DRILL

The drilling machine is fairly simple to use, but it is worth knowing how to get that little bit extra from it

Next to the lathe, the machine most likely to be found in the home workshop is a drilling machine. In fact, drilling machines are popular with all sorts of do-it-yourself enthusiasts as well, and such machines are to be found in their workshops as well as those of model engineers. No doubt most people can use a drilling machine with reasonable success but it is worth knowing a little about the tool to achieve that bit extra from it.

Let us start by thinking of the drill bit or, as it will probably be, the twist drill. These useful items are remarkably cheap to buy when one realises how much is involved in their manufacture, but even so, there is no reason to abuse them. In most cases drills should be kept sharp, the exception being when drilling brass, copper, bronze or gunmetal. In the case of these materials it is still desirable to have a sharp drill but if it is sharpened in the usual way it will snatch in the material and this can be rather unpleasant at times as the work tries to climb the drill.

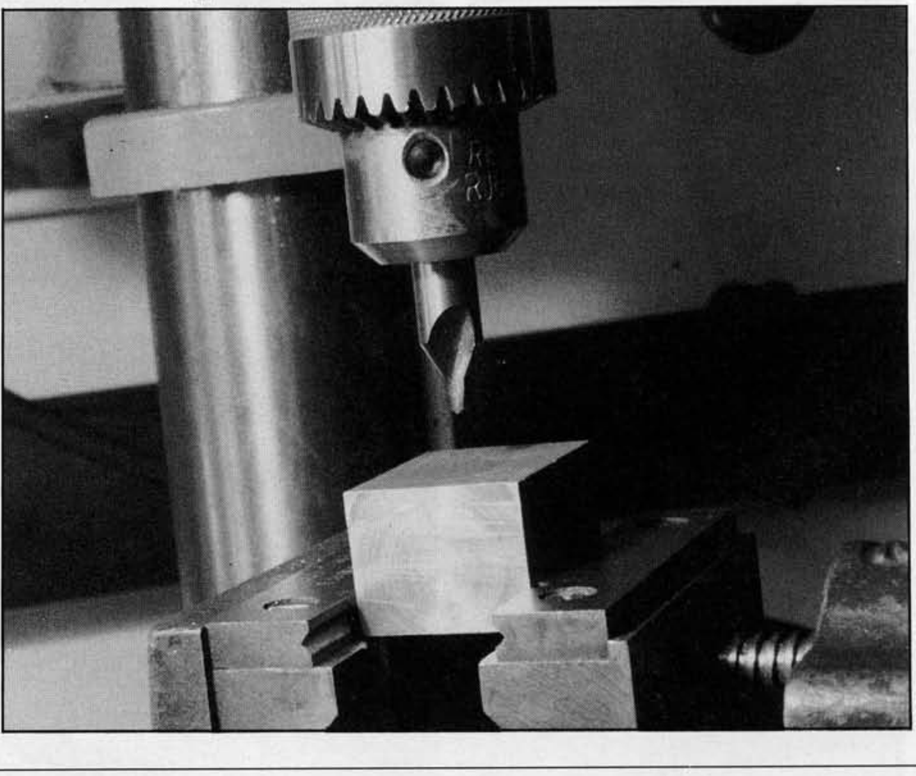
Technically speaking, the drill should be backed off to ensure it does not snatch. In this case we have a sharp drill and the backing off giving us the best of both worlds. Backing off a drill properly is not easy, particularly for the beginner. In the case of very small drills, backing off is almost impossible and so the drill should be sharpened in the normal way and then the cutting edge lightly honed off with a smooth oil stone.

For steel and iron, the sharper the drill is, the better and, unless you are an expert it is as well to use a drill-sharpening jig of some sort. If we examine a new twist drill, as it comes from the manufacturers, it will be seen that the cutting edge is even on either side and will have two angles. The one at the edges provides the cutting action and the second, clearance for the swarf. In practice, unless specialist equipment is available, the drill will have to be ground with just one angle which will have to both cut and clear the swarf. This angle should be 10-12 degrees. The included angle of the point for normal purposes should be 118 degrees. However, for drilling brittle plastics this can be increased to 60 degrees and, for hard materials such as gauge plate, reduced to 140 degrees.

The webb of the twist drill is the part that runs up the centre between the flutes. It is thinner at the point than it is at the shank and this is to increase the strength of the drill. It follows then that with constant sharpening the thickness of the webb at the point will increase and it may well reach a thickness where the drill no longer really has a point because the webb is so thick. When this happens, the webb may be just ground away a little to restore it to its original thickness. Do not overdo this as it will unecessarily weaken the point.

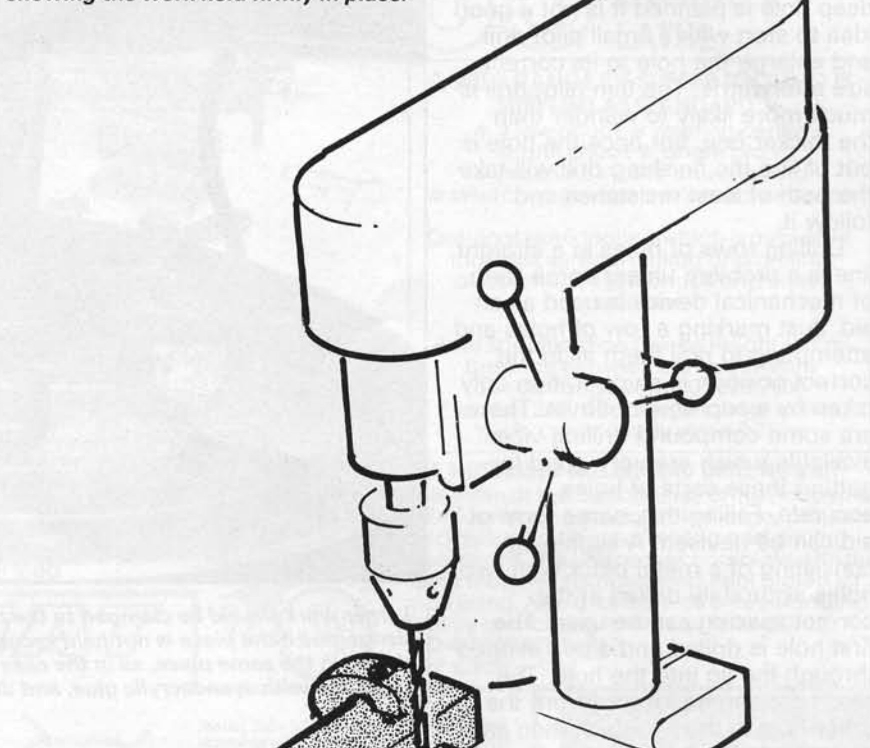
Drills should be run at as near the correct speed of rotation as possible. A chart of suggested speeds from a major manufacturer is included on the pull-out wall chart supplied with this issue; pin it up over the bench for handy reference. Feeding the drill will normally be a matter of feel and a light, sensitive touch should be used with frequent withdrawal of the drill to clear the swarf. Don't be tempted to seize the handle of the drilling machine with both hands and force the drill through the work. If, as often happens, particularly when drilling aluminium and similar alloys, the flutes of the drill become clogged,

All drilling operations should be started with a centre drill; this gives an accurate and clean starting point.



NG

A typical drilling machine in use, showing the work held firmly in place.

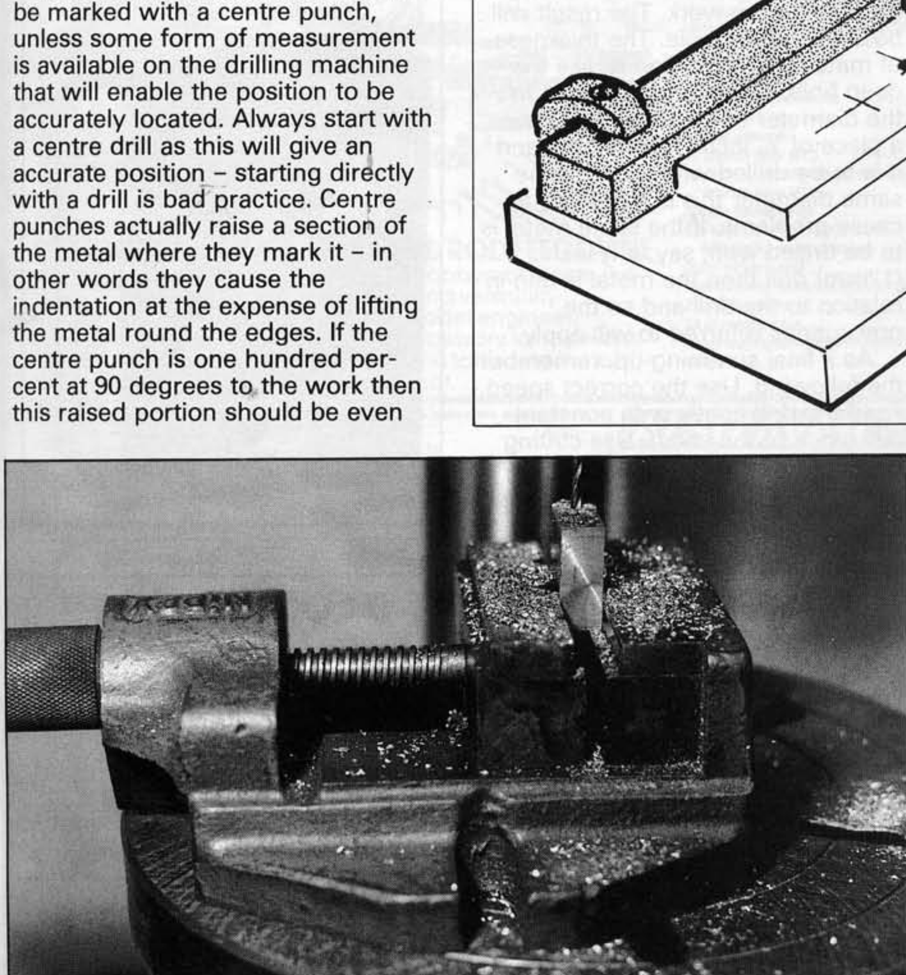


then SWITCH THE MACHINE OFF, and clear the hardened swarf from the flutes. A cutting fluid will always help clear swarf during the drilling operation as well as keeping it cool and helping to maintain the edge on the drill point.

All work on the drilling machine should be bolted down or held in as heavy a machine vice as possible, this too being bolted down if possible. If work is difficult to hold then try putting a G clamp on the drill table and the work, and holding it that way.

All positions to be drilled should be marked with a centre punch, unless some form of measurement is available on the drilling machine that will enable the position to be accurately located. Always start with a centre drill as this will give an accurate position – starting directly with a drill is bad practice. Centre punches actually raise a section of the metal where they mark it – in other words they cause the indentation at the expense of lifting the metal round the edges. If the centre punch is one hundred per-cent at 90 degrees to the work then this raised portion should be even around the mark. It is highly unlikely that the punch will be held as accurately as that though, and there is a real danger of the twist drill wandering off the centre punch mark as it slides from the high part of the raised portion to the bottom. The use of a centre drill will ensure an accurate start to the drill; it should be taken into the work just enough to get it level with the top of the point – neither too deep nor too shallow.

Drilling very deep holes can be a problem. Drills have a nasty habit of wandering even if work is bolted



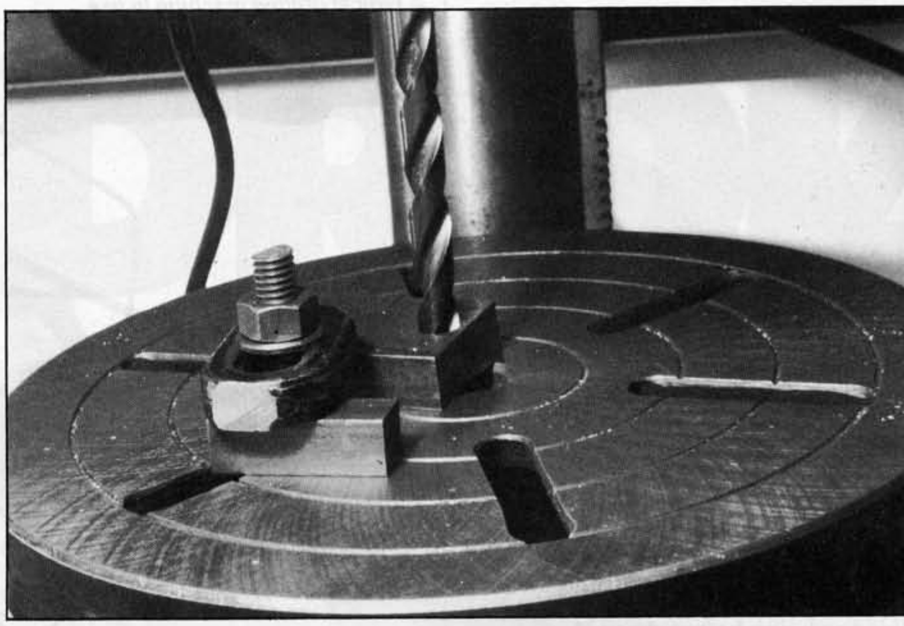
All work must be held securely; small items such as this can be held in an ordinary machine vice.

hard down. Where a large diameter deep hole is planned it is not a good idea to start with a small pilot drill and enlarge the hole to its correct size afterwards. The thin pilot drill is much more likely to wander than the thicker one, but once the hole is out of line the finishing drill will take the path of least resistance and follow it.

