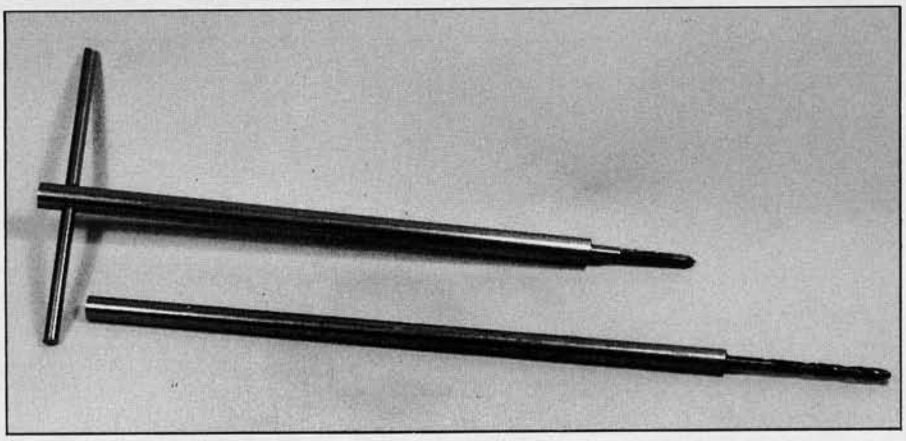
BOILERMAKING



The holes for the stays in the front of the firebox are usually awkward to drill. A bar with a hole in it, and the correct drill secured to it, allows the holes to be drilled easily. Alternatively, a long tap wrench can be used, with a crossbar to act as a handle and the tap being secured with a grub screw.

stationary engines and very basic small steam locomotives.

An advancement on the pot boiler is one with tubes running through it. These either carry water and pass over the heat source or take hot air through the water in the boiler. There are many variations and the efficiency of the boiler depends upon the design. The boilers can be either vertical or horizontal and are used for stationary steam engines and boats. Readers interested in this type of boiler would be advised to read the book *Model Locomotive and Marine Boilers* by Martin Evans.

The locomotive type boiler consists of the pot or boiler inside which are a number of heat tubes. There is a separate firebox built into the boiler and, whilst intended for coal firing, such boilers can be used for firing by other means. Although described as 'locomotive type' the boilers are used for stationary engines, as well as traction engines. The only difference really between a locomotive boiler and a traction engine boiler is that, with the locomotive, the steam is taken away from the boiler in pipes to the cylinders, whilst on a traction engine it will go directly into the cylinder block. It is the locomotive type boiler I intend to describe but readers can use the methods explained to make any form of boiler.

To build our boiler we will need a piece of tubing for the outer barrel. This can either be obtained as a tube or rolled. Rolling calls for a set of rollers for the best work, but I have rolled a boiler sheet round a wooden former, pulling it tight with large jubilee clips, so it is not impossible to roll one's own shell. Anyone contemplating a taper boiler barrel such as on Great Western locomotives will have to get the shell rolled one way or another.

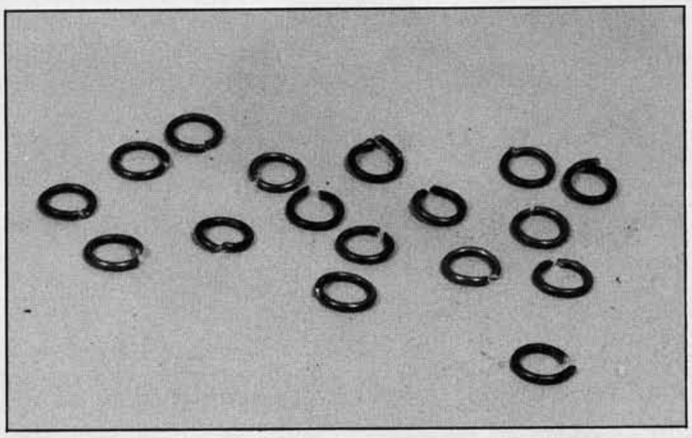
If a shell is being rolled then it will be necessary to make a seam along the edges and this can be done in several ways. The obvious thing is to have an overlap of about half an inch or 12mm. This should be riveted together before being silver soldered with a high melting point solder such as Johnson Mathey Silver Flow 15. An alternative is to butt the joint and fit a strip either outside or inside over the seam with rivets and then silver solder this in the same way. A third alternative is to make what is known as a coppersmiths joint, which consists of a series of castellations which fit together. The seams are then soldered in the same way but there is no overlap.

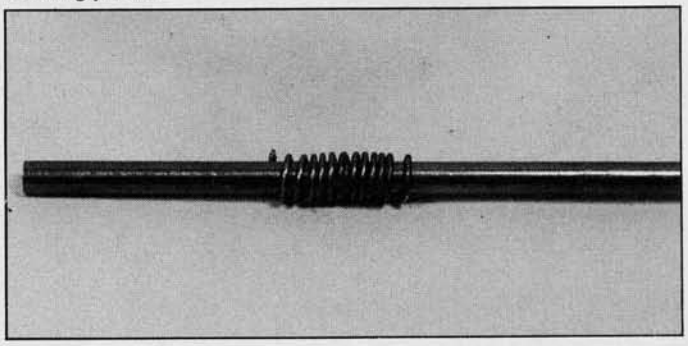
On the end of our main barrel we have what is known as the outer firebox. If the boiler is rolled this will have to be added. If a tube is used it can be formed in two ways. In the first method, the tube can be slit lengthways and then across the diameter so that it can be opened out. This will be too short for the firebox and pieces will have to be silver soldered on, to extend it either side. The three methods mentioned for seaming a tube can be used for making these extensions.

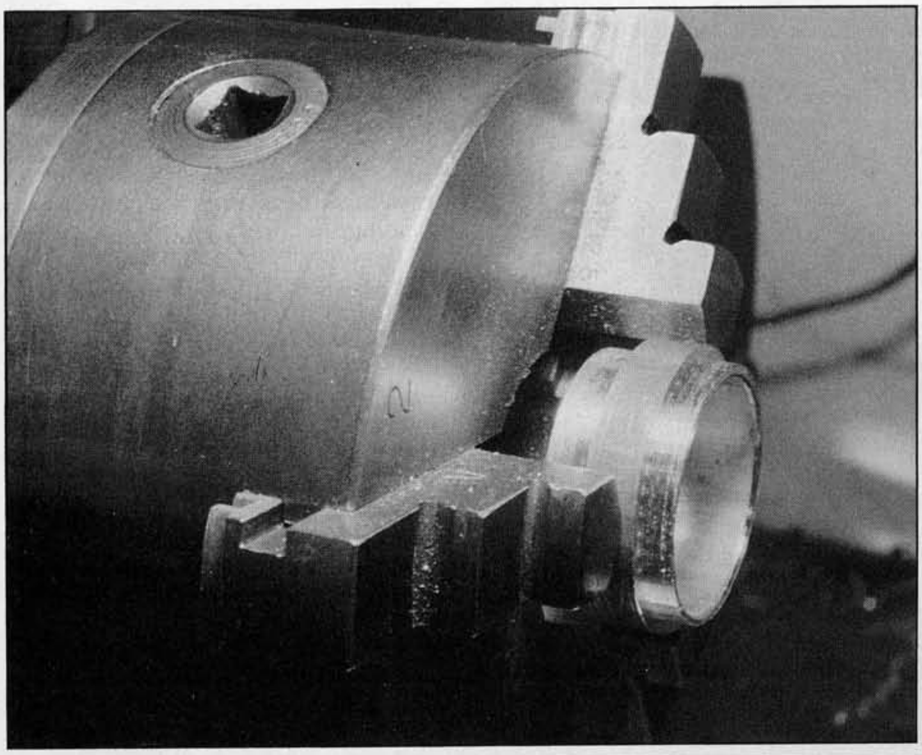
A second method of making the outer firebox is to put a separate piece on the end. Here the outer firebox is shaped and then fitted to the tube once more using one of the three methods mentioned for seaming the tube. The boiler at this stage can be drilled for any bushes and the dome flange as may be required.

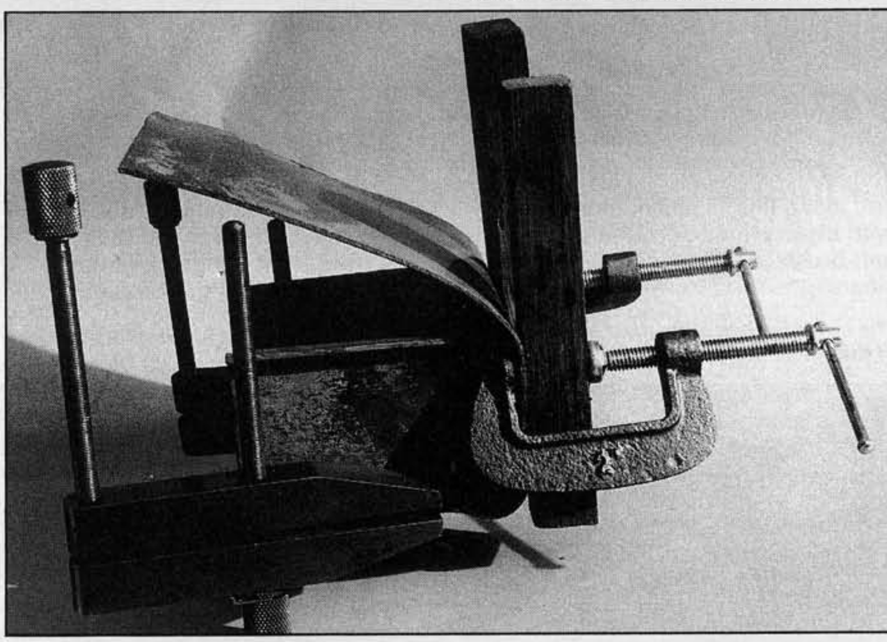
A set of plates are required for the boiler; we need a round plate for the front, a piece to form the front of the outer firebox, and a piece for the back, called the backhead. Inside the boiler we will need two plates for the ends of the inner firebox. All these plates are flanged to allow for the making of a sound joint and are known as flange plates. They are flanged round formers of the correct shape and

Using these small rings of silver solder, which fit exactly around stays or tubes, can save a lot of solder. They are made by wrapping around a suitable size bar, and snipping with cutting pliers.









