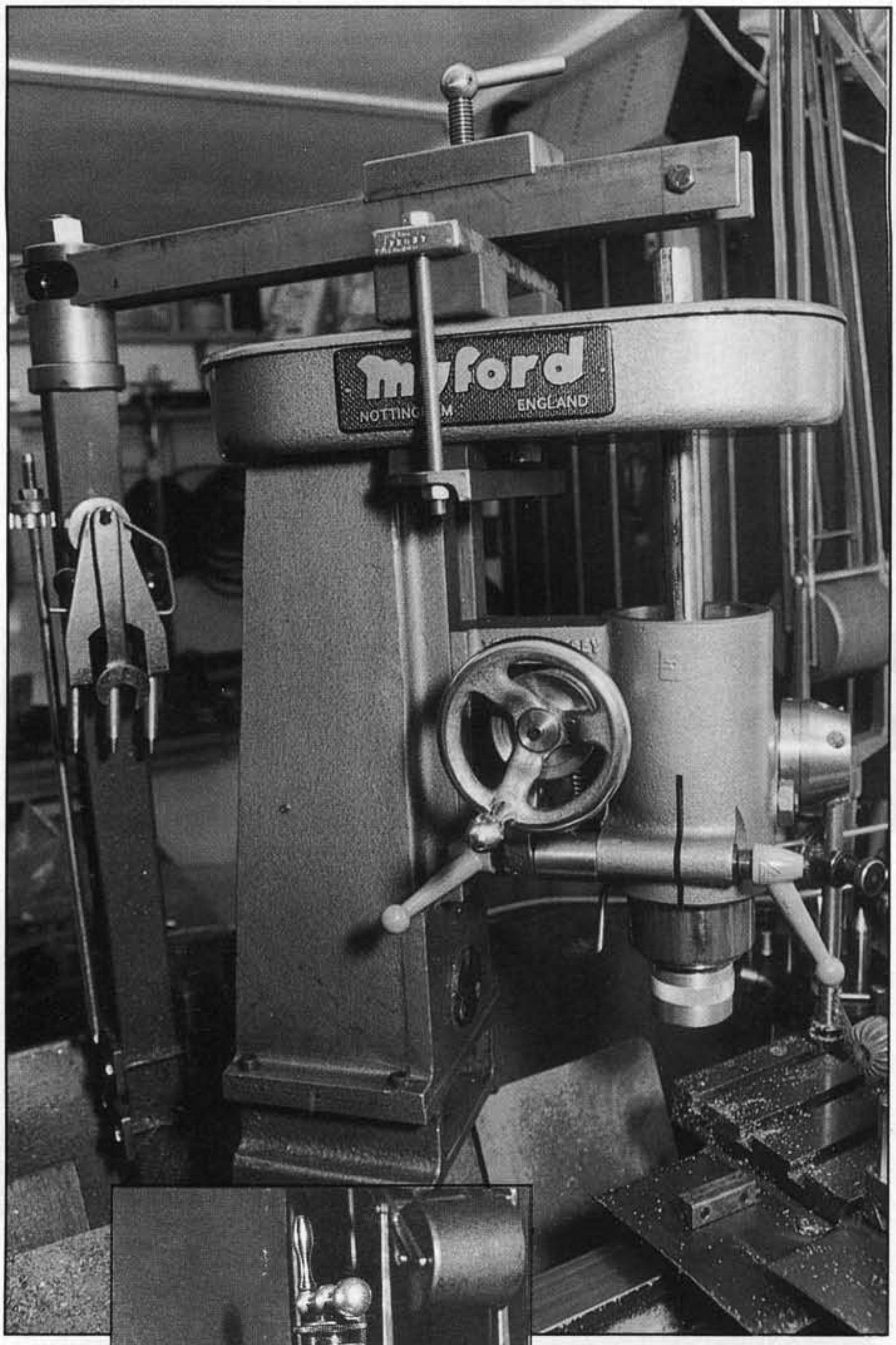


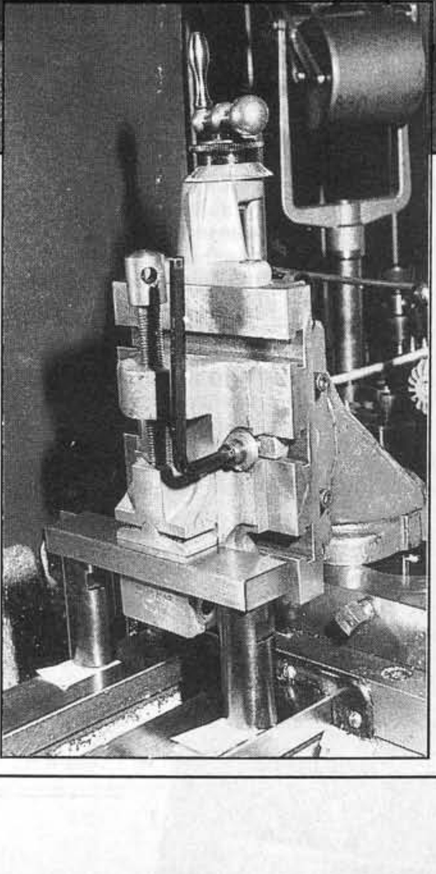


Ted uses this broken vice as a surface plate with bolt-down holes.



A stop for the milling machine vice enables easy repetition

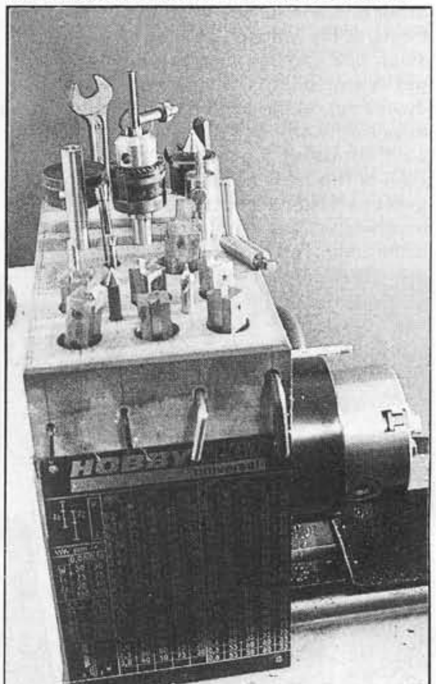


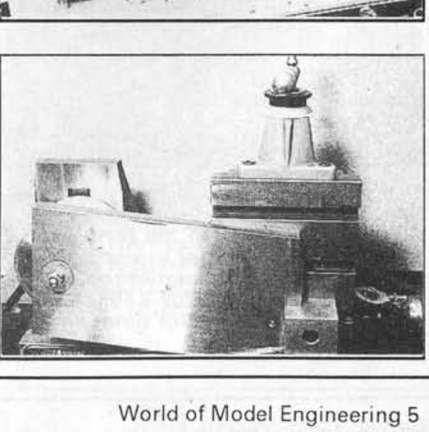


machined from round bar rather that the more normal flat section. These are machined accurately to diameter and width and are made in a number of sizes. Holes are bored in them and they are stored on a piece of dowel set in a wooden block. This makes them easy to get at and saves the inevitable search through a box for the right size when required.

Of particular interest is a device for machining the set on cutting tools. Consisting of an adjustable circular holder which is clamped to the vertical slide, the steel for the tool can be lined up accurately with a protractor and then machined with a milling cutter held in the lathe chuck. This is useful when making tools to be used for special purposes as an accurate set is guaranteed.