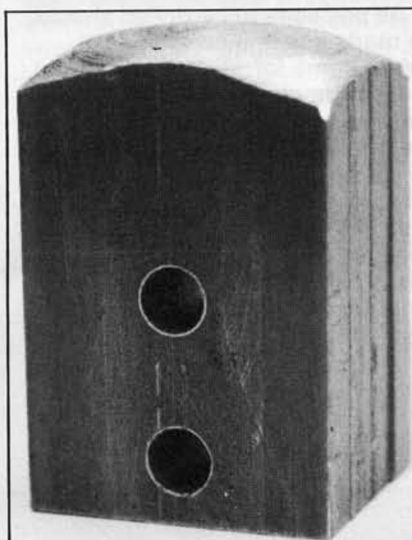
Drilling rows of holes in a straight line is a problem unless some form of mechanical device is used as an aid. Just marking a row of holes and attempting to drill them all in the correct position is an operation only taken by a supreme optimist. There are some compound drilling vices available which are very good for getting these sorts of holes accurate. Failing this, some form of aid can be devised. A simple jig consisting of a metal block with two holes accurately drilled at the correct spacing can be used. The first hole is drilled and a peg slipped through the jig into the hole. The next hole can be located from the other hole in the jig which then can be moved along and so on. Another way is to clamp a bar of metal to the drilling table and to use this as a guide. This is particularly useful where the holes are fairly far apart and a jig such as the one described above is not a very practical proposition.

Drilling very thin metal is always difficult. The drill causes the metal to climb up it and, because of its thinness, there is little that can be done to hold it securely. Drills also have a nasty habit of drilling octagonal holes in these circumstances. This can be overcome by lining the drill up accurately and then putting a piece of emery cloth over the place where it will enter the work. The result will be a nice round hole. The thickness of material to be drilled is, like the deep hole, directly proportional to the diameter of the drill. If we have a piece of $\frac{1}{32}$ inch (1mm) metal and it is to be drilled with a drill of the same diameter this is not going to cause problems. If the same metal is to be drilled with, say, a $\frac{1}{2}$ inch (12mm) drill then the metal is thin in relation to the drill and so the precautions referred to will apply.

As a final summing-up, remember the following. Use the correct speed. Feed the drill lightly with constant clearance of the swarf. Use cutting fluid where necessary, and secure the work.

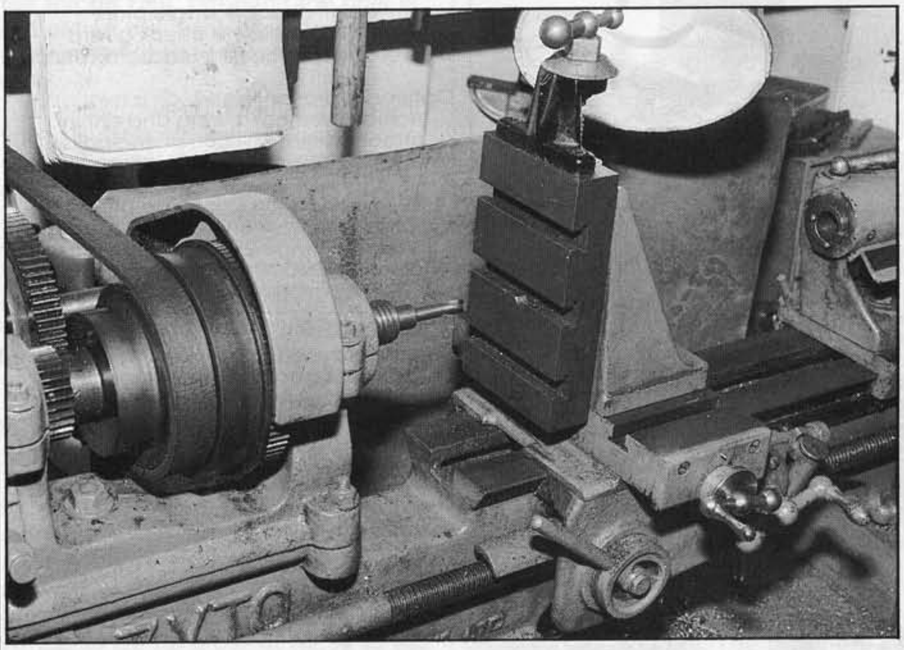


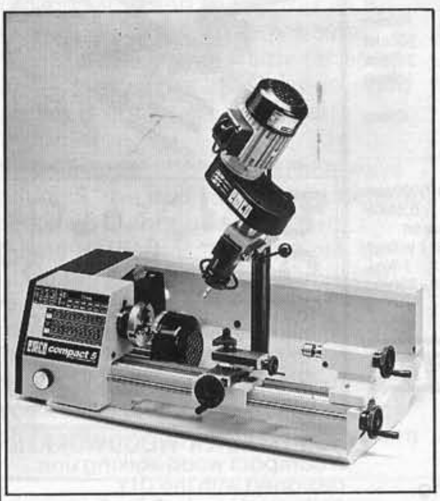
Larger work should be clamped to the table during operations (above); it could be dangerous if the piece is not held securely. If a number of components are to be drilled in the same place, as in the case below, it may be possible to hold them together, with cyanoacrylic glue, and drill them all at the same time.



MILLING

Investing in a milling machine may not be essential, but certainly makes life easier

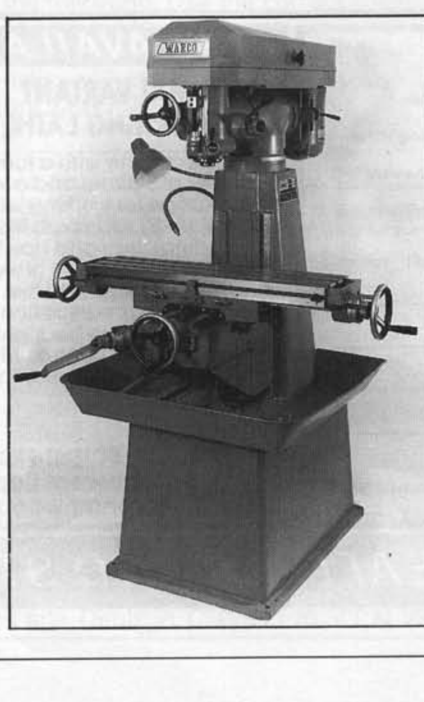




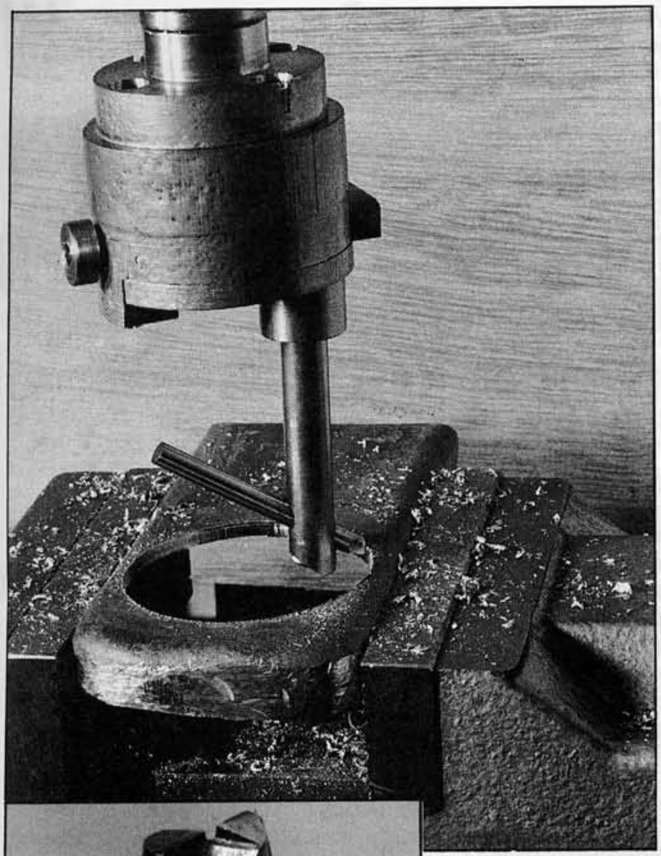
Our lathe will generate round surfaces and, in fact, can also be used in certain circumstances for obtaining flat areas as well. In normal circumstances such operations are very limited however and, without recourse to other equipment, our flat surfaces will need to be obtained by filing. Not that there is anything wrong with filing – in fact, the exercise can be a most satisfying experience. However if we can employ some mechanical means such as milling, the work is physically easier, and quicker as well.

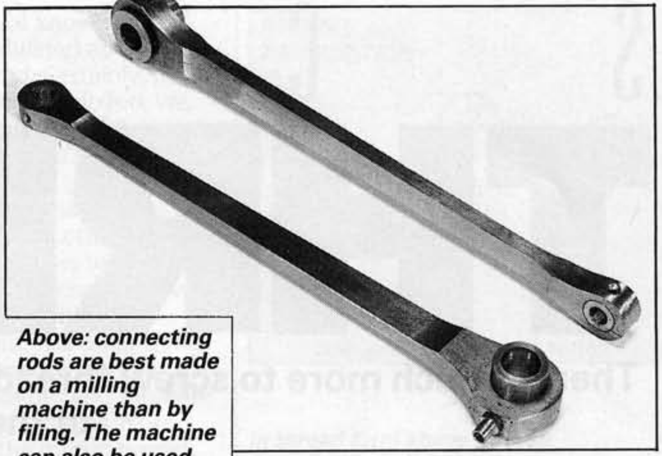
Whilst, in the normal use of a lathe, the work is rotated and the cutting tool remains static, when milling the reverse happens. By far the cheapest way to indulge in milling operations is simply to pack the work up and bolt it to the lathe cross slide. Put the tool in the chuck and get the desired effect that way; it is something to which I still sometimes resort for particular jobs. The problem with it is that the area being milled is limited to the width of the cutter but large areas can be covered using a fly cutter, with considerable success.

If we want more versatility we can invest in a vertical slide. This allows work to be secured in such a way that it will traverse across the chuck and the height can also be varied; in that way, a limited

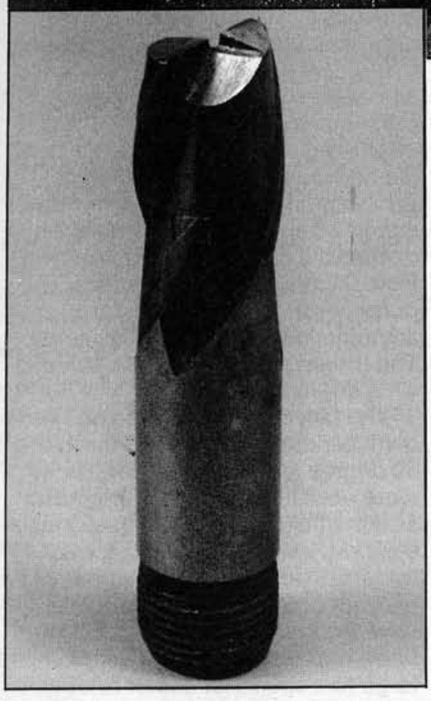


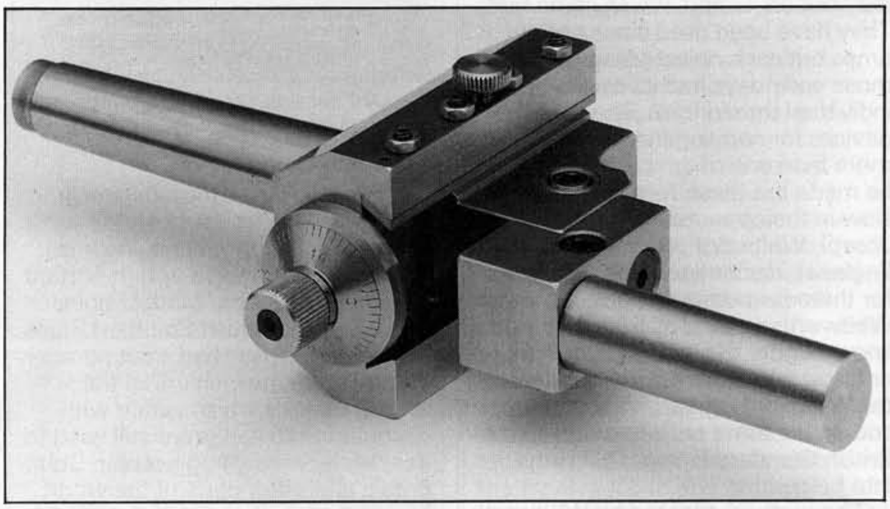
Left: the simplest and cheapest way to carry out milling operations is to use a vertical slide such as this, while a good compromise (far left) is this lathe attachment which allows the cross slide to be used as the milling table. Bottom left: a vertical milling machine and (below) a typical end mill.