Fire hole rings (above) are usually stepped to provide accurate location of the rear inner firebox plate and the backhead. Right: bending the inner firebox to shape can be difficult, and the copper must be continuously annealed. Do not hammer the copper, as it will stretch and go out of shape.

size and the formers can be made of metal, but, as they need to be about ½in. or 12mm thick if only one boiler is being constructed they can be made of wood. When making the formers, allowance must be made for the flange that will be formed on the boiler plates.

The copper which is being flanged will need to be well annealed by heating it to red hot and quenching in water several times during the flanging process. It is possible to purchase ready-made flange plates and these are worth considering. A very wide range is available and, because the suppliers are able to use the copper more economically than is normally possible at home, the plates cost very little more than buying the copper. If the gas used is taken into consideration the cost may well be about the same. Some of these plates are also ready spotted for the holes that need to be drilled in them.

Assuming that we now have our flange plates, whether bought or home-made, and that the outer firebox has been formed, the first operation should be, in my opinion, to put the front of the outer firebox in position. This should first be riveted in place. Do not go mad on the rivets — all rivets are a potential source of leaks in the finished boiler — but fit enough to hold the flange plate in position while it is silver soldered. Before fitting, it may be necessary to cut the shape for the boiler barrel. The question of whether or not the flange plate will be further flanged over to fit the boiler barrel will be a matter for the individual. I know some people like to do so but personally I do not and have not had any problems. However there is no doubt that this flange will give extra strength to the boiler. Whatever happens, care must be taken to get good close fitting joints, as silver solder will not readily fill gaps.

To silver solder the front firebox in position mix up some flux with either water or methylated spirits — either will work. Sometimes flux mixed with water has a tendency to run whilst, if it is mixed with methylated spirits, it will not, since the spirit evaporates the minute heat is applied and leaves the flux in position. Water would boil and this causes the flux to run. Whatever you decide, coat the joint with flux, I use a small paint brush for this, and try to get the flux well down in the joint. I then draw a line about ⅛in. or 3mm away from the joint and right along it with a thick lead pencil. Should the silver solder tend to run, this will help to prevent it from doing so.

Pack the boiler well round with fire bricks leaving only the part to be joined exposed. Heat it until the silver solder will run on the metal and not in the heat of the torch. One way to ensure this is to cut a short length of the solder, lay it in the crevice formed by the joint and then not apply any further solder until the test piece has melted. I use high melting point flux designed for prolonged heating, such as Tenacity Five, for all work on the boiler where silver solder is employed. For this particular joint we also need a high melting point solder such as Silverflo 16 or Silverflo 24. When the solder has solidified take away the bricks, lift the boiler with tongs and plunge it into a bucket of cold water. When it is cold put it into the acid

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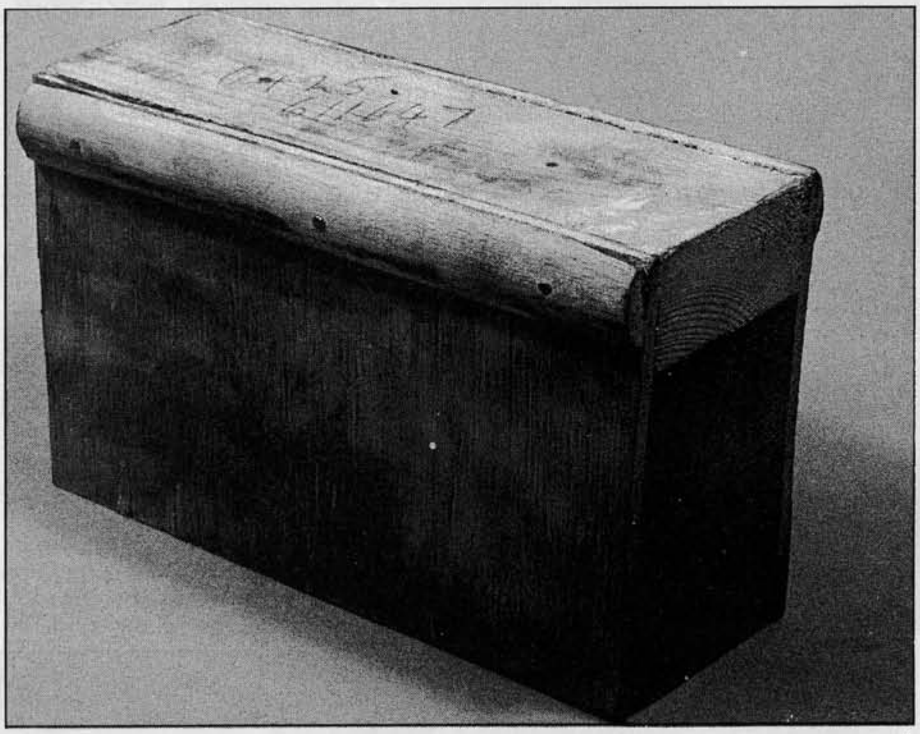


A simple wooden former can be used to more or less finalise the shape of the inner firebox. There is no need for elaborate carving, in this case pieces of half round beading have been used to create the required shape.

and leave it until clean, then wash it with clean water. A rub over with a soft brush at this stage will help the cleaning.

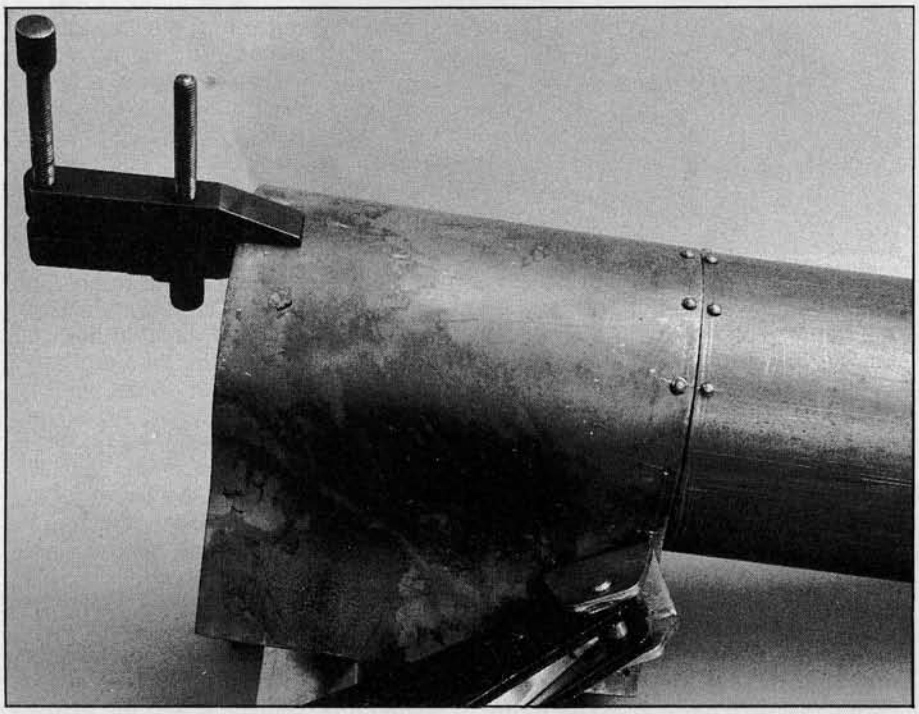
I next form the inner firebox and, using the same methods, silver solder the front flange plate into position, repeating the treatment with acid, etc. There are several schools of thought on the next process. Some people like to put on the rear of the inner firebox, others leave this off until very near the end. I have tried both methods and there seems to be little difference in the results. If the rear flange plate is being put in, then, before doing so, fit the firehole tube in place with a high melting point solder.

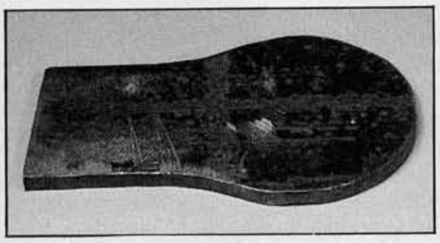
Whichever way the boiler is to be made the next step is to put the crown stays on the firebox. Here again there are various forms suggested; some connect to the outer barrel and others do not. Certainly, in the case of a traction engine, the crown stays will not join with the outer firebox but they may on some locomotives. If they do, then this can be done later. The crown stays can be held in position with rivets or bronze screws whilst they are soldered. Use Silverflo 24 for the job. Pack it well round with fire bricks and again clean with acid after quenching it in cold water.

The next job is to fit the boiler tubes. The holes should have been made in the flange plate before making up the firebox. I make a ridge on the tubes using a little tool in the lathe. This stops them slipping through the firebox plate when heated. To fit the tubes I flux around and in the holes in the firebox. I put in the tubes and support them with the front tube plate to keep them in position. Before doing so, however, I slip a ring of silver solder over each tube. These rings are simply made up by winding silver solder round a metal bar and clipping it with a pair of side cutters. I use 1.5mm diameter silver solder and for this job, use Easy Flo No 2. Using rings saves a great deal of silver solder which will run away if one is not careful. It is, of course, very expensive and should be conserved. Having fitted the tubes and supported them, the assembly is again packed round with bricks and heated until the silver solder runs and forms a joint. The quenching and cleaning process is repeated.