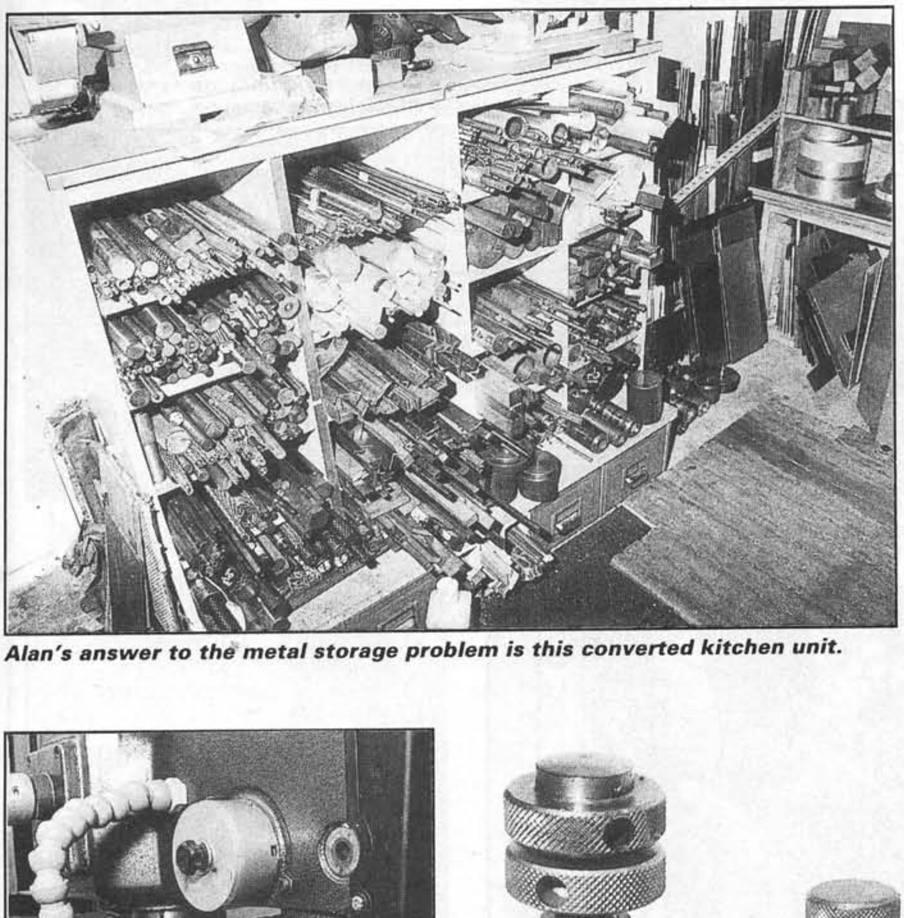
To describe *all* the clever ideas in the workshop of Ted Barker would half fill this magazine and so we must move on. The next visit was to Alan Turner. An engineer by trade and still so employed, Alan brings the expertise he has learned over the years to his home workshop, and this too is full of good, practical ideas. Like the previous visit it is the rear half of a garage and similar although maybe slightly larger in size. Although also resident in the country he lives in a village and is less isolated; even so attention has been paid to security. There the similarity ends as the equipment is different and the approach to making life easy and gaining maximum accuracy entirely different, whilst the end result is almost the same.





Above, the cradle for Ted Barker's milling attachment allows it to be swung easily into position with little or no effort. At left, Ted's method of setting the vice on the vertical slide square. The device rests on the bed (protected with paper) and the jaws rest on it. Above right, a tool rack on the headstock tcp of the Hobbymat lathe. Below right, another of Ted's clever and very useful ideas is this one for milling curves. As the vertical slide is wound up or down, the plate describes an arc.

Over now to the workshop of Alan Turner; here he is in his neat and tidy set-up, the rear part of his garage.



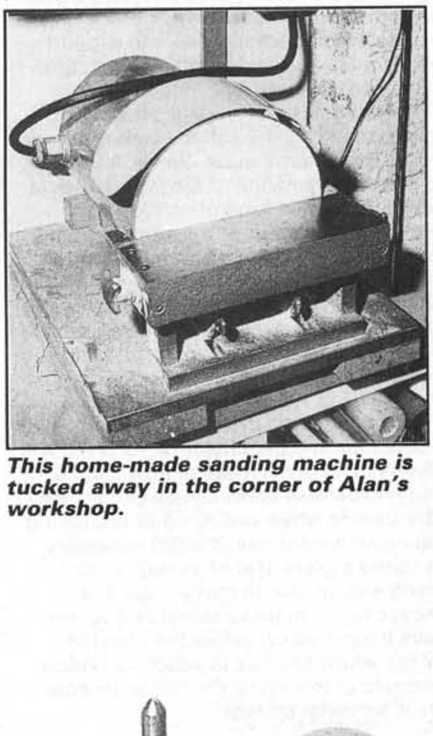
Alan's answer to the metal storage problem is this converted kitchen unit.

The workshop is equipped with a Myford ML7 Lathe, a drilling machine and a milling machine. The latter is the newest aquisition and takes up a great deal of valuable space. Thought has therefore been given to storage of tools, etc., and the home-made stand on which the machine is set has a drawer which is shallow but goes the length of the stand. This is suitable for storing clamps, parrallels, etc., and makes them easily accessible. Parallels in this case are ground steel strips in the more traditional manner than those of Ted.