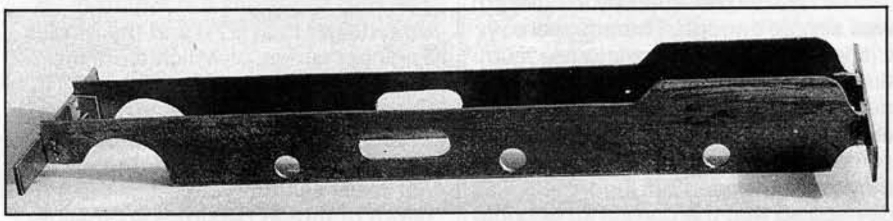




Above: connecting rods are best made on a milling machine than by filing. The machine can also be used for boring operations (left), in this case a fire box hole for a boiler, being maachined with a home-made facing and boring head. Below: for those not wishing to make their own boring head, they can be purchased complete. This George Thomas design is marketted by Hemingway.







Above: a compromise between the slot drill and end mill is this three flute cutter and (right) this pair of frames for a gauge one locomotive were finished on a milling machine.

diameter cutter can be used to cover a much larger area. For many, the vertical slide is the answer to all milling problems and very fine work can be done with it.

A real luxury comes when a vertical milling machine is obtained. It really is no different to a vertical slide turned through a right-angle but it has the advantage of being more rigid, almost certainly much bigger and with a lot more travel, which means that larger areas can be covered.

Using a milling machine is no problem providing commonsense is applied. The big secret is to make sure that everything is kept rigid and to lock securely any slides not immediately in use. Do not expect the machine to work miracles; success, as in all machining, depends on the operator and therefore the newcomer to milling operations is advised to go carefully until he or she is absolutely familiar with what they are doing.

Having fairly recently covered the subject of milling at great length in *Model Engineer* magazine I do not propose to explain the various operations in great detail; however, a number of photographs are reproduced for the benefit of those who may not have had the opportunity to see the series.

S C R E W THREADS

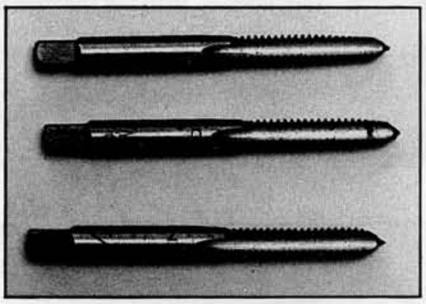
There's much more to screw threads than meets the eye; here are some of the facts

Everyone is familiar with screw threads and will have used them at some time or another. For the model engineer they have extra significance as a great deal of our work will use threads in one form or another. It is, therefore just as well to know something about them, as well as to be able to form them as and when they are required. We must remember, of course, that screws have two basic purposes; one is as a securing device and the other as a method of driving.

It is doubtful if anyone knows when screws were first used for either purpose or, indeed, which came first. They have been used since ancient times but each object using them in those early days had its own individual thread form. There were devices for copying threads so that more than one of the same type could be made but these were primitive and slow in their operation. In 1841 Sir Joseph Whitworth, an eminent British Engineer, decided to set a standard for threads and the famous Whitworth series was born, becoming known under the initials BSW. It was not long before it was realised that the Whitworth thread was somewhat course for some purposes and so the British Standard Fine or BSF came into being.

The method adopted by Whitworth was simple enough. Threads were triangular in form with various numbers of threads to the inch depending on the diameter. As an absolute triangle would have been somewhat weak at the sharp points, they were rounded off. A formula was devised so that the correct sizes could be worked out, and the angle adopted for the thread triangle was 55 degrees. The standard was further adapted for pipe, fittings only, in this case, instead of the diameter of the thread being the size quoted, the figure used was the pipe diameter.

There were a number of further developments to suit various trades and some of these are still in use today. The photographic industry used their own version as did the watch and clock industry, however the latter was quickly superceded.



A trio of common taps; top, a taper tap, centre, a second tap and bottom, a plug tap.

Another version of the Whitworth thread was devised for conduit work.

As far as the model engineer is concerned there were two important developments – the Model Engineer series and the British Standard Brass or BSB. Both these had a set number of threads to the inch unlike the normal threads which varied with diameter. Both series are still used to this day by model engineers in Great Britain and other parts of the world. The BSB series has a standard of 26 threads per inch (TPI) and the Model Engineer series, of which there are now two versions, have 40 or 32 TPI. Some years ago there was a further Model Engineer standard of 60 TPI and even one of 80. Such threads are not really all that practical as the depth of thread becomes so shallow as to make it too weak.

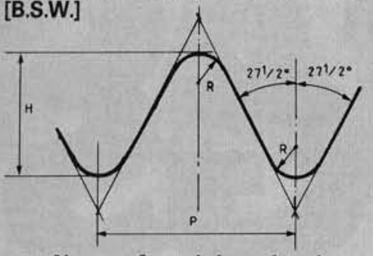
Nowadays the use of BSW and BSF is becoming very rare as other better threads have taken their place. The model engineer, however, will still need to use the BSB and Model Engineer series and these are included in our pull-out chart. A look at how the threads are formulated will help us when threads are to be formed by means of screw cutting on the lathe.

The Whitworth thread, even in the BSF form, was far too coarse for small screws and so a Swiss type of thread which had been approved in that country in 1875 was used to form the basis of the British Association thread or BA as it is always known. This became a standard in 1903 following a number of minor alterations to suit what was required in this country. The BA series threads which are still popular today with model engineers, are numbered and so, unlike Whitworth forms, the diameter is not stated when screws are ordered, but instead a size is given. The sizes run from 0 to 25 but for all practical purposes there is little call for anything lower than 12BA as a rule. The thread angle for the BA series is 47 ½ degrees.

The bicycle industry also had its own standard threads and these had a 60 degree angle. At one time these were popular with model engineers as the smaller sizes were based on standard wire gauge sizes. It was therefore possible to thread directly a piece of brass or steel wire. These days the standard seems to have fallen into disuse and one would need to go to a specialist dealer to obtain taps and dies.

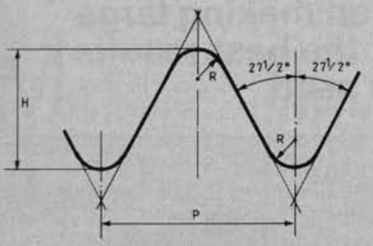
Unified Coarse and Unified Fine threads are an American standard which was introduced in 1864 in that country. The principle is the same as with the Whitworth standard but a sixty degree angle is used and the series has a slightly different set of figures for working out thread forms. Apart from standard diameters the Unified series also inlcuded some number-designated sizes. Although at

BRITISH STANDARD WHITWORTH [B.S.W.]



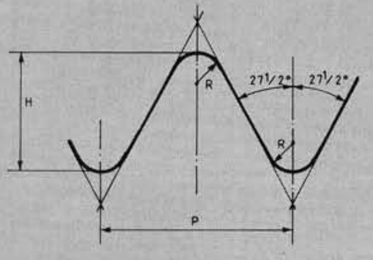
Non-preferred thread series

BRITISH STANDARD FINE [B.S.F.]



Non-preferred thread series

BRITISH STANDARD PIPE [B.S.P.]



In the three threads above [B.S.W., B.S.F. and B.S.P.]:
R = Basic Radius = .137329P
H = Basic Depth of Thread = .640327P
P = Pitch = 1/t.p.i.

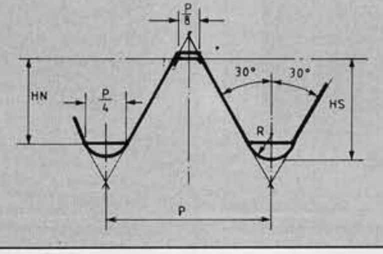
one time extensively used in the automobile industry, they have never found favour with model engineers in Great Britain.

Apart from the Model Engineer series, the Whitworth form of threads has now become quite rare. There are a few cases of the heavier bolts being used, mainly for agricultural purposes. The unified forms are still used by some American manufacturers but the tendency now is more towards the ISO metric series of threads. These come as standard and fine forms and cover an exceptionally wide range of sizes. The triangular pattern is to the 60 degree angle as is the Unified system. Instead of the number of threads being given as so many per inch as is the case in all the other threads so far mentioned, the metric ones are given as the pitch or distance between the peaks of two threads.

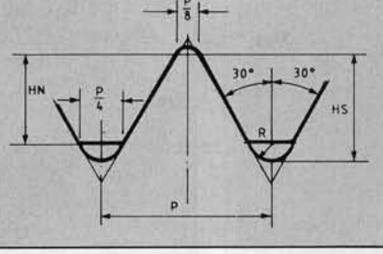
It is as well that we know how thread sizes are calculated so that we can do this if required. Certainly, if screw cutting is to be employed, we will need to know the depth of the thread as well as its pitch in order to get the thread right.

If we take the thread as a series of triangles alongside each other then the top and bottom of this triangle will be rounded off, and the charts show the calculation for this with the various thread forms. The other thing we need to know, apart from the pitch, is the thread depth and this can be calculated from the tables. Note that, in the case of the metric thread, instead of a rounding off, the top and bottom of the thread is flattened or squared off, which makes screw cutting somewhat easier.

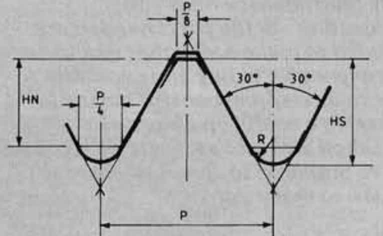
UNIFIED FINE [U.N.F.]



UNIFIED COARSE [U.N.C.]

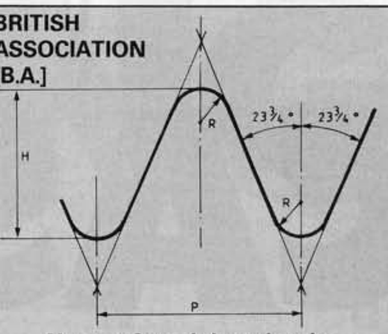


I.S.O. COURSE



In the three threads above [U.N.F., U.N.C. and I.S.O.]:
R = Basic Radius = .1443P
HN = Basic Height of Internal Thread and Depth of Thread Engagement = .54127P
HS = Basic Height of External Thread = .61344P
P = Pitch = 1/t.p.i.

BRITISH ASSOCIATION [B.A.]



Non-preferred thread series

In thread form above [British Association — B.A.]:
R = Basic Radius = .1808346P
H = Basic Depth of Thread = .6P
P = Pitch

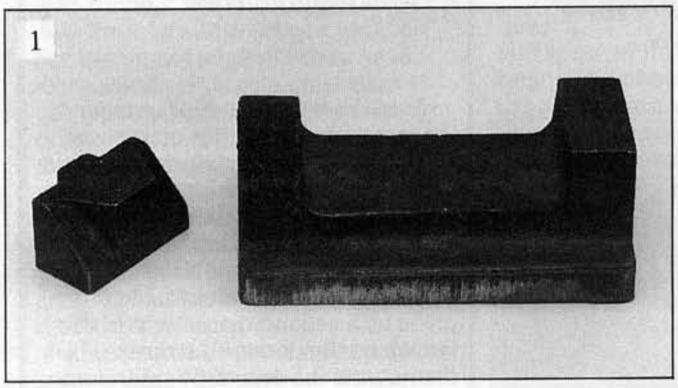
Tables are supplied for obtaining the size of tapping drills on the wall chart. It is possible to work things out for oneself, however, as all that we need to know is the depth of thread and, in the case of a tap, take twice this from the outside diameter. Taking off twice the thread depth, of course, gives us a second diameter and this is known as the core of the thread. This diameter is the one to be taken into account if the strength of a screw has to be calculated.