Take off the front tube plate and fit the inner firebox into the outer barrel. Use a piece of the copper bar that will form the foundation ring as a spacer and clamp the firebox in position. Fit the front tube plate. This is quite tricky and I use the pieces of bar mentioned earlier. I slip them through the holes in the tube plate and into the tubes one at a time and use them to guide the tubes through. I have an extra long one for

The outer firebox can either be made by adding a whole length and shaping it, as in this case, or by cutting the boiler tube and adding extension pieces.





at the front and sides of the firebox using the usual procedure. The

Left: former plates can be made by bending them round wooden or metal formers. Below: sets of formers can be purchased ready-made. These come from Messrs Reeves, and are pre-spotted ready for drilling.

are to be silver soldered, do this before fitting the last piece of the foundation ring. Finally, fit any bushes which may be required in the main barrel. If the back of the inner firebox was fitted before the box was put into the outer shell, put the backhead on before doing the foundation ring and stays. In this

any awkward tubes as the extra length allows added persuasion to be given to it. I do not use these on superheater flues as I find that I can get them through easily enough, as there is room to get one's fingers through. Once all the tubes are in place adjust the inner firebox again and, if the crown stays are meant to join the barrel, make sure that they do. If these are to be joined then now is the time to solder them in position.

The next operation will depend on the type of boiler being made and if longitudinal stays are being fitted it may be as well to leave the front tube plate until last. When the front plate is fitted, whether now or later, flux the front tubes and fit rings of solder (Easyflo 2) round each one. Put the stays and regular bushes in place and, after fluxing, put silver solder rings round them as well. I then use my pieces of steel rod to prevent heat going down the tubes, so keeping it where it is needed most. As usual, set the boiler into bricks so that only the part to be dealt with is showing, heat up until the solder runs and again quench and clean.

The foundation ring can be fitted holes can then be drilled in these sections for the stays. What form these take I will discuss later. The foundation ring must be carefully fitted and machined or filed so that there are no gaps at the joins. If by bad luck such gaps do appear, fill them with pieces of copper in such a way that the filling material is the same depth as the foundation ring.

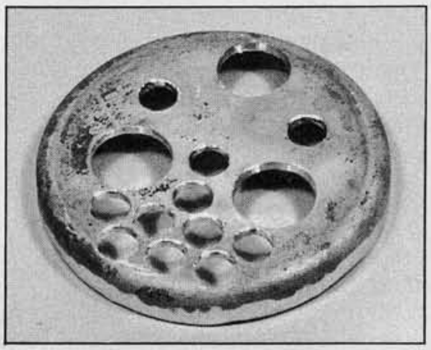
If the rear of the inner firebox has not been fitted and the stays are to be silver soldered, these can be done now, first on the outside and then on the inside. I like to put a small piece of steel plate inside the firebox while I do this, to protect the tubes. After cleaning, fit the back of the inner firebox, although you must make sure that it is well fitted before trying to silver solder it, and it is for this reason that some like to fit it while it is out of the main boiler shell.

The backhead can be done next and I always just hold it with a bronze screw or two whilst it is soldered. Again, Easyflo No 2 is used and I put the backhead bushes in at the same time, there being little point in heating everything up again to do this later.

Drill for the rear stays and, if they case do the stays first and follow with the foundation ring. Silver soldering the stays will require air drawn in from outside and a metal tube through the firehole will help. The boiler is now ready for testing.

A quick mention of staying is worthwhile. All flat surfaces must certainly be stayed to prevent the internal pressure pushing them outwards. Ideally the stays should be silver soldered inside and out. If this is done then there is no need whatever to thread them. Leaving the back of the inner firebox makes it easier to silver solder them inside,

A completed front tube plate, with all the holes ready to accept tubes and bushes.



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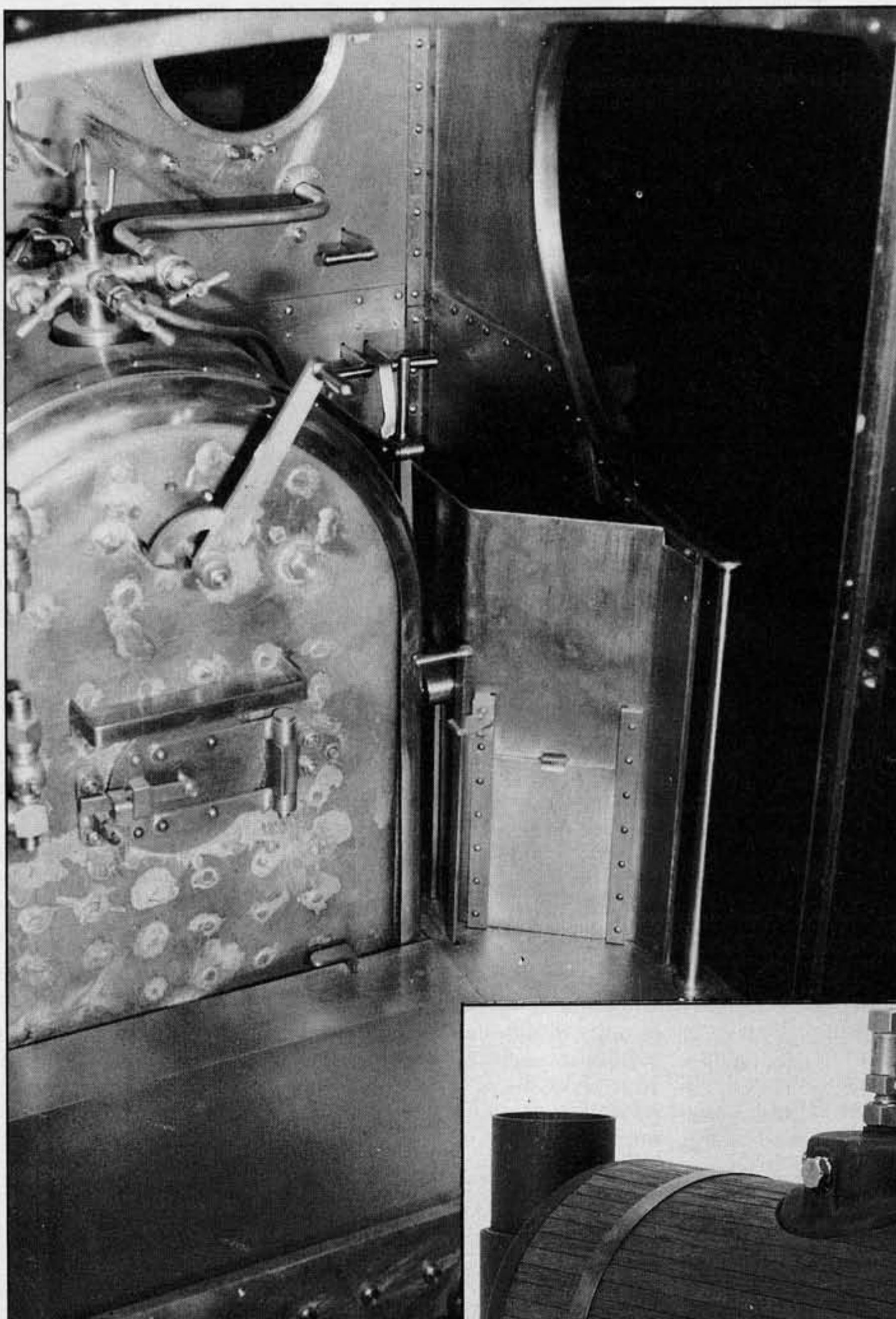


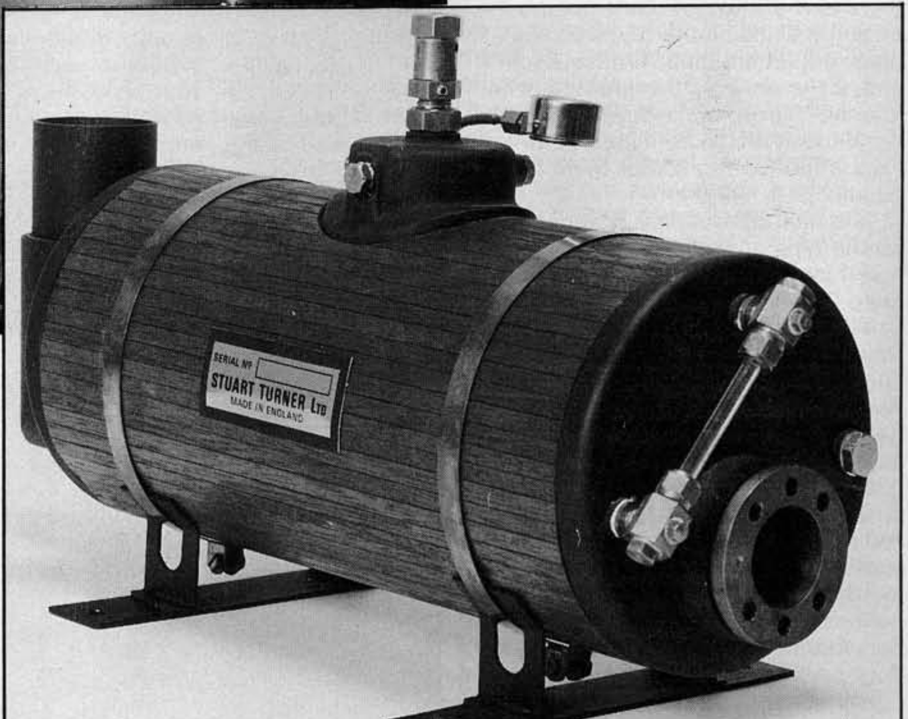
Above: ***the backhead of a completed boiler, showing the staying pattern.***

but creates the problem of fitting the back of the firebox afterwards, so it may be that, if some of the stays are threaded in this case, the inner fire box will retain its position better. Anyone not happy about silver soldering the stays in this way should drill through outer and inner firebox and tap through both. The stays can then be screwed into position. Silver solder the outside and put a nut on the inside. This can be floated over with Comsol, a silver-bearing soft solder of reasonably high temperature. It is quite safe providing the stays are screwed and nutted.