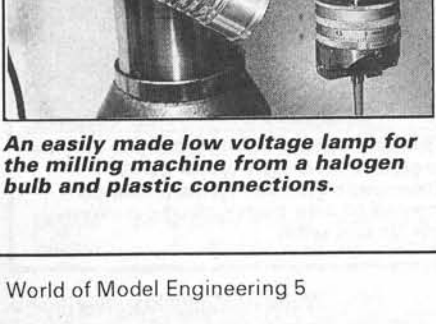
Good lighting is essential to the operation of any machine and, where possible, it should, for reasons of safety, be of low voltage. On the milling machine the problem has been neatly solved. A halogen bulb rated at 50 watts was bought from a Texas DIY store and this was set into a very heavy aluminium holder which was polished to act as a reflector, the idea being to dissipate some of the heat produced by the bulb.

The holder is attached to the milling machine via a series of plastic connectors used normally for directing the flow of cooling liquid to a machine. These are rigid yet flexible and are reasonably cheap to buy. The leads pass through these and to a twelve volt transformer which stands on a shelf at the back of the machine, housed in a heavy steel case for safety.

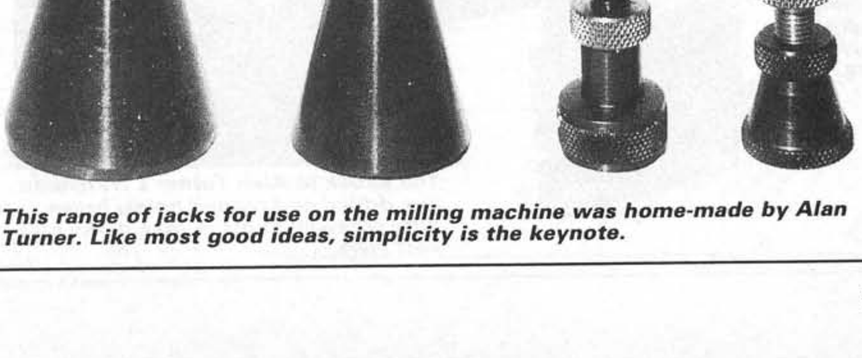
There are a number of time-saving devices which have been made and find plenty of use. Alan is also a great one for



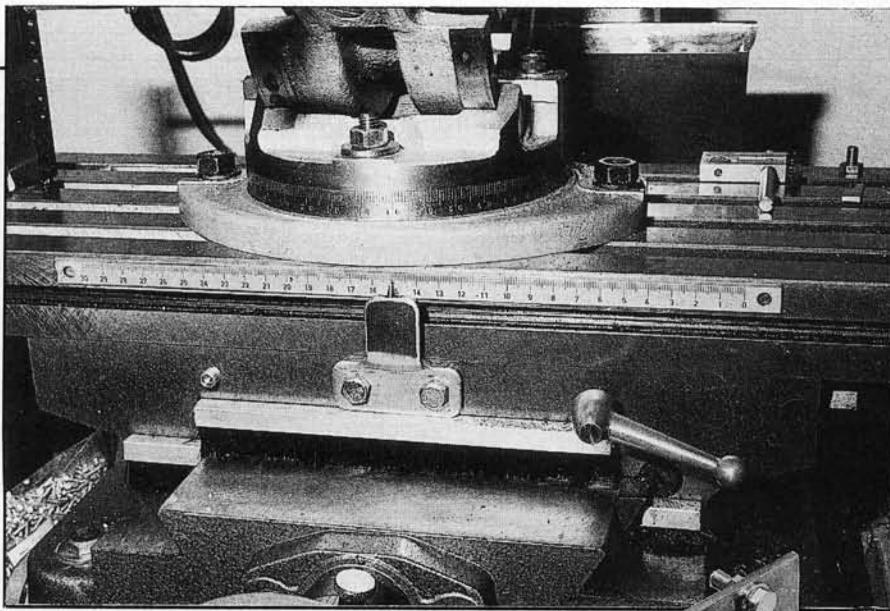
This home-made sanding machine is tucked away in the corner of Alan's workshop.