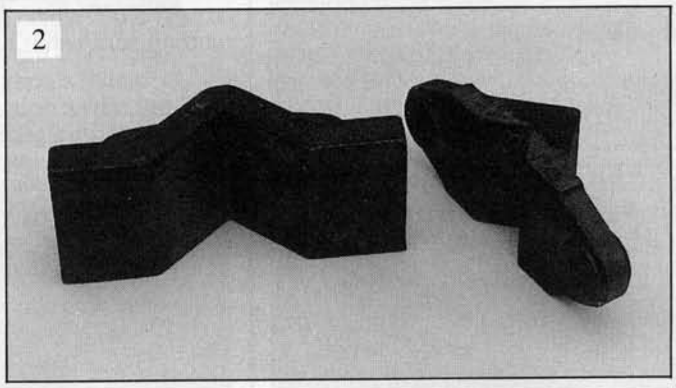
In addition to securing things, threads can be used as a drive mechanism as, for example, in the case of a vice or a lathe lead screw. Although, with small diameters standard threads can be used for most purposes, we will use either a square or acme form for these purposes. Whilst taps and dies can be bought for these threads, screw cutting will be necessary in the early stages.

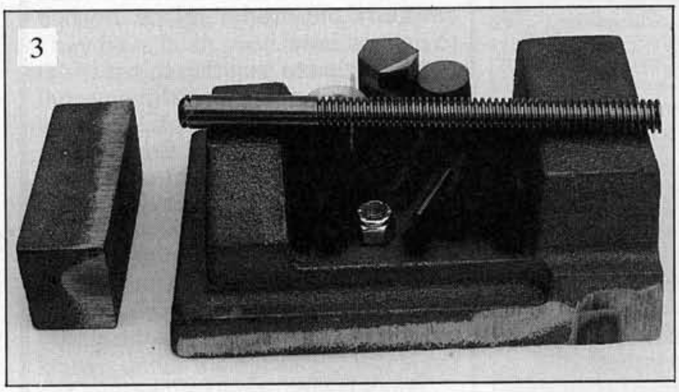
Threads are formed either by screw cutting as suggested or by the use of taps and dies. In the case of taps, three general types are used – the taper, second and bottoming. It is possible to use just the first and third type and get satisfactory results. Taps must always enter the work square and lubricant should be used to prevent them from binding. The tap must be unwound from time to time to prevent the build-up of swarf. Round or button dies are used for outside threads and these again should be used with plenty of lubricant and undone at regular intervals to prevent swarf binding them. Again, care must be taken to ensure that the die is square with the work.

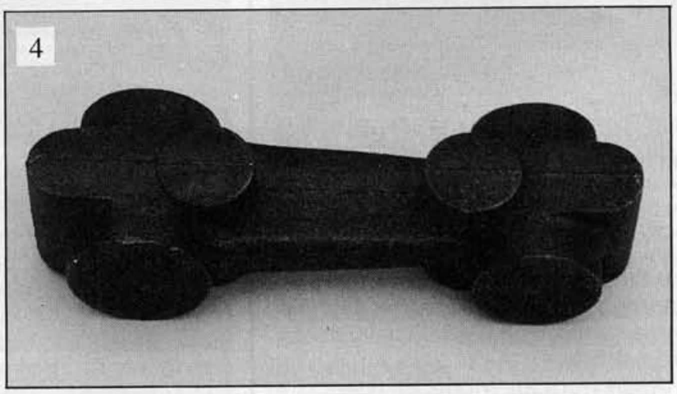
U S I N G CASTINGS

So far the small workshop products described have been fabricated from stock materials. For larger equipment – as when making large models – the use of castings is recommended. To get the best results it is essential that best quality castings are used.









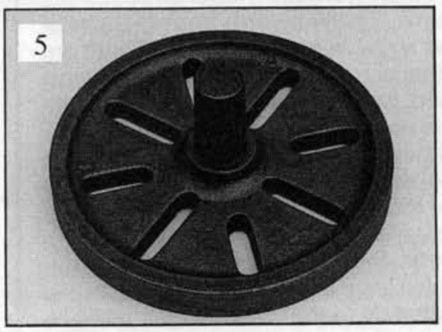


Photo 1
Two castings for a very neat little machine vice from Reeves. This little tool could easily be machined on a milling attachment on the lathe – or even on a vertical slide.

Photo 2
These two castings from College Engineering Supplies are for a Keats angle plate, a device which assists with the mounting of odd-shaped work. Once again the minimum of work is required to complete the tool at a fraction of the cost of purchasing the finished item. Castings make obvious economic sense and the techniques for finishing them are enjoyable to learn and extremely satisfying.

Photo 3
A set of castings and other pieces for a hefty machine vice from Town Engineering. All the parts needed are included to make a vice that would be very expensive to buy and such 'kits' offer relatively inexpensive means of amassing a useful inventory of workshop aids and accessories provided you're prepared to spend the time they require to make up.

Photo 4
This casting from Messrs Reeves will form part of a small drilling machine. A close look at it shows how good pattern-making has resulted in a casting that makes very easy work of a shape that would be very difficut to make from solid materials. All that need be done in this case is to bore out the necessary holes.

Photo 5
Another useful casting, again from Messrs Reeves, is this lathe faceplate, shown here as a rear view. Apart from the machining needed for fixing the casting to the lathe (possibly a screw thread), all that is needed is a lick over and the result is a first class faceplate at virtually no cost whatever. Can't be bad!

PAINTING

& LINING

Many models are spoiled by bad painting. Some years ago there was an excuse for this as the range of paints and equipment was very limited and most of the paints did not have the flow qualities of modern ones. I must say that I have learnt a great deal on the subject in recent years, not least from listening to Bob Moore who lectures on the subject and whose talks are most explicit. I have also been fortunate enough to talk to several

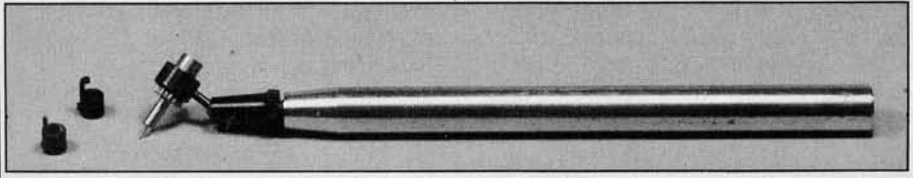
A good paint job is essential to the final appearance of a model

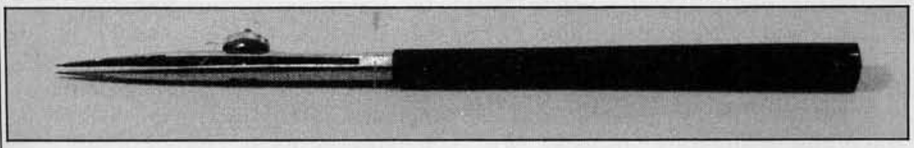
other experts and to get their views on the subject and on which of the various compounds to use. There is no doubt that the main secret, as with so many things, is patience!

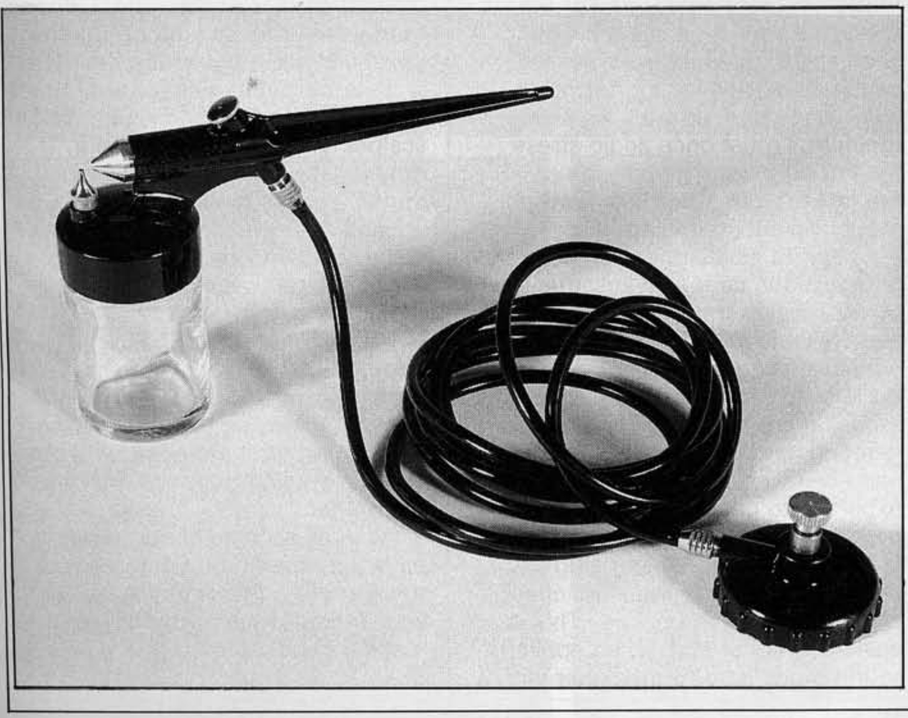
Where possible, models will need to be dismantled for painting. It is as well to bear this in mind when constructing them as the easier they can be dismantled and re-assembled the less damage is likely to be done to the finish. Steel will take paint better than brass or copper. As a matter of course, metals should receive a coat of etching primer before applying the final paint.

Etching primer in itself will not always prevent the paint chipping away and the actual metal should be etched before applying the primer. This can be done with phosphoric acid. Red Oxide, which is used in industry as a primer, contains phosphoric acid and Jenolite or similar rust-proofing liquids are basically the same chemical so can be used to treat the metal. The acid should be applied with very fine wire wool and then rubbed off with a clean, dry cloth for the best results. A better etching effect can be obtained on brass with weak nitric acid, but this is not as easily available as phosphoric.

Once the metal has been etched, the surface must be wiped over with methylated spirits, petrol or a liquid paint brush cleaner. The reason for this is that the acid residue will react with some primers leaving a very fine deposit on the surface of the metal which is not easy to see. Before applying the primer, rub the surface with a tacky cloth. These clothes can be obtained at car accessory suppliers as well as at some decorators, D.I.Y. stores, etc., where they are frequently called 'pre-paint cloths'. They actually pick up any fine particles of dust that are not normally visible to the naked eye.







The main picture shows a typical air brush, the perfect tool for painting smaller models. Above this is a bow pen, used with dilute paint for lining and lettering, while at top is the Master Lining pen, a tool which makes lining easy – even for the most ham-fisted amongst us!

Where possible the paint and primer should be sprayed on. For small models an airbrush will do but, for larger ones, it is as well to use a small spray gun. A good alternative is to use primer and paint in an aerosol can. Spraying should be carried out in a dust-free environment and one should avoid wearing woolly clothing because of the danger of fine hairs floating on to the paint. For safety's sake, it is as well to wear a hat and a mask when spraying paint. The paint being used in a spray gun must be thinned to suit the gun and should always be strained before filling the reservoir of the gun. The type of paint to be used is a matter for the individual but the choice may be limited in order to get the right colour. It would, no doubt, be possible to mix one's own paint colour if necessary. Enamels are as good as anything and the primer should be the correct one for the type of paint. It is also well worth while considering the use of car spray paints; it is quite incredible the range available with these as each manufacturer offers subtle colour variations. They are a convenient method of getting a good quality spray paint.

When the model (or parts thereof) has been primed, the primer must be given ample time to dry and this means at least twice that recommended by the manufacturer! It should be examined for dirt and dust and, if need be, rubbed down with 800 grit wet and dry paper. If necessary apply a second coat of primer. Remember, the primer is the base on which your super finish will be built so it must be right to start with. It is a mistake to the adopt an attitude of "I can cover it up". In fact, it works the opposite way and what happens at the start will be reflected right through.

It is doubtful if undercoat paint will be available but two or more finishing coats will do just as well. Again the tacky cloth must be used before applying the paint and the paint must be given plenty of time to dry between coats. If it can be popped in the domestic oven for a couple of hours this will harden the paint off. Whilst paint sets in, say, twenty-four hours it takes much longer without heat for it to dry. Do not paint on a damp, humid day as this will cause problems with the paint. Wait for a good, dry one and, if it is warm, so much the better. The top experts on painting are the car manufacturers who always, in spite of pressure to keep the production line going, bake their paint and give it plenty of time to dry.

Using an airbrush correctly is not the easiest of skills to pick up, but this picture shows the correct technique for holding the tool.