All that remains is to test the boiler — I like to test mine to twice the working pressure. Make up plugs and blank off all bushes except two — one near the bottom and one near the top. Connect a hand pump to the one at the bottom, fill the boiler with water until all air is excluded and then connect a large pressure gauge to the bush at the top. Pump water in until the gauge reads twice the working pressure. Any leaks should show up by now. They must be sealed with silver solder. The pressure should be held, by pumping if necessary, for about half an hour. The pressure can then be released and the boiler is ready for use.

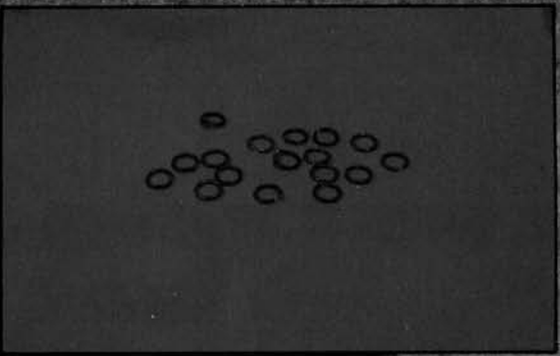
Testing is most important. Remember, you will almost certainly be the nearest person if anything goes wrong so it is in your own interest! Leaks do not mean a boiler is not safe but they do make it difficult for the model to retain pressure and so operate properly. It is easier to seal them at an early stage rather than have to dismantle the model later on.

A marine boiler made by Stuart Models. It is a simpler form of construction than the locomotive type.

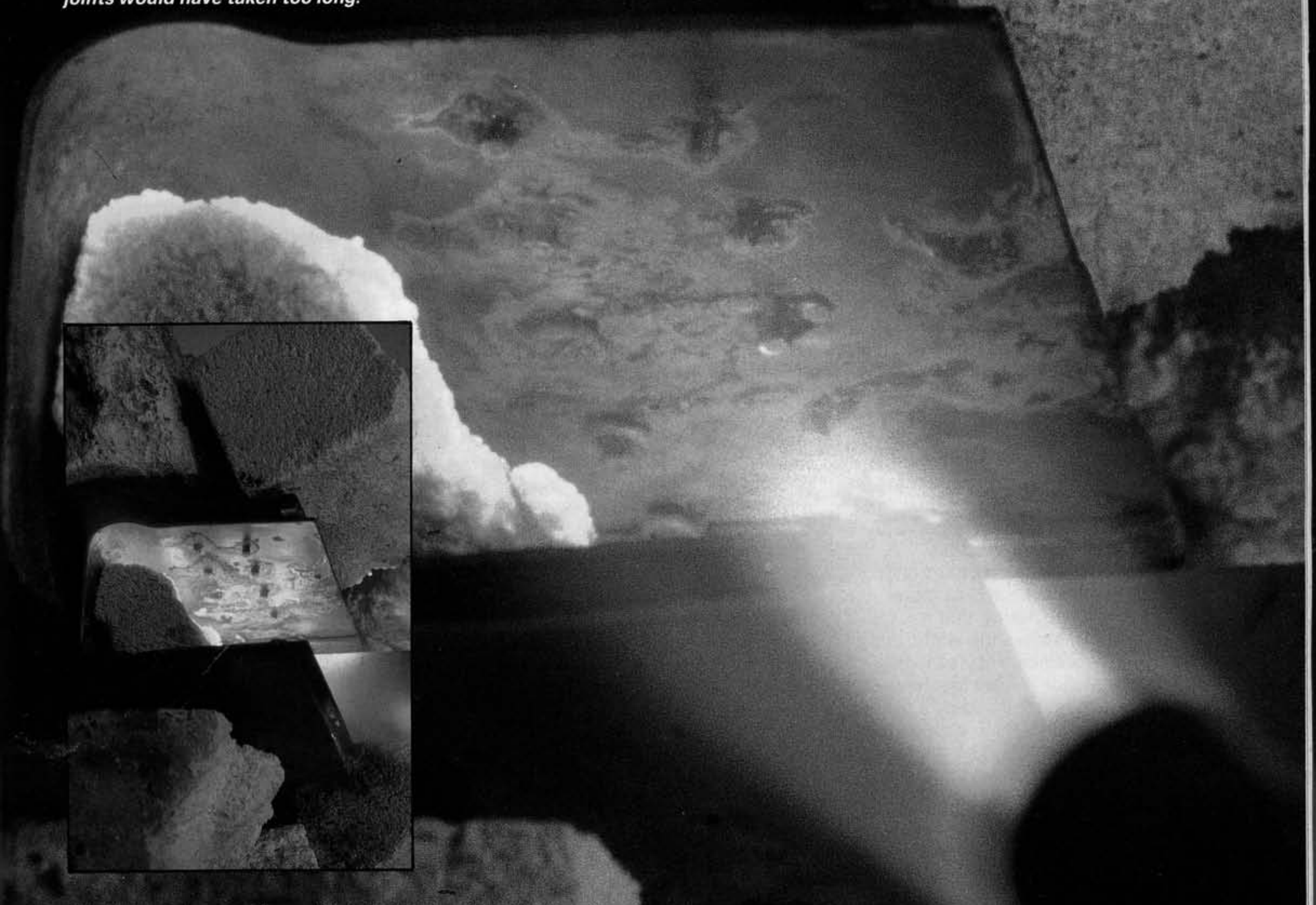


Main picture shows the outer stays being prepared.

The crown stays are soldered to the outer firebox. Without the preheat, temperature raising of the joints would have taken too long.



Silver solder rings prepared for dropping on the the stays.



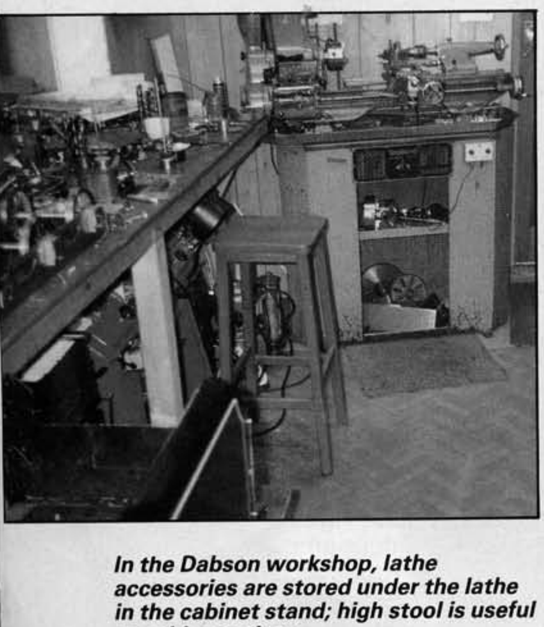
The inner stays are silver soldered with Easyflo 2. Leaving the firebox rear off helps with this operation, but makes it more difficult later on. Previously soldered joints are protected here by a stainless steel strip. Below and right: silver soldering the foundation ring into position. If the backhead and rear firebox plate have been left in place, as here, the foundation ring can be done in one go.

WORKSHOP SHOWCASE

Looking at how someone else sets about organising their workshop is always a useful exercise. Modellers are constantly finding new ways of laying things out and their ideas can be adapted for one's own use. I frequently make minor changes to my own workshop after visiting someone else and I know that other people have copied from me. This exchange of ideas is all for the best.

Here we will take a peep into three workshops. As it happens, the three owners are all good friends and so one would expect their places to be similar, particularly as their interests are the same —they all like building large scale locomotives. However, it is not at all like that and each workshop reflects the individuality of the owner. All three are lucky enough to have above-average space; this because they set about having an active retirement and used capital to set themselves up and get the pleasure of their investment as time slipped by.

Dick Stockings shares his workshop with his son Richard and, between them, they turn out many fine models. Considering that it is for two people, the workshop is not really that large. It contains a Myford 254 lathe and a Senior Milling Machine. The latter is to be replaced by a more modern Warco VHM with a motorised table in the near future. The workshop is maintained in a neat and tidy condition so that there is no hunting around for what is wanted. For storage purposes, shelving is most prominent and metal is kept in wooden racks under the bench in one corner, with other sheet and similar material nearby. This makes it all easy to locate as required. An interesting point is that locomotive construction is carried out on a moveable stand with shelves underneath it, rather than on the bench. The stand is in the middle of the workshop which enables them to get to any part of the model as required.



In the Dabson workshop, lathe accessories are stored under the lathe in the cabinet stand; high stool is useful on odd occasions.

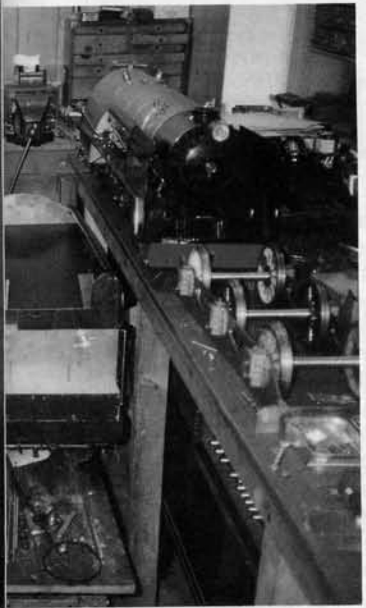
John Ward has only recently set up his new workshop and obviously a lot of thought was given to the layout, although in the past he has made many models. The lathe, a Myford, is on an industrial type stand and building is done on benches. Cupboard doors under the benches prevent the build-up of dirt and unwanted material. Open shelving is used higher up on the walls. Small drawer storage units for screws, etc., are very much in evidence at the right of the lathe. The workbench where the vice is located has open knee hole space and a high stool enables John to sit and work. A drilling machine and bench-mounted milling machine make up the rest of the permanent machinery, but a band saw is kept in a position where it can be moved to the bench for use as required.