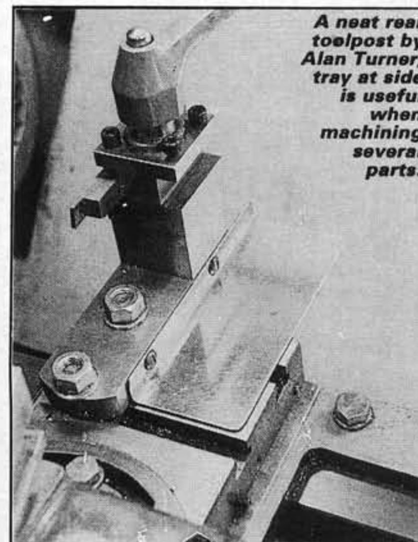
An easily made low voltage lamp for the milling machine from a halogen bulb and plastic connections.



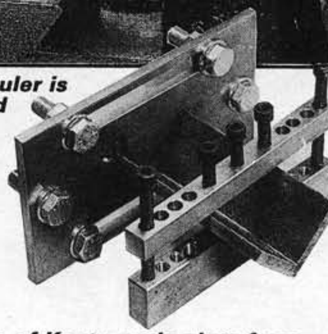
This range of jacks for use on the milling machine was home-made by Alan Turner. Like most good ideas, simplicity is the keynote.



A neat development on the milling machine; a ruler is stuck on the table and a point has been inserted in the stop. The Allen screw for locking the table has also been replaced with a home-made handle.



A neat rear toolpost by Alan Turner; tray at side is useful when machining several parts.



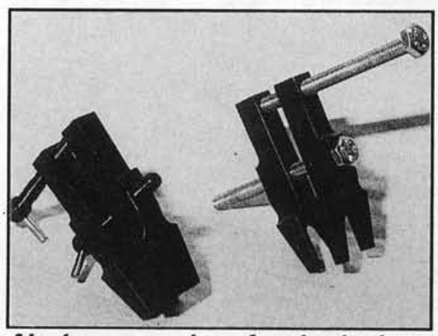
A form of Keats angle plate from ordinary angle iron - more versatile than the usual form.

A 'fiddling block' with a series of grooves to support virtually any small material to be worked on.

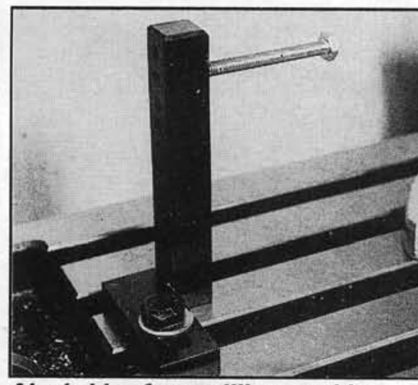
browsing round the surplus dealers and picking up bargains which are very useful. General storage is on high shelves, which keeps things safe and unlikely to be accidentally damaged. Metal storage differs considerably from that of Ted Barker. Ted used pieces of four inch plastic pipe with plywood bases. Allan has an old kitchen unit. He has carefully drilled across this and set in dowels to support shelves, leaving the metal lying flat. Both systems work very well indeed.

The lathe has received its fair share of attention. There are various carriage stops and it has a home-made clutch. A useful idea is an adaptation of the lathe chuck to take Allan's own form of soft jaw. For accuracy, of course, soft jaws are essential. He has drilled and tapped holes in some jaws that have been softened and simply screws brass nuts to them. These can be trued and recessed as required and are easily and cheaply replaced. Being brass they are unlikely to mark work as much as soft steel ones.

It is to be hoped that the visits to the two workshops and the photographs taken will give readers some ideas of how simple and inexpensive ideas can be of considerable benefit when setting up or improving their own workshops. It is not necessary to spend a great deal of money on so doing and, in fact, in many ways it is always better to make something which suits the individual rather than buying things which one has to adapt – a typical example of this being the two individual ideas on metal storage.