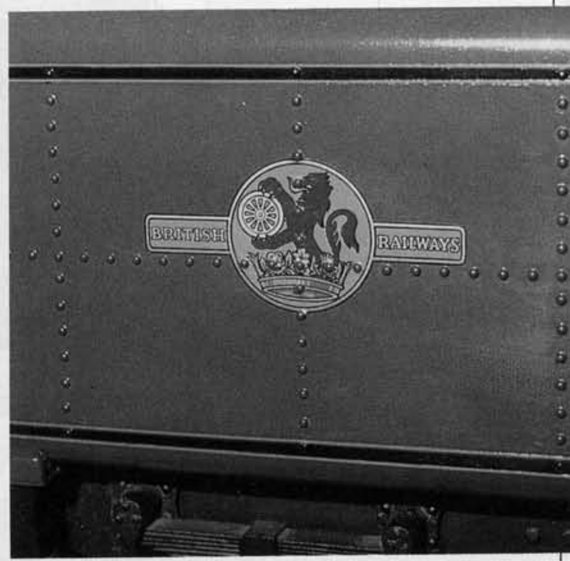
Lining of models can be carried out with either a bow pen or, nowadays, with a special lining pen called a 'master lining pen'. This pen makes life really easy; it accepts neat paint and has a couple of guides that come with it which enable lining to be guided round curves and along edges. It is available from a number of outlets or direct from the manufacturer at The Forge, Stapleford, Leicester. No matter whether a bow pen or the master lining pen is used, it will soon show up whether or not the paint has hardened. If it has not it will start to peel up with the lining medium. I must once again stress the importance of getting the paint not just dry but absolutely hard no matter how long it takes.

Lettering, coats of arms, etc., can be applied in various ways, the most obvious being transfers. Transfers are available in three varieties. One type is applied by varnishing the back, sealing the transfer to the model. It is a very effective form of lettering, and is difficult to tell from hand finishing. It does need a bit of expertise to get the transfers on properly and, if you're not careful, they can break up when being applied. Waterslide transfers consist of letters on a thin backing. This is soaked in water and, when applied to the model and rubbed over with a cloth, all the air is excluded thus sealing the letter in place. The transfer, however, is always visible as such and, whilst it is an easy way of applying lettering, it is glaringly obvious what has been used. The third type of transfer is the dry-rub type. This is now quite common and the transfer is simply rubbed on the model using a ball point pen or stylus. It is quite an effective method but the range of such transfers is rather limited at the present time.

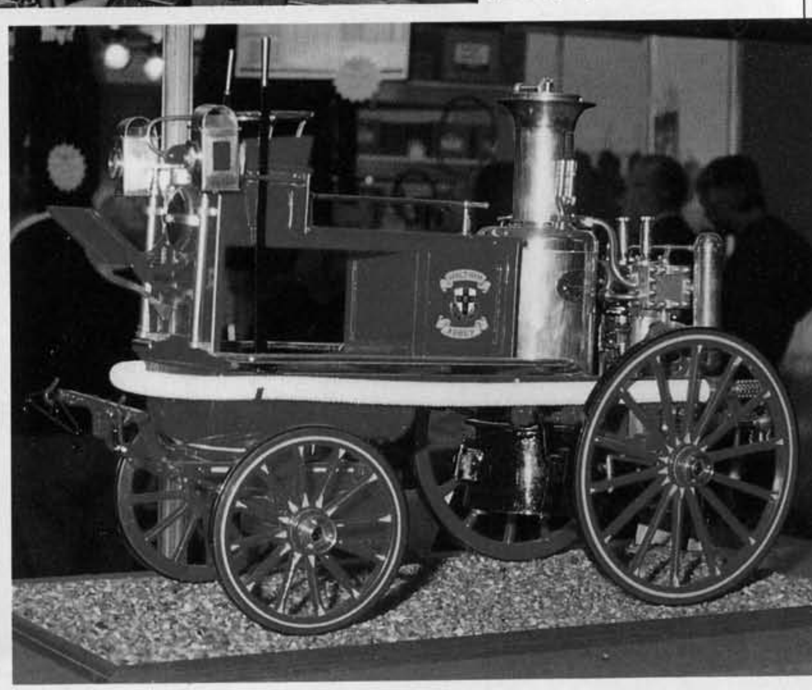
The use of Frisk Film may suit the person who wants to paint on his or her own lettering. The film is very thin and is applied direct to the painted surface of the model. Prior to this the letter or coat of arms or whatever is cut out of the film. This is done by laying a suitable template on the film and cutting round with a scalpel. The template can be a drawing, photograph or anything that will act as a guide. Paint can be applied over the film when it is in place on the model and, when dry, the film is removed while the letter, of course, remains in place.

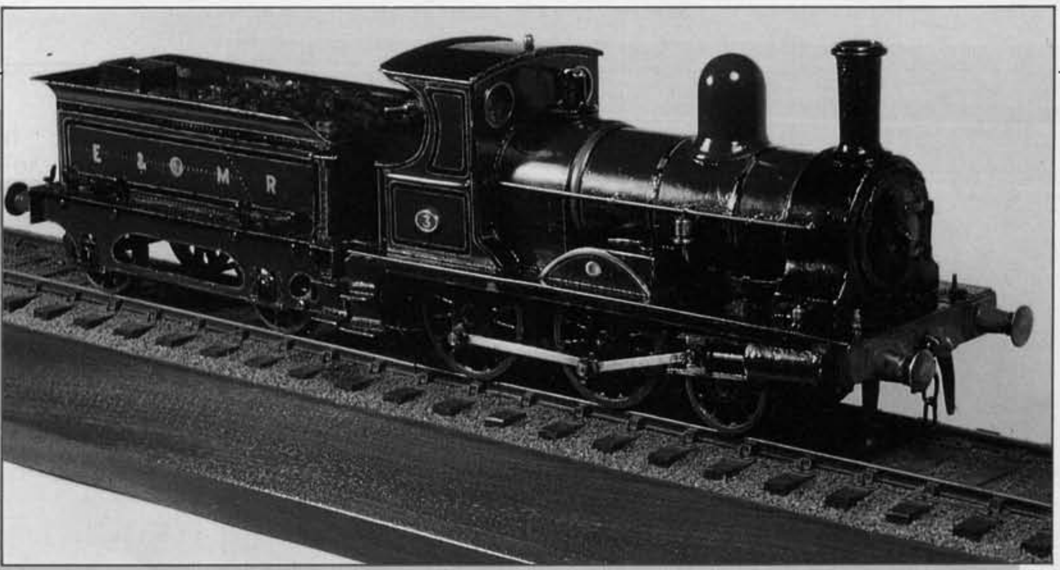
It is possible to use colour photographs as transfers. The backing can be soaked and then peeled off leaving just the gelatine film carrying the image. A gum can then be applied to this to stick it to the model.

As in all aspects of our hobby it pays to experiment but remember – the first thing that is noticed about your model is the paintwork so make a good job of it!

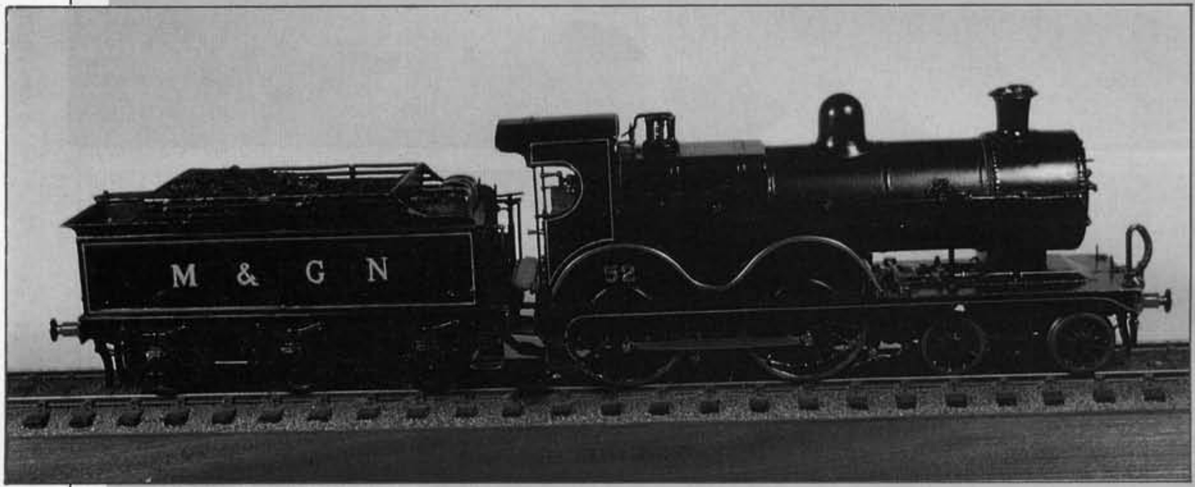


A good paint job does so much for the appearance of a model. Emblems such as the British Railways logo (above) can be hand painted or bought as a transfer, while lining on carriages (above left) is time consuming but very impressive when done well. This fine model (left) could so easily have been ruined by poor paintwork, but the care that has been taken only enhances the quality of the engineering. Below left is a superb example of a hand painted coat of arms, while the Shand Mason fine engine (below) presented special problem. Transfers are not available for this model, but if one does not feel confident enough to hand paint, it is possible to adapt a colour photograph – see text.

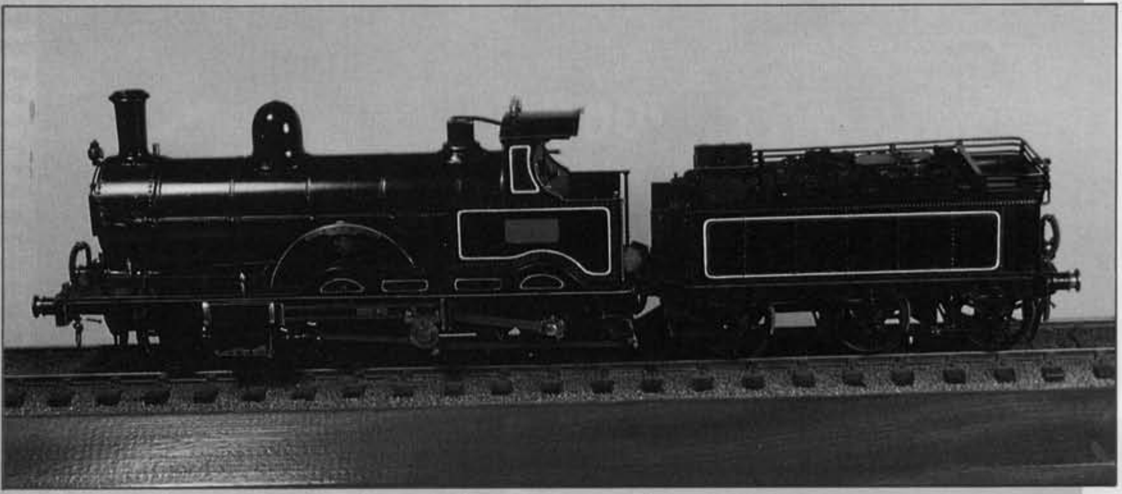




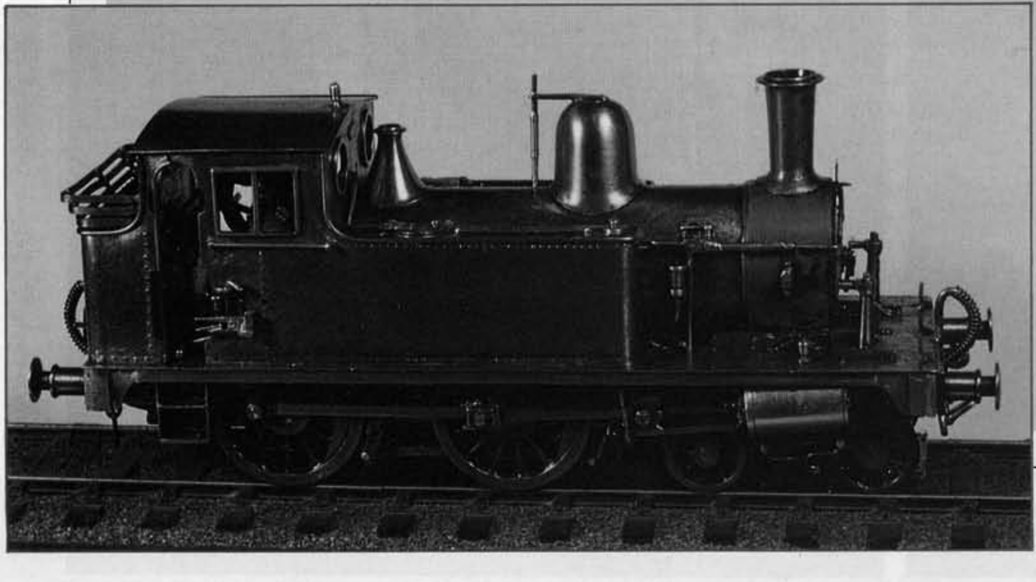
This unusual 2-4-0 of the Eastern and Midlands Railway makes a delightful model. Notice the high standard of painting, all done by hand. The lining was applied with a bow pen.