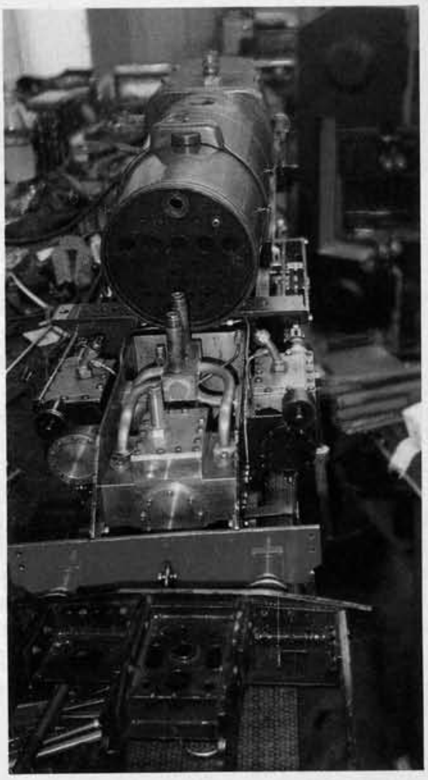
John Dabson is a man who likes to be really busy. At the time that these photographs were taken he had several locomotives in the workshop for maintenance. Not all were his; he is well-known for his generosity in helping other people who are less skilled than he. Having taken to building 7.¼ inch gauge models he has now obtained a second lathe in the form of a forty-five year old Harrison. At the same time he obtained a shaping machine.

He too builds models on stands and has to shunt these about to work on a particular model at any one time. A great deal of odd machinery and other workshop equipment has been acquired over the years and, together with all the many models, there is not a lot of room to spare. John spends many very happy hours in his workshop and there is little in the way of construction that he is not able to tackle.

Top left, John Ward's workshop features doors underneath the benches to prevent the entry of dirt and dust. Notice also the carpet which covers a concrete floor; ideal for working during the winter months. Above, some of the locomotives in John Dabson's workshop awaiting essential maintenance or repairs. Included are two 7¼ inch gauge Black Fives of the 'Highlander' design and, as locomotive storage space is at a premium, John's Workmate has been pressed into service as well! At right, a cramped corner in the same workshop; machine is a shaper.

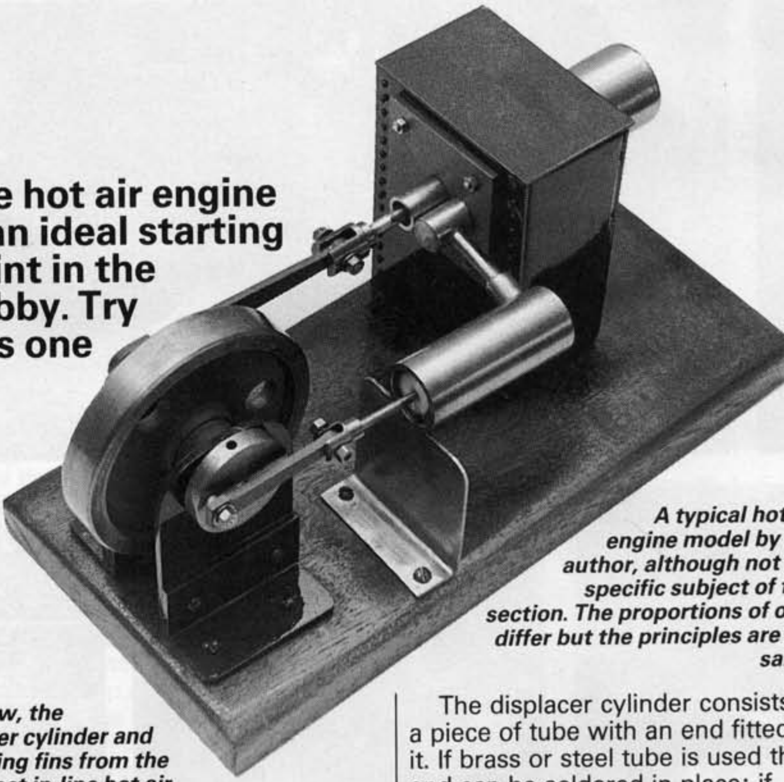
Right, neat and tidy is the rule in Dick Stockings' well-equipped workshop. Extensive shelving and countless small drawer units are the order of the day. In John Ward's workshop [below], this bench is devoted to assembly work – the working bench is on the other side of the shop.





Above, another locomotive on its stand, this time a five inch gauge Royal Scot in John Dabson's workshop. Above right, another view of Dick Stockings' super set-up; see what I mean about plenty of drawer units and under-bench storage space! Truly a place for everything and everythng in its place... At right, in John Dabson's workshop the milling machine with bolt-on power feed is set up to deal with a cylinder block.

MAKE A HOT-AIR ENGINE



A typical hot air engine model by the author, although not the specific subject of this section. The proportions of ours differ but the principles are the same.

The hot air engine is an ideal starting point in the hobby. Try this one

Every year a competition is held at the Model Engineer Exhibition for the most efficient hot air engine and some of the entrants dream up the most ingenious of ideas! However, although there inevitably must be a winner, the efficiency of the engines is hardly anything to write home about. The hot air engine came into being as an economical means of supplying power. Unfortunately while such engines can be made to work, they are very limited and, apart from some that did a little pumping, the only other job they seem to have done with any regularity is to drive fans.

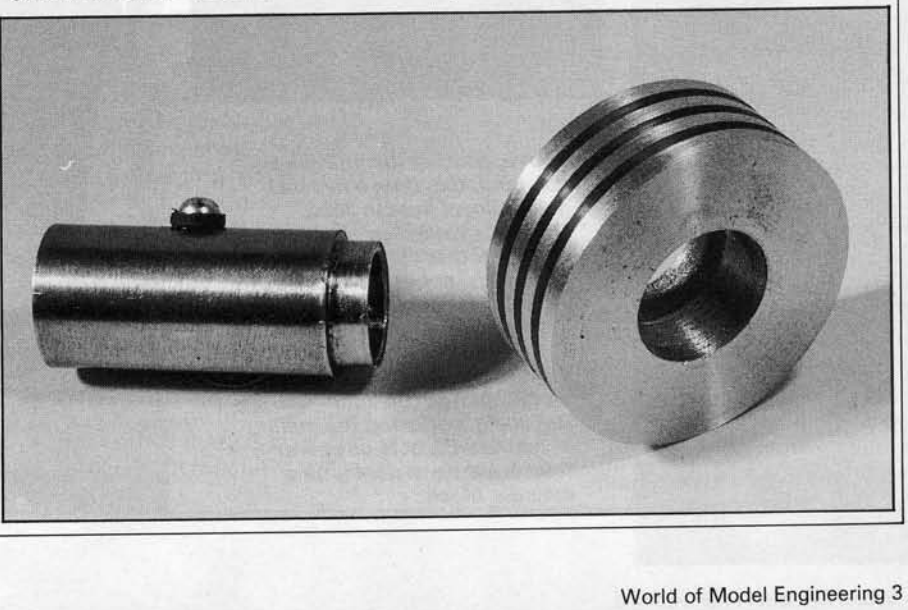
The principle of the hot air engine is simply to heat up a quantity of air and, since it will then try to move to a cooler place in the machine, to get it to move a very loose-fitting displacer. The displacer is rather like a piston but, as I said, is very loose fitting and so the air is able to move past it. In doing so, cool air takes its place. The hot air that has been displaced strikes a power piston and forces it back, which moves a crank and so rotates a shaft with a flywheel attached. In order to work, the system must be airtight and the power piston crank at ninety degrees to that of the displacer.

Hot air engines are fascinating models to build and teach one a lot about engineering practices. Apart from the system being airtight the displacer must also not leak air or the machine will not work. The power piston has to be airtight but at the same time sufficiently friction free to allow it to move easily. They are not difficult to make but they do mean sometimes checking and re-checking one's work to get them to run satisfactorily. This is a good thing as it soon becomes obvious where one has gone wrong and the fault can be rectified. In future projects it is unlikely that the fault will occur again . . .