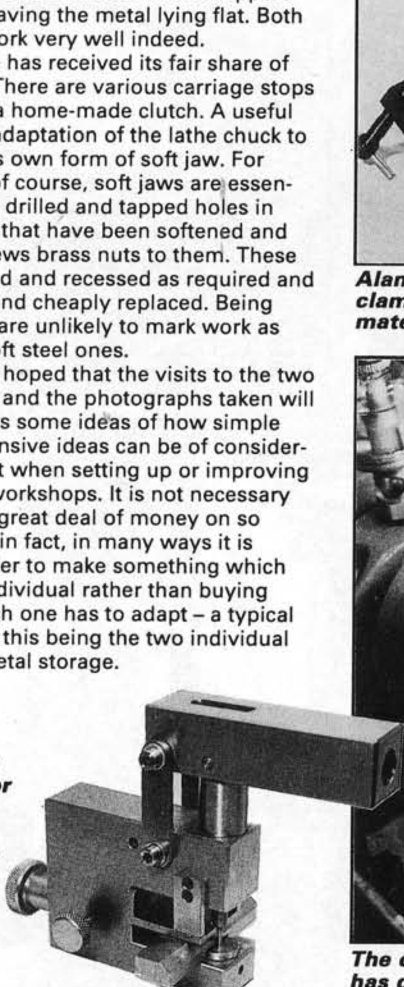


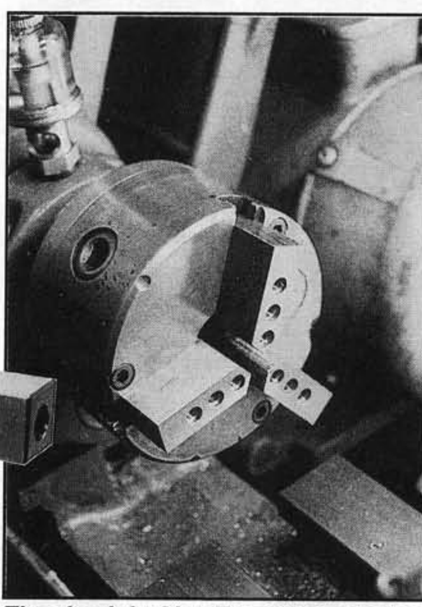
Alan's own version of toolmaker's clamps are made from simple basic materials in a few minutes.



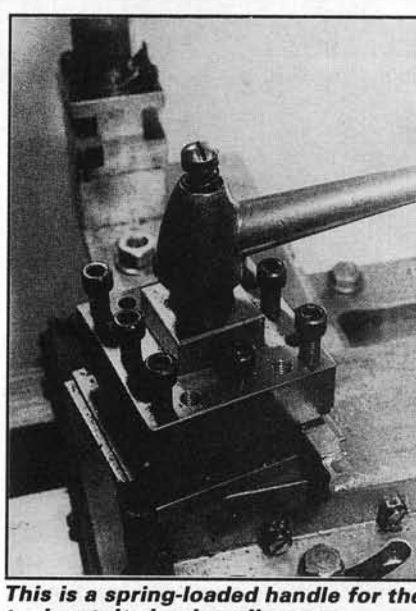
Alan's idea for a milling machine stop; compare with that of Ted Barker...

A home-made press which can be used for bending, punching holes, etc.





The chuck in Alan Turner's workshop has drilled and tapped holes; brass nuts screwed in place then make nice soft jaws.



This is a spring-loaded handle for the toolpost; it simply pulls up to disengage and the handle can be moved to any convenient position out of the way.

GONE BUT NOT FORGOTTEN

Not so very long ago the tram was an everyday sight in the streets of many towns and cities in the UK. How times have changed! Today, the memory is kept alive by models of these intriguing subjects in a variety of scales

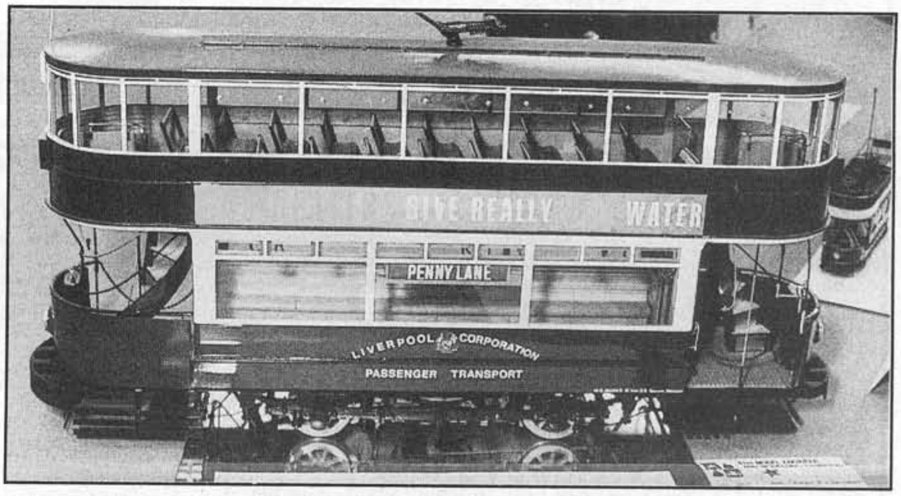
Like the fairground, tramway modelling would appear to be a fringe element of model engineering. Whilst much of the modelling involved is woodworking and other similar skills, the making of the frame and bogies is definitely model engineering. There is no doubt that a well built tram is a delight to see as well as to operate. Trams are now coming back into fashion in this country although not in the form older readers will recall.