Clary has lived and worked on or near the Midland and Great Northern Line for most of his life, so it's not surprising that he has made some of this Railway's engines. This is a M&GN 4-4-0, and was one of the last of their prototypes to run.



This diminutive London North Western Railway Compound, as per the original, features true compound valve gear. It is only a few inches long.



As yet unpainted, Clary's latest model is this lovely 4-4-0 tank locomotive.

SMALL IS BEAUTIFUL

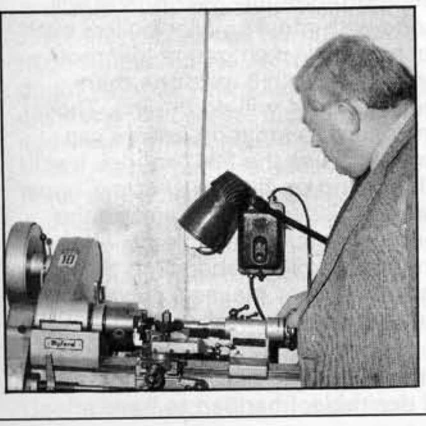
Clary Edwards does amazing things with small scale locomotives

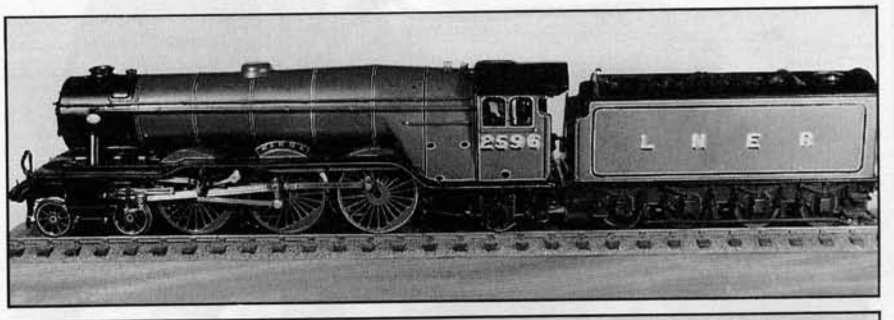
Most model engineering seems to be about the construction of large scale live steam locomotives. Clary Edwards also builds model steam locomotives but his are in 'O' gauge. His workshop is quite sparse by the standards of some, and contains little more than a well maintained Myford Speed 10 lathe plus bench vice and hand tools.

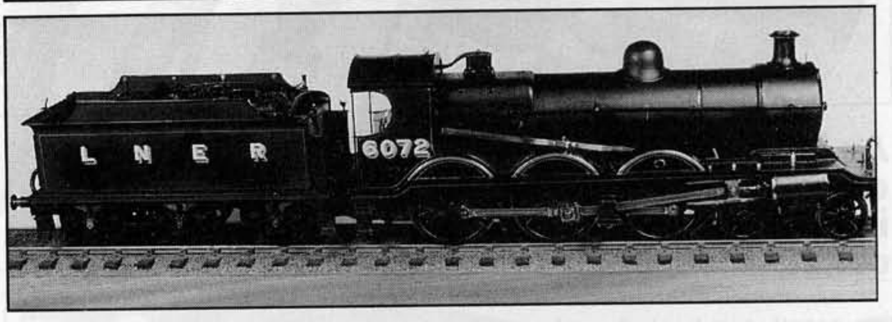
To get to the workshop one must negotiate a wooden staircase which is similar to the type found on ships and, whilst Clary nips up and down like a two-year-old, lesser mortals like myself find getting there something of a struggle! Clary however spends a great deal of his life in there and makes absolutely beautiful models for which he has frequently won awards.

All the models are steam driven and fired with methylated spirits; they all run as well as they look and are not spared on the track, being constantly in steam and running either on the track in his garden or at exhibitions.

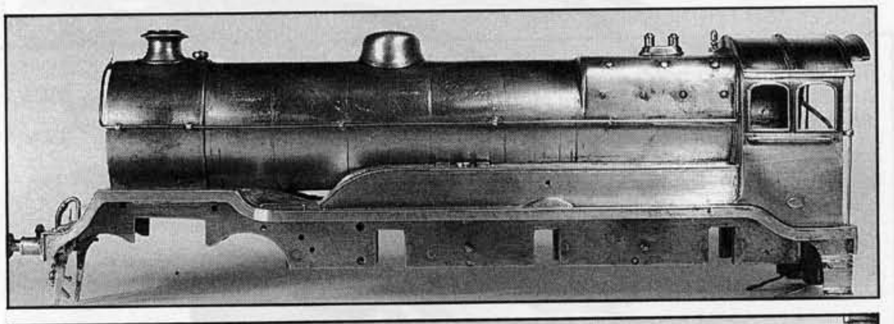
Clary at home with his lathe.

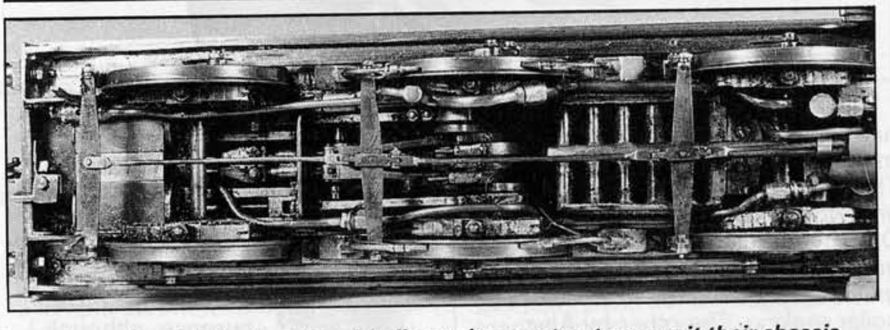






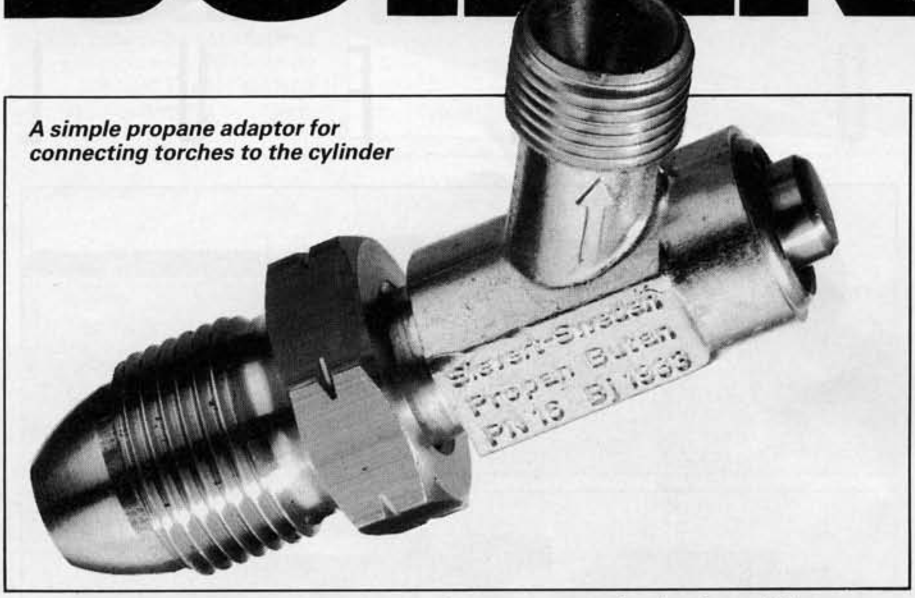
Above: Two LNER subjects. Top is a class A3 Pacific, with etched name and works plates, while below is a Great Central 4-6-0, commonly known as 'The Fish' as it was often used for carrying produce from the Eastern ports.





Two views of unfinished models. A boiler and superstructure await their chassis (top), and the underside of a model, showing the fully working valve gear. Remember, this model is only one inch across!

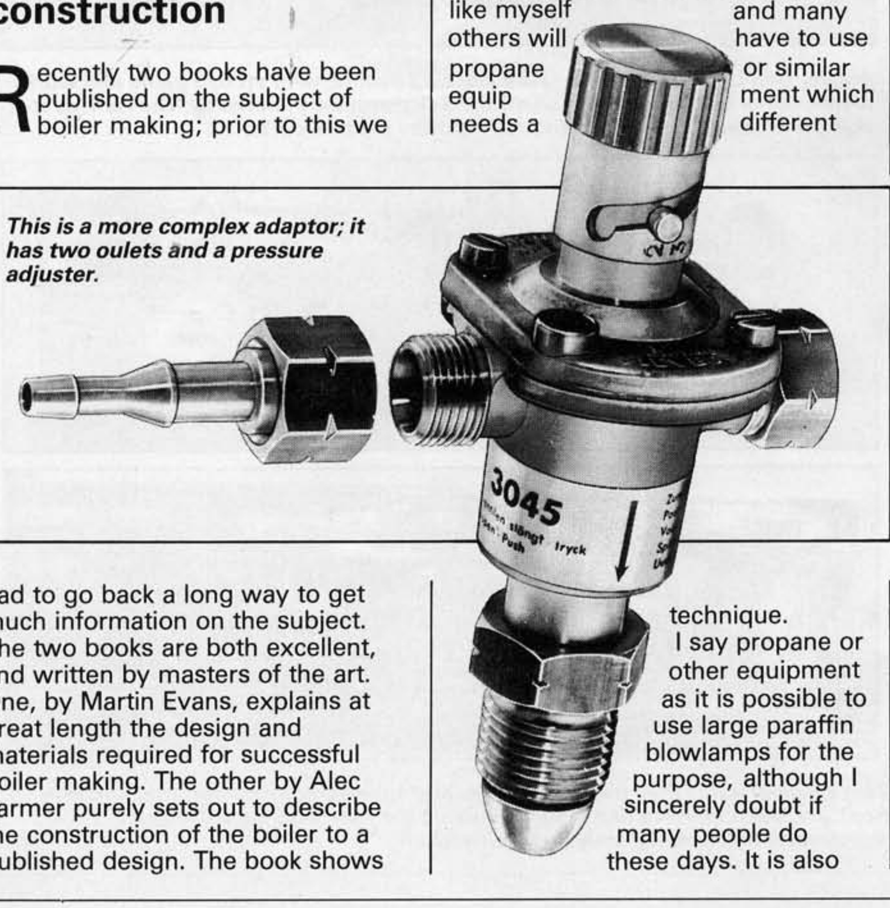
BOILERMAK



A simple propane adaptor for connecting torches to the cylinder

An in-depth and comprehensive introduction to boiler construction

Recently two books have been published on the subject of boiler making; prior to this we had to go back a long way to get much information on the subject. The two books are both excellent, and written by masters of the art. One, by Martin Evans, explains at great length the design and materials required for successful boiler making. The other by Alec Farmer purely sets out to describe the construction of the boiler to a published design. The book shows every operation but it explains making boilers with oxy-acetalyne equipment which is, of course, the way a professional like Alec Farmer goes about things. Lesser mortals like myself and many others will have to use propane or similar equipment which needs a different technique.



This is a more complex adaptor; it has two oulets and a pressure adjuster.

I say propane or other equipment as it is possible to use large paraffin blowlamps for the purpose, although I sincerely doubt if many people do these days. It is also possible to use gas torches supplied with gas from the domestic mains. I must advise readers that butane is not suitable for our purposes. Using large quantities of butane for periods such as is needed for boiler making, will result in a lowering of the temperature of the gas bottles which could even cause freezing.

One of the problems with boiler making, of course, is cost. People often say that the cost of purchasing equipment makes it uneconomical to make one's own boiler. This need not be so as the necessary equipment can be hired at most tool hire firms, and doing this is not at all expensive. Alternatively, many clubs own such equipment which members can use as they wish.

What then will we need? First of all, of course, a propane cylinder of reasonable size. I use a 12 kilo capacity and this is quite big enough for a couple of five inch gauge boilers. We will need a regulator to fit the cylinder and this should incorporate a hose failure valve. A length of hose, connected to a handle with a regulator and a nozzle will complete the outfit. The nozzle will need to be a large one, but two smaller ones can be used with equal success. Personally I prefer the use of two small ones, one to give a general heat and one to apply locally where the main heat is needed.

There are various makes of blowlamps and I obviously cannot have details of all types, but in the Seivert range the 2942 nozzle will cope with most smaller boilers such as for a 3.½ inch gauge locomotive and for a large 5 inch one then number 2954 will do the job. Those making small marine boilers can probably use the 3941 model. It will all depend on the boiler size. Copper rapidly disperses heat and so the burner must be capable of maintaining it. At the same time too large a burner makes a successful but rather messy job.