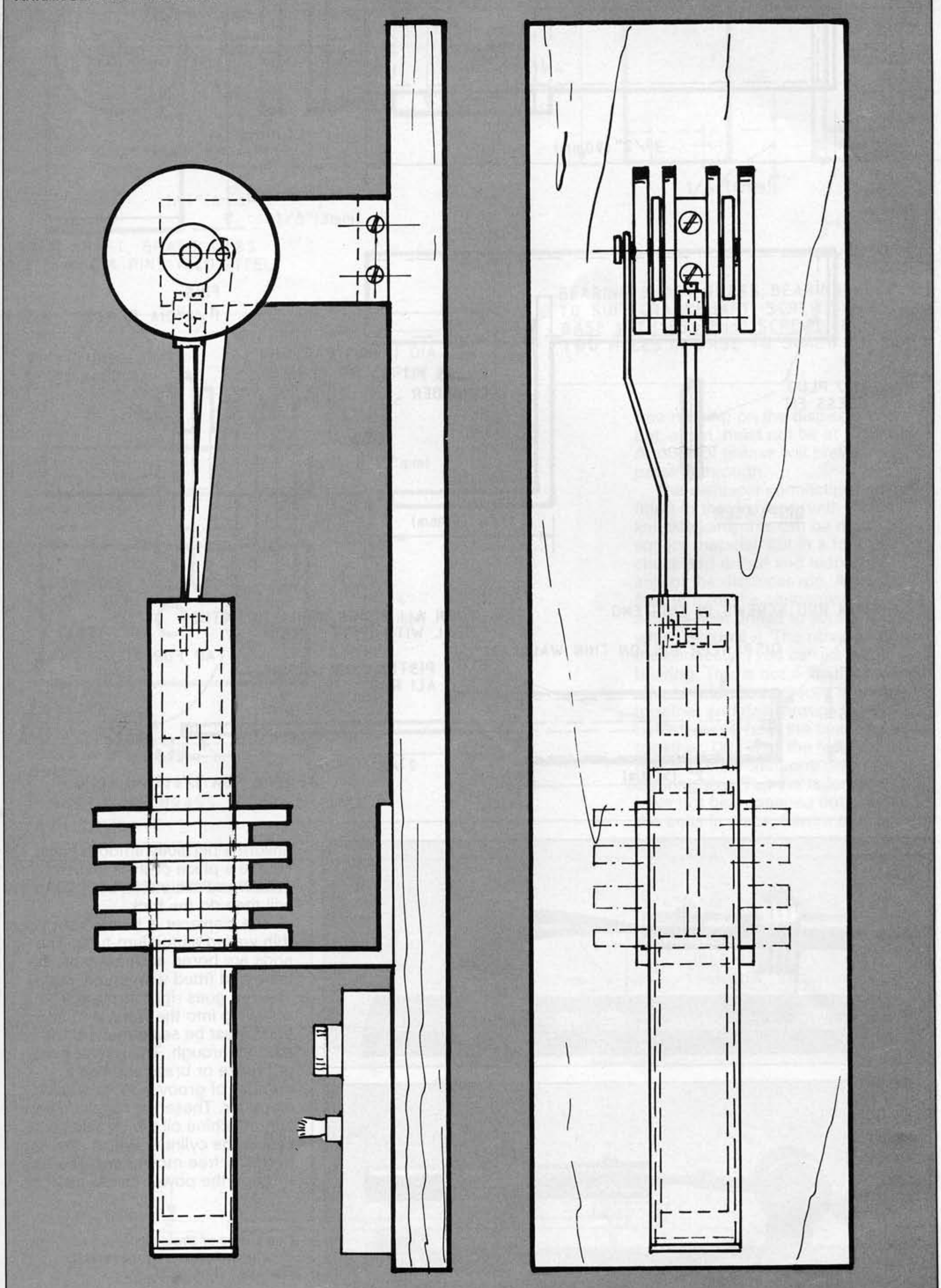
I have included drawings to make a small hot air engine. The construction is a little unusual; whereas it is normal for the power cylinder to be separate from the displacer cylinder, with the connection made via a tube, this engine has them directly connected to each other. It calls for even more careful machining than the common type. The displacer rod passes through the centre of the power piston and this must not leak air so a good, free fit is needed.

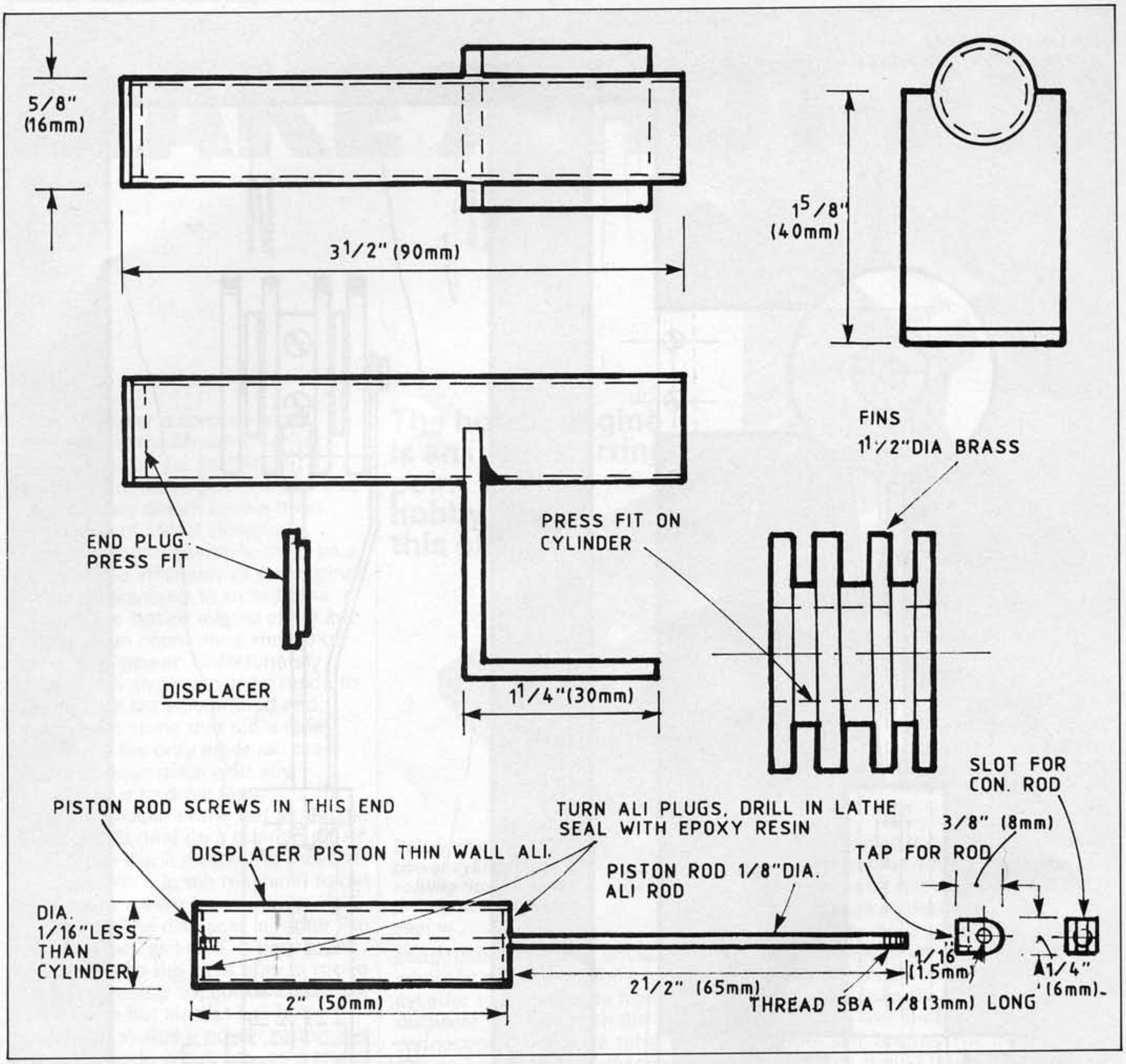
The displacer cylinder consists of a piece of tube with an end fitted to it. If brass or steel tube is used the end can be soldered in place; if aluminium tubing is used it can be sealed with Araldite or a similar epoxy resin. On the end of the displacer cylinder is the power cylinder. This should be brass or, better still, bronze. The inner diameter should be a little less than that of the displacer cylinder. Do not be tempted to use a piece of ready-made tubing; such material does not have anywhere near a fine enough finish for our purposes. The hole must be bored on the lathe to

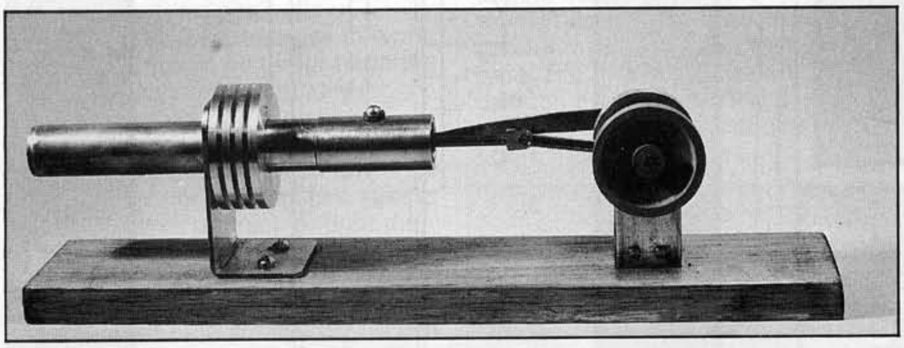
Below, the power cylinder and cooling fins from the project in-line hot air engine.