In many countries they never went *out* of fashion! Only Blackpool remained faithful to the tram and developed it whilst others were replacing it with buses and trolleybuses. Blackpool was also the first town to have a tramway of what can only be described as traditional English type. At one time nearly every town of any size in the country had its tramway system. Fortunately there are a number of museums which still have examples, many of them working. The National Tramway Museum at Crich in Derbyshire has a large collection which is used regularly.

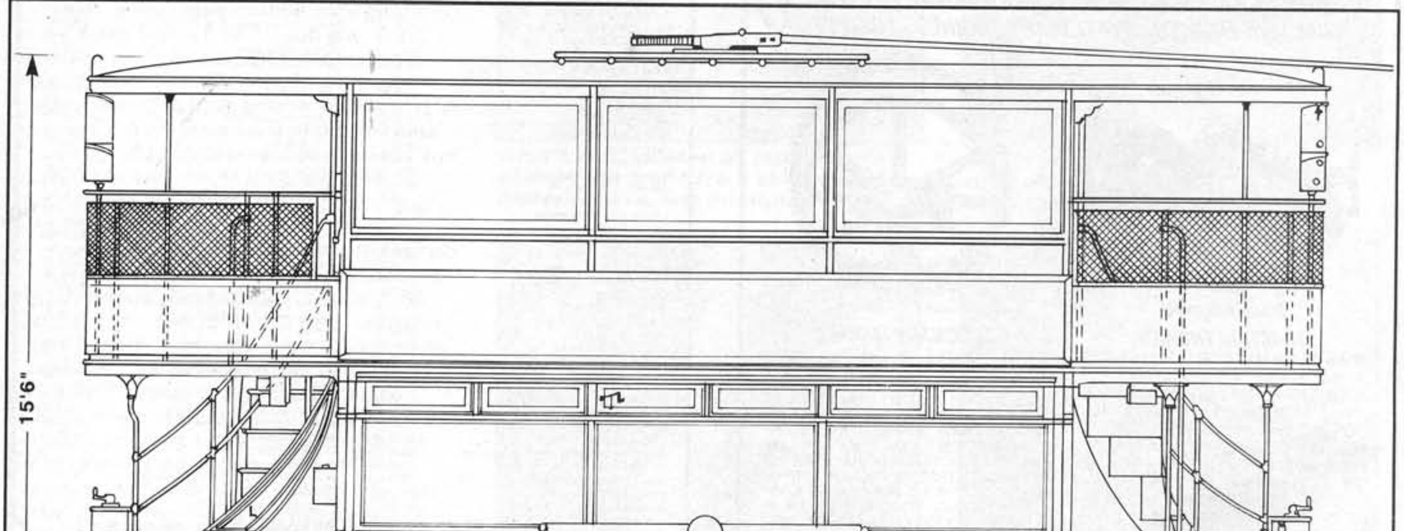
Variety of choice

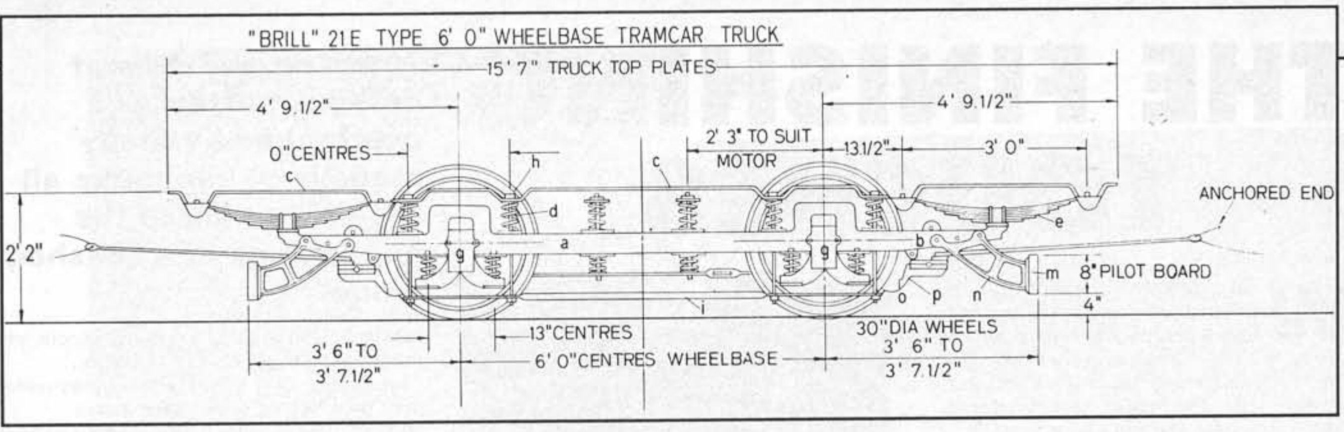
It follows that the range of models that can be built is extensive because of the wide variety of vehicles which once existed. There are single-decked vehicles, some of which are on the toast rack principle for the benefit of visitors to places where they were suitable. Others have covered tops and some were open. Then there were the double-deckers with a choice of open or closed tops. Add to this the range of liveries for the various towns and it can be seen how wide the choice is when considering which model to make ...

Many trams ran on four wheeled trucks even though they were quite long and there was a considerable overhang. Others ran on bogies. Motors were placed across the frames or bogies and this makes it convenient for would be modellers as simple gearing is sufficient for transmission. When it comes to interiors there is, once again, a whole range of