To actually do the brazing, if possible, some sort of brazing bench is desirable. I happen to have a

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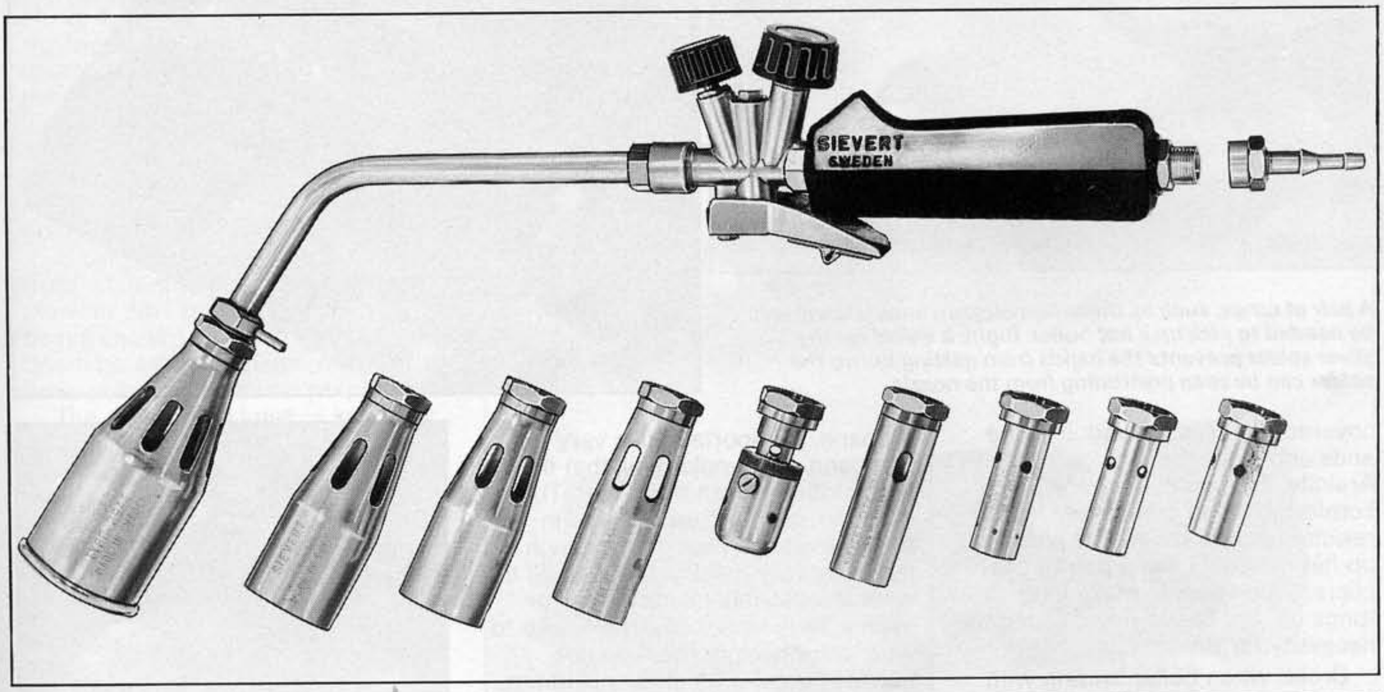
old, not Geoff). He builds boilers professionally and he uses a shield to apply the silver solder. He also uses one attached to the handle of his blowlamp. The one for the solder is quite simple; a brass centre piece is made up to accept the silver solder which runs through a hole in

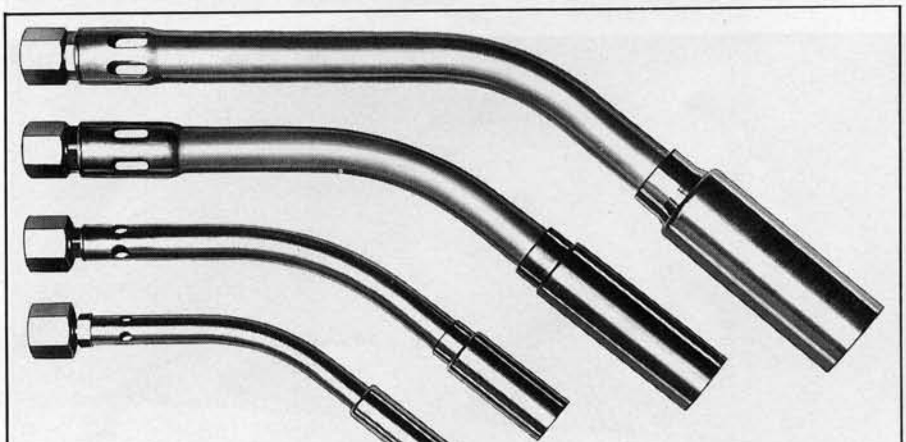
used up close to the work.

I also use some home-made tongs. These, too, are made from ½ in. by ⅛ in. mild steel strip, and they are bent round in such a way that, when closed, they form a loop just sufficient to close up on the boiler barrel. On the handles are pieces of



properly constructed one now but it was not always like that and, in the past, I have used a couple of wooden boxes with a steel sheet on them, covered with fire brick. Fire bricks will be part of the equipment required and these cannot be hired, but will last most modellers a lifetime once they have been obtained. Do not get the ordinary fire brick sold by builders merchants for building fireplaces; whilst these are fire-proof they offer the workman no assistance. There are various types of reflective bricks available and some of these will be available from specialist builders suppliers, others can be obtained from suppliers of kilns. If in any doubt write to your local brickworks, enclosing, of course, a stamped addressed envelope. The reflective bricks mean that less heat will be required from the blowlamp.

There are a few other bits and pieces that we will need before we get cracking with the actual boiler. Anyone who has ever tried to apply silver solder to a hot boiler will know that it is not so very easy. I therefore use an idea I got from an old friend, Geoff Shepherd. (The friendship is



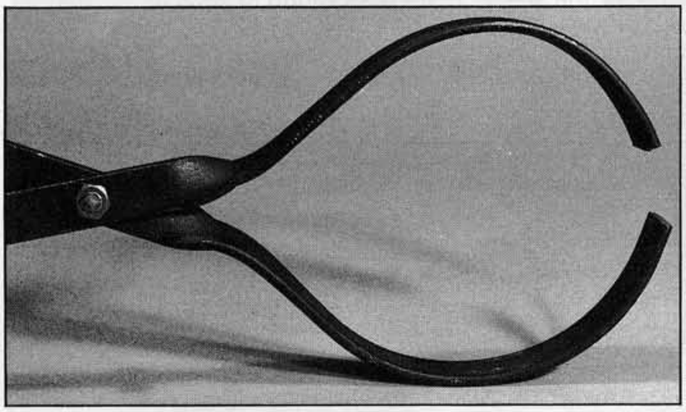
***Top:** a typical torch handle from Sievert, with a range of nozzles. The neck tube which connects the torch to the nozzle can be obtained in varying lengths, but it is probably best to buy a longer one, as a lot of heat is generated. The further you can stand away, the better.*

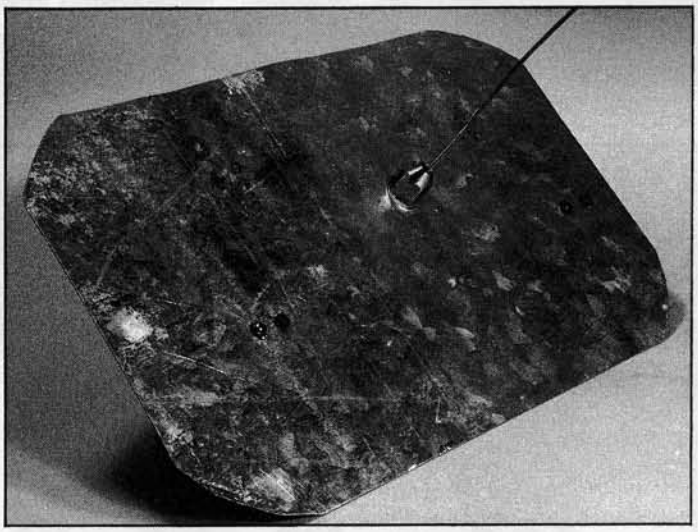
***Above:** cyclone adaptors, which allow the flame to go round a tube, applying heat to the whole circumference. In boilermaking this lets the flame go right inside a firebox, to heat internal stays.*

it, the size of hole being adjusted by a simple screw. This centre piece goes through a twenty gauge mild steel shield with a handle of ½ in. by ⅛ in. mild steel riveted to it. This is sufficient to allow the solder to be

tubing. Any suitable tubing such as gas piping will do. On one pair I made I could not get any scrap gas piping and used scrap central heating copper tubing instead. As this would conduct the heat I

BOILERMAKING

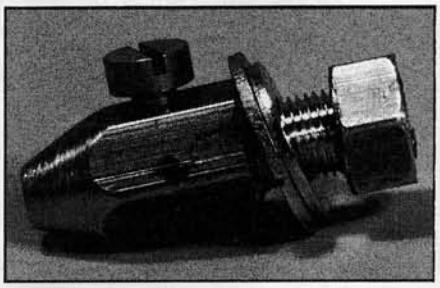




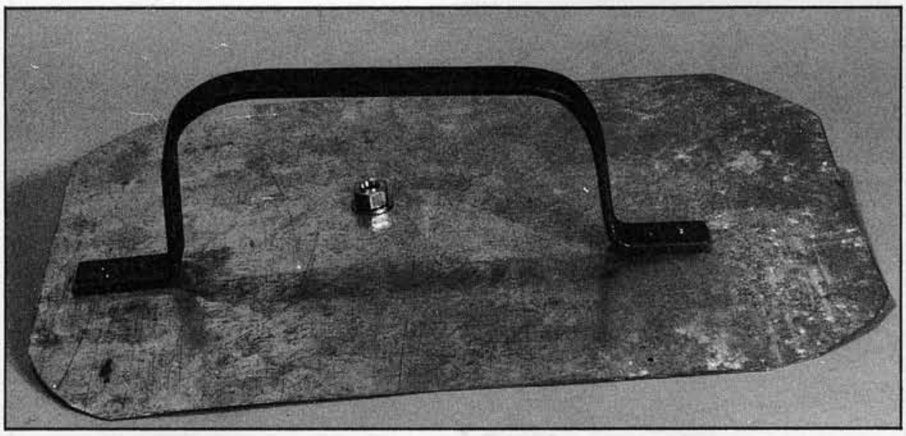
A pair of tongs, such as these home-made ones (above) will be needed to pick up a hot boiler. Right: a shield for the silver solder prevents the hands from getting burnt; the solder can be seen protruding from the nozzle.

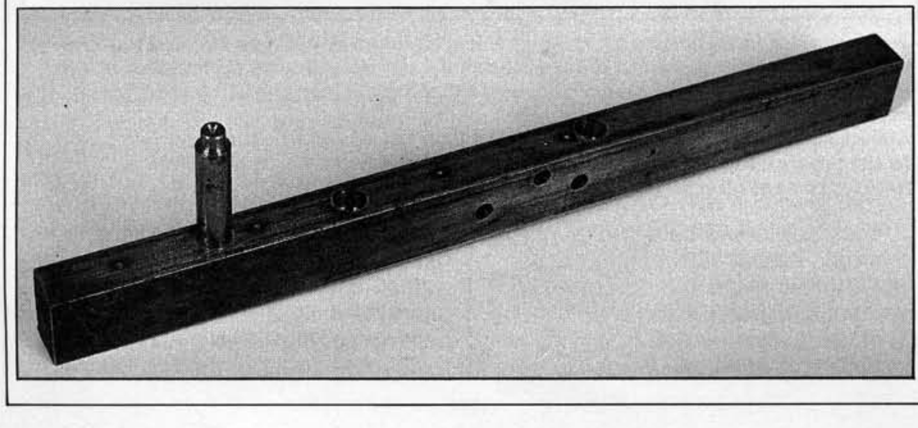
covered it in plastic conduit at the ends and stuck the lot together with Araldite. The result is a very comfortable and completely heat resistant pair of tongs. For picking up flat material I use a pair of gas pliers. Some people make long tongs up, but I have never found the necessity for this.

Dress, when boiler brazing with propane, is important. It is very hot work and one would think that the least clothing worn the better. This is not so, as if one works, say, in shirtsleeves the heat gets through to the body very quickly. It is as well to wear a reasonably thick overall or even a fairly heavy coat. I also like to wear a lightweight hat. I do not normally wear a hat of any kind but,



Above: the nozzle for the silver solder – the diameter can be adjusted to the correct size. Left: a rear view of the shield, showing the riveted handle. Below left: a heavy metal bar, with a dolly to allow awkward rivets inside the boiler to be closed.