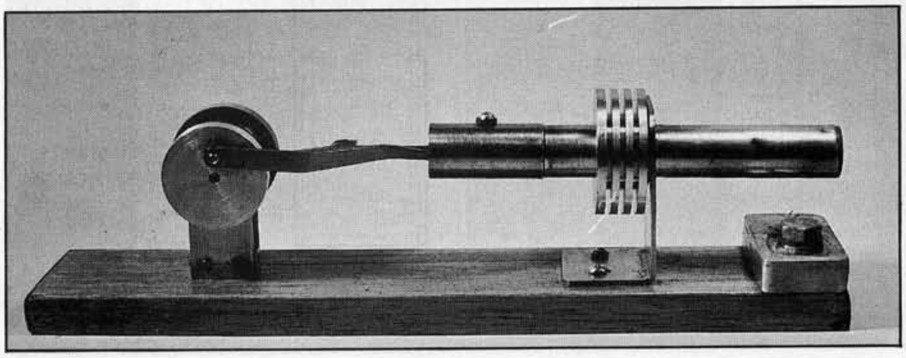


FULL-SIZE GENERAL ARRANGEMENT DRAWINGS





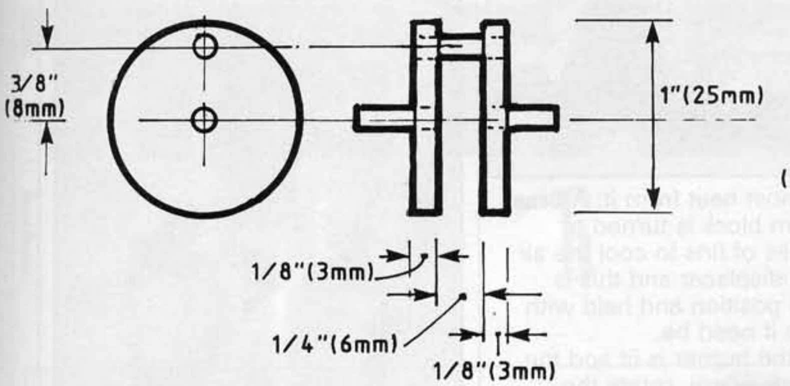




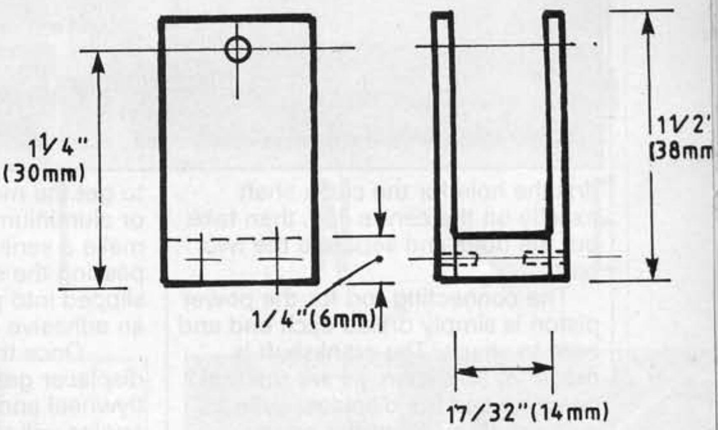
ensure a perfectly smooth finish. Of course a piece of thick walled tube could have the inside bored and this will then do the trick.

The displacer is made from very thin walled aluminium tube. The ends are bored accurately on the lathe and fitted with epoxy resin. The rod goes right through, screwing into the front, end and the ends must be sealed where the rod passes through. The power piston is of bronze or brass and has a number of grooves in its outside diameter. These are to take a very light machine oil which acts as a seal in the cylinder whilst allowing perfectly free movement. The hole through the power piston must be

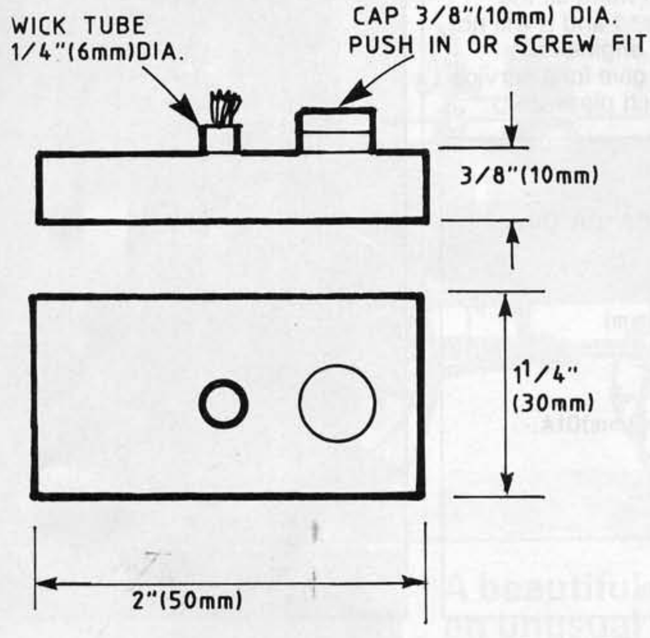
Two views of the completed hot air engine; quite an elegant beast, don't you think!



CRANK SHAFT, BRASS WEBS
1/8"(3mm)DIA PINS MILD STEEL



BEARING BLOCK BRASS, BEARING HOLE TO SUIT CRANKSHAFT. SCREW SIDES TO BASE WITH 8BA(2mm) SCREWS. DRILL TWO HOLES IN BASE TO SCREW TO FLOOR

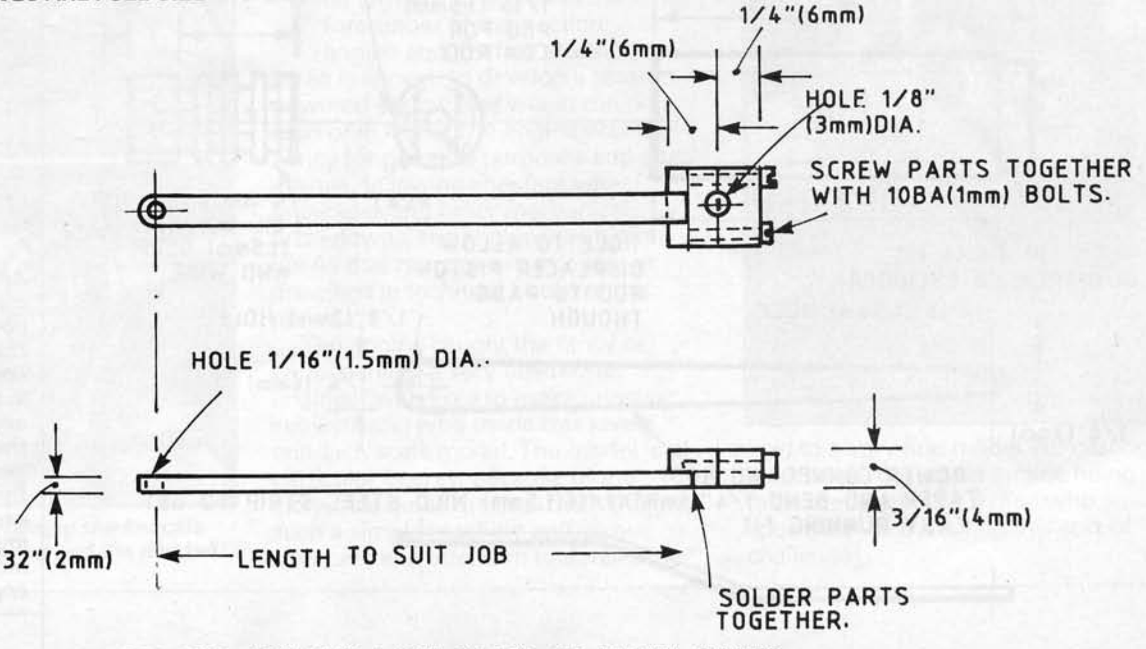


BURNER 1 OFF BRASS (THIN) OR MAKE FROM TINPLATE

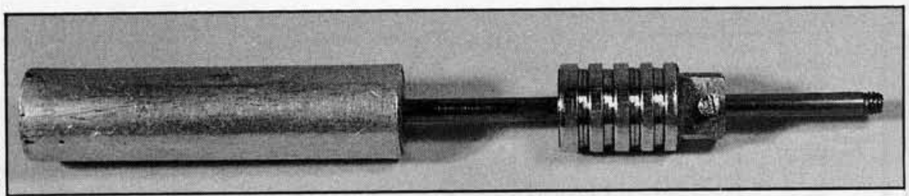
free-running on the displacer rod but, again, must not be at all sloppy. A touch of grease will prevent air passing through.

The displacer connecting rod is fitted to the displacer with a small knuckle joint; this can be made from square material, put in a four jaw chuck and drilled and tapped to accept the displacer rod. A slot is filed in it for the connecting rod, and a cross-hole drilled to accept a pin which secures it. The other end of the connecting rod carries a split bearing. This is not difficult to make; simply solder two pieces of metal together and drill through for the bolts that will hold the bearing together. Drill with the tapping sized drill and then open one piece to clearing size. Tap the holes that have not been opened out and put the bolts in place. Centre punch and

ALL DRAWINGS ARE FULL-SIZE



DISPLACER CON-ROD 1 OFF BRASS OR NICKEL SILVER

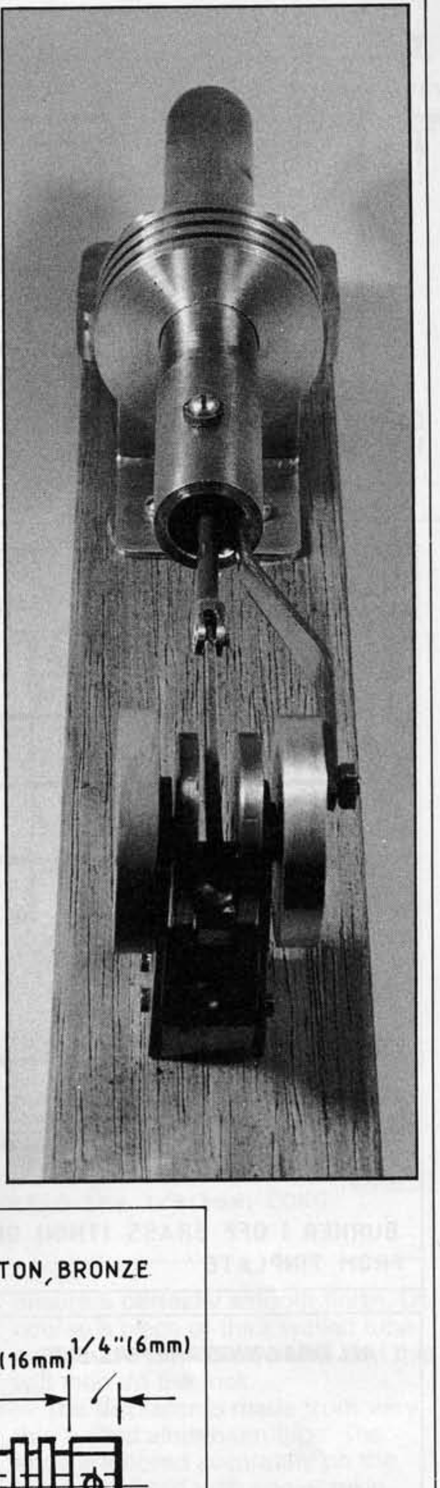


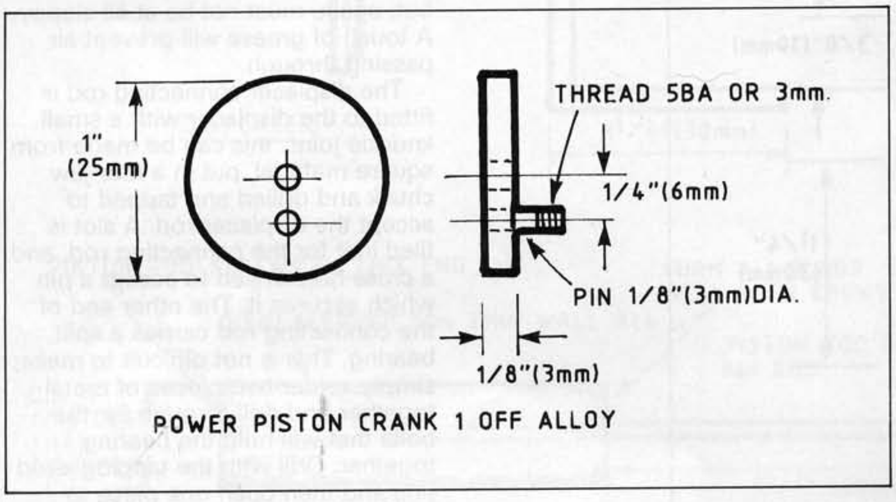
drill the hole for the crank shaft exactly on the centre line, then take out the bolts and separate the two parts.

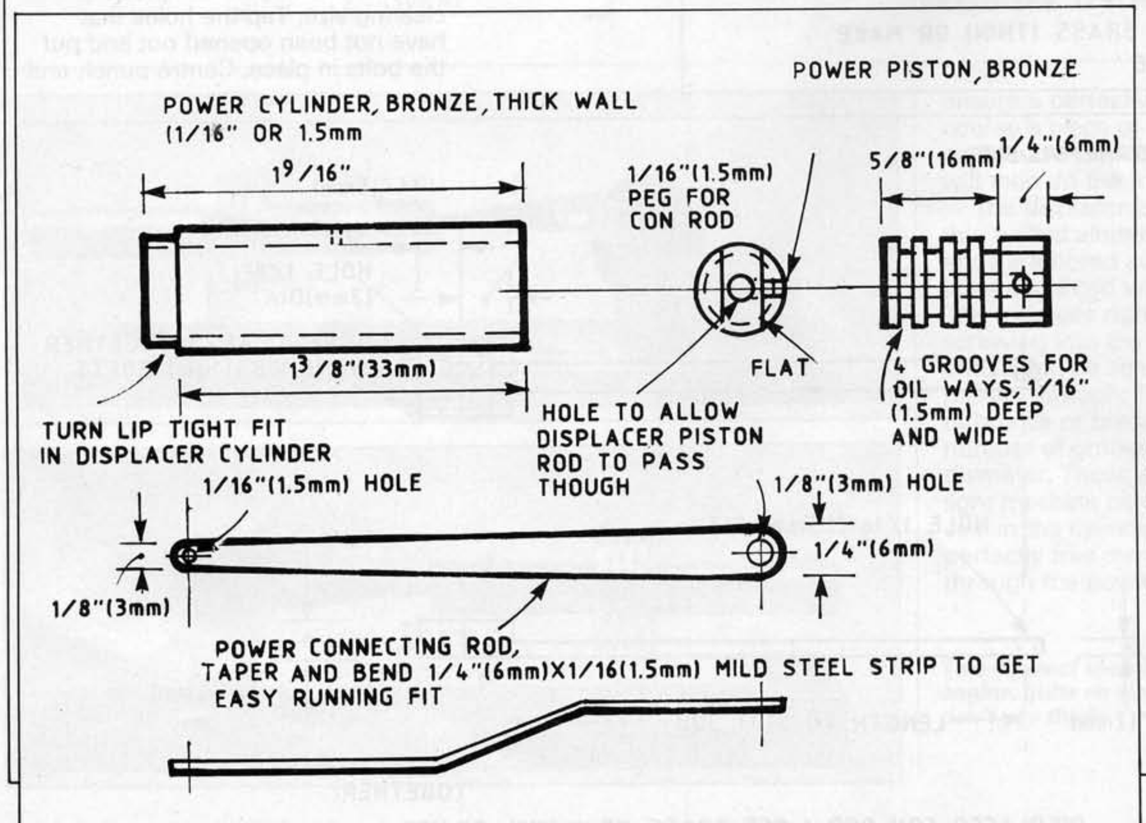
The connecting rod for the power piston is simply drilled each end and bent to shape. The crankshaft is made up as shown, as are the main bearings and the displacer cylinder support. Remember the power piston crank must be set at 90° to the displacer.

The burner as shown is rather on the small side and you could increase its size if you desired. However, do not increase the height as the tip of the flame needs to touch the displacer cylinder in order to get the most heat from it. A brass or aluminium block is turned to make a series of fins to cool the air passing the displacer and this is slipped into position and held with an adhesive if need be.

Once the burner is lit and the displacer gets warm, rotate the flywheel and , if all is well, the engine will run. It is far more likely that various adjustments will be needed to make it successful and it is these that represent valuable experience. Bear in mind all the points I have stressed and it will not be long before the engine is running. It should give long service and, hopefully, much pleasure.

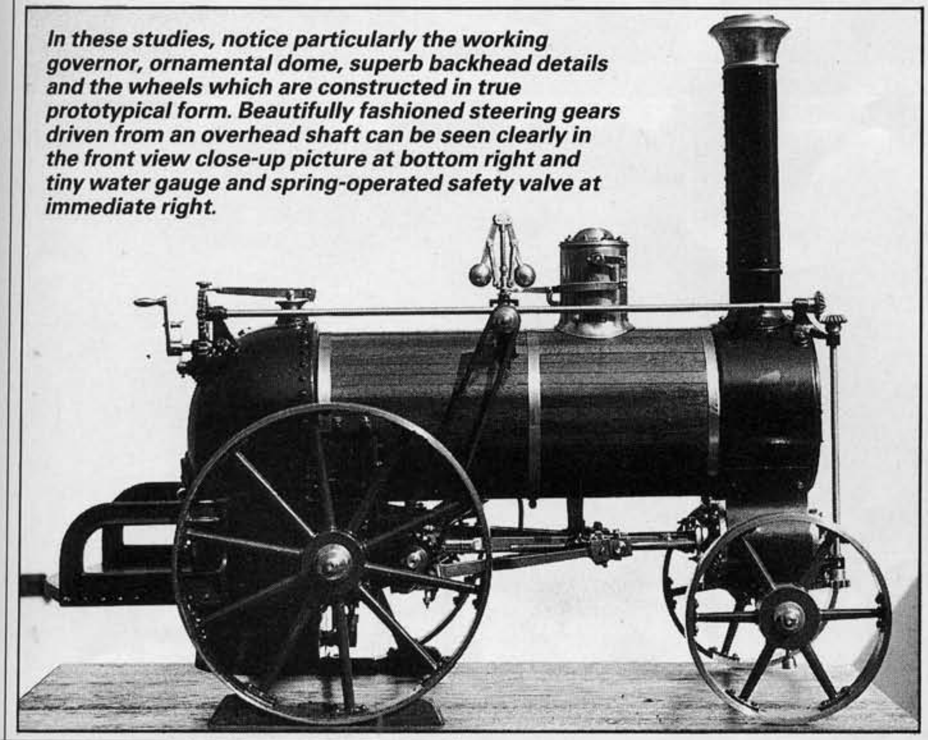




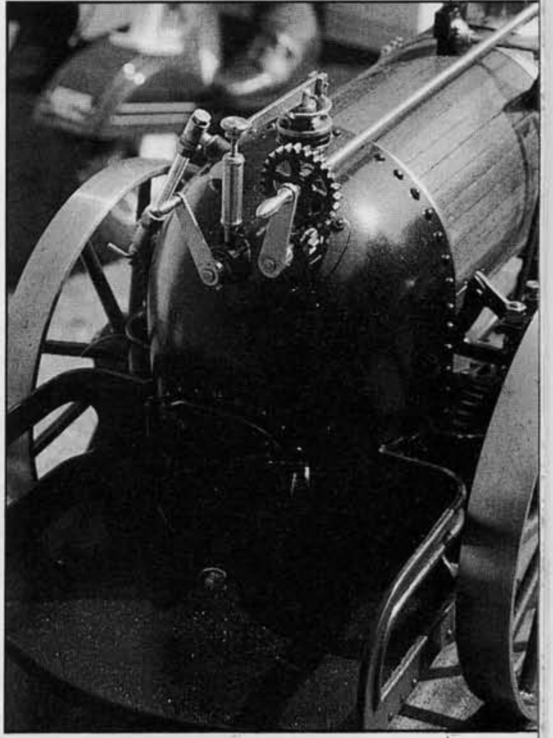