Above, a fine model of a Liverpool tram, this one running on a four-wheeled truck. Below, drawing of a typical four-wheeled tram, this one of the covered top, open balcony type. As you can see, they make tempting modelling subjects . . .

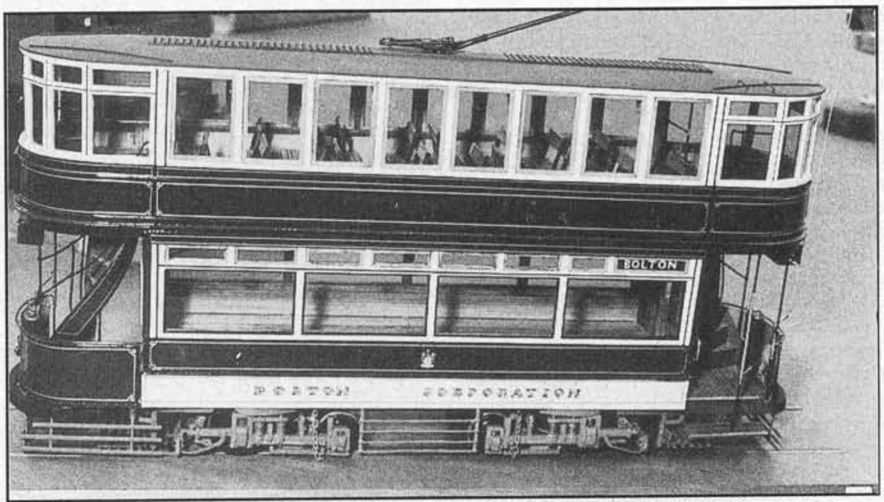




things to pick from that generally would suit anyone's taste. The seats on some trams were upholstered and on others consisted of wooden slats. Many were reversible. Controls were simple and some vehicles operated from overhead wires whilst others picked up current from a central conduit.

There are plenty of drawings availabe for the construction of trams whether they be British or foreign. It is also possible that some parts might be available. Would be builders should make contact with:- The Publicity Officer, Tramway and Light Railway Society, 1 Redwing Court, Kidderminster, Worcestershire DY10 4TR.

The society markets a range of parts for tramway modelling. A variety of scales are used in tramway modelling and these range from 4mm to the foot to 3/4 inch to the foot – so the would be modeller is really spoilt for choice.



A Bolton Corporation tram running on bogies; although at first glance the superstructure appears to be the same as that of the Liverpool tram opposite, there are numerous differences. The shape of the top windows and curvature of the stairs are examples.