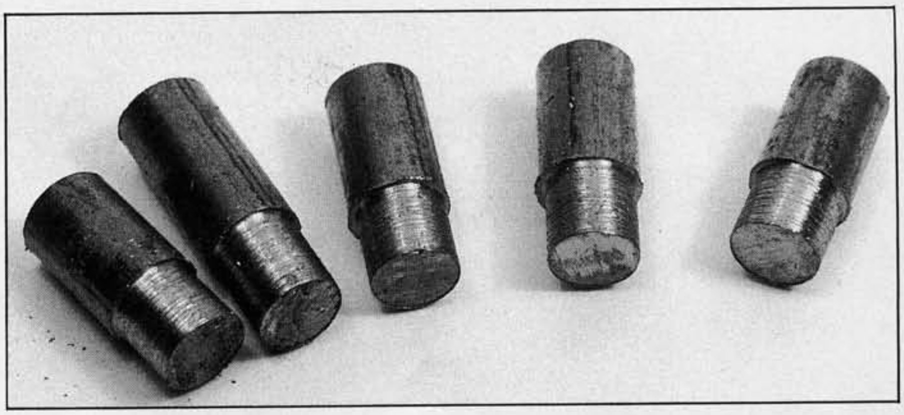


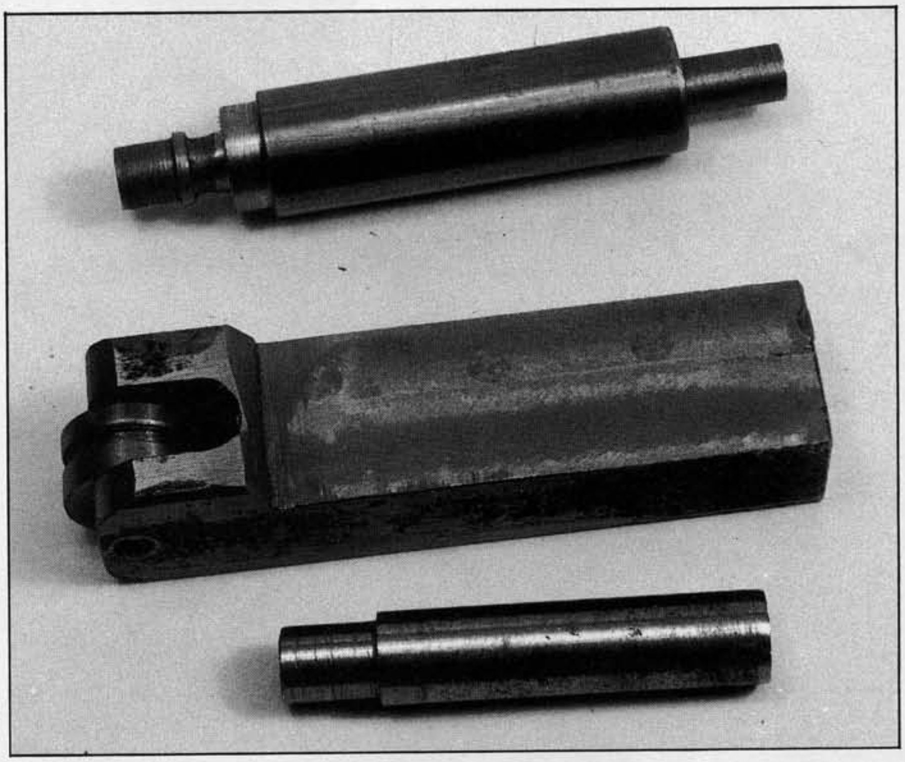


having scorched my hair a couple of times, decided that a soft hat might be advisable! Gloves, again, will prevent the transfer of heat — do not wear plastic ones, though, as there is every chance they will melt with nasty consequences.

It should go without saying that heavy shoes or boots should be preferred to light ones, just in case of mishaps. I also wear a throat mask; this is something I have started to do with increasing age, and did not bother with when I was younger. Silver solder gives off fumes and nowadays I find these cause irritation in my throat, so I prevent this with the mask. It is nothing elaborate, just a simple item, which can be obtained at any do-it-yourself shop. Most silver solders contain cadmium and the fumes of this can be dangerous if a mask is not worn.

Right: mild steel bars, with the ends turned down to fit in the flue tubes, allow the tubes to be pulled through the front plate and act as heat shields if left in place during brazing. Below these are the parts that make up the tool for raising a ridge on the flue tubes. This prevents them slipping through the firebox holes during brazing.





There are one or two other items I have taken to using and these I will explain. Firstly I make a number of short mild steel pieces to fit inside the ends of the boiler tubes, and I also make one long one. These are just pieces of black mild steel turned down to slip inside. They vary in length and one is quite long; they help when fitting the front tube plate to locate the tubes. They are also used while the tubes are fixed in place at the front and prevent the heat transferring down the tubes. At one time asbestos plugs would have been used for the same purpose.

The other thing I use — and here again I have to thank Geoff — is a tube-raising tool, a simple device which raises ridges on the boiler tubes and so prevents them slipping through when heated. Again we will see as we progress the advantage of using them.

Finally before we make a start we will need two buckets or similar containers and a jar. The jar is to mix the flux in and a small paint brush will help to apply this after mixing, although it is not essential. The buckets or containers are for acid and water. I use heavy plastic buckets, the one with acid having a lid. I have heard people say that plastic should not be used as there is a danger of the boiler, when hot, being put in and burning a hole in the bucket. Well, it is my experience that the second the hot boiler strikes the cold liquid the temperature will drop to a point that it cannot melt the bucket. I have never had any problems with plastic, and the only time I did melt one a little was above the water level when a hot boiler was picked up wrongly and tilted into the side of the bucket. It did not melt right through even then and, as the lower part entered the water, the top cooled enough to prevent further damage.

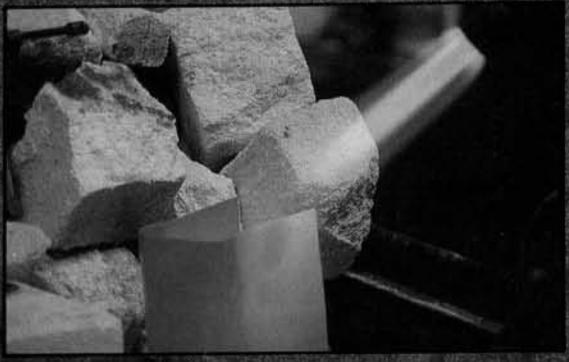
I do not put hot boilers in acid, I quench them first in cold water which shakes the scale from them. When cool they go in the acid and stay there until clean. They are then again well washed with clean water, and brushed over with a soft brush to remove any remaining dirt. No other cleaning is done between operations. I use citric acid now for boiler cleaning. In the past I have used sulphuric acid, and I have used a proprietary non-acid pickle. The latter was a disaster and the boilers kept corroding after so-called 'cleaning'. Although sulphuric acid was very efficient I did not like having it around the place and tried several other cleaners. Vinegar and salt worked quite well and alum dissolved in water made a very safe pickle but took a long time to clean the copper. Citric acid is a nice compromise; it is not as quick as sulphuric but there are no unpleasant fumes. I purchase it as a powder and mix it up good and strong. It does mean that it will take a couple of hours to get the boiler clean but, as long as there is no hurry, that is of no consequence. The acid I have at present has been used for five boilers and many other smaller items and is still strong enough for use. I use rubber gloves when putting a boiler in or taking it out, but in fact splashes from the acid are not harmful to either flesh or clothing, although I would suggest that if you do get splashed you rinse it off as soon as possible.

We should now I suppose start to think about the types of boiler to be made. Marine boilers come in a wide variety of types and these range from simple pot boilers to more complicated types. The pot boiler is, as its name suggests, just a simple tube with the ends sealed and a couple of bushes fitted for safety valve and boiler filling. Some form of heat is applied underneath and this heats the water which comes out of the boiler as steam. This type of boiler is used on very simple boat plants, for small

Annealing flange plates by heating. It will save both gas and time to do as many as possible in one go.

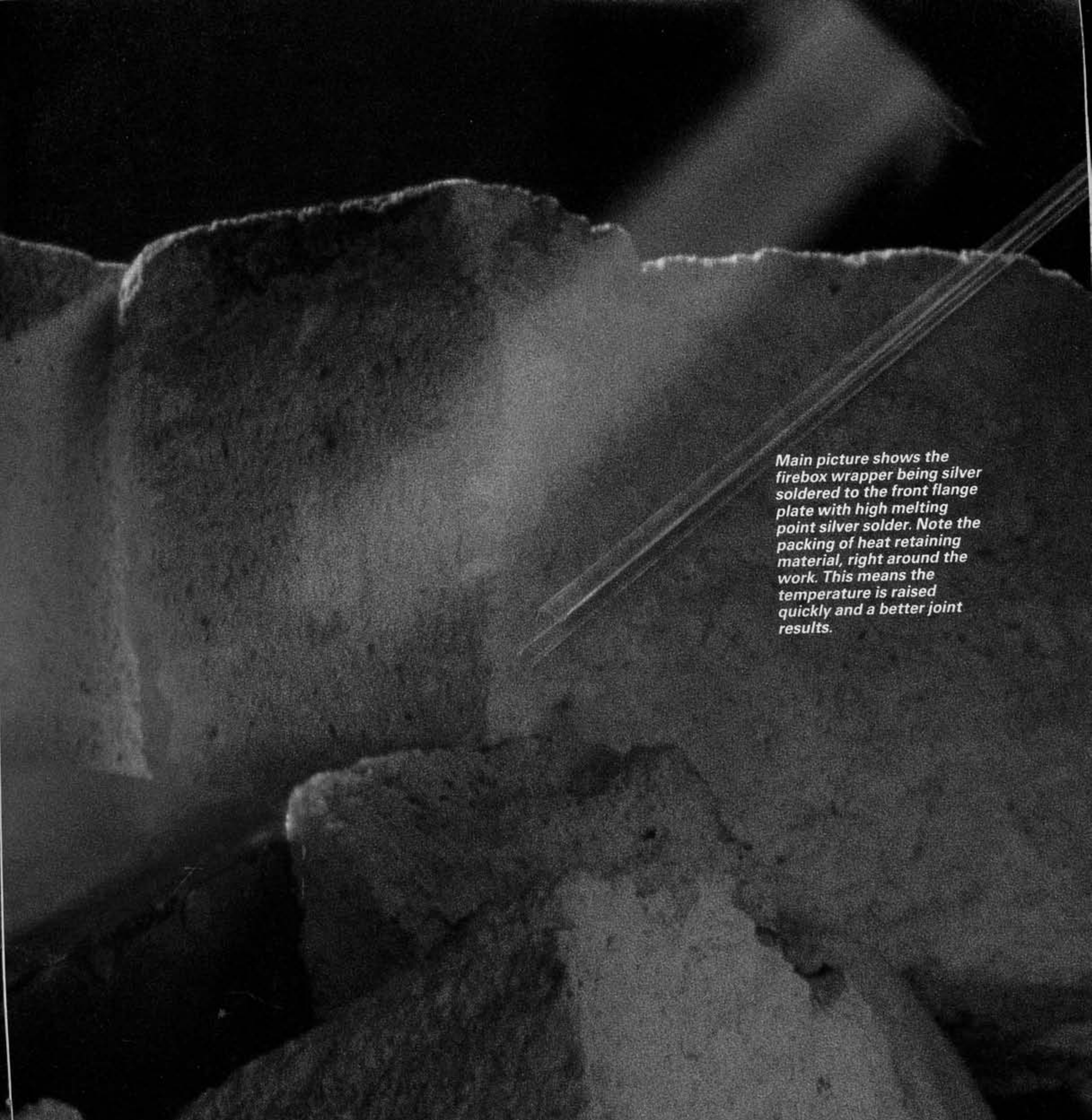
When hot, the flange plate is quenched in water.

The plate is hammered into shape on a former, although it may need to be annealed several times before the copper is suitably stretched into the flanges.



Parts that need to be bent, such as this firebox, will also need to be annealed. Below this, is the firebox set up for silver soldering. The fire hole ring (below) is silver soldered (use a high melting point solder) into the inner firebox plate before assembling the firebox.

Use a lower melting poir Easyflo 2, for soldering t top of the firebox.



Main picture shows the firebox wrapper being silver soldered to the front flange plate with high melting point silver solder. Note the packing of heat retaining material, right around the work. This means the temperature is raised quickly and a better joint results.

nt solder, such as th crown to the

The tubes being soldered to the inner firebox. If the ridges were not raised on the tubes, there would be every chance of them sliding down. Correct alignment of the tubes is ensured by locating them in the front tube flange plate.

The inner firebox, with the tubes, is slid into the outer shell. The inside of the firebox is packed with retaining brick and the shell preheated, ready for the next operation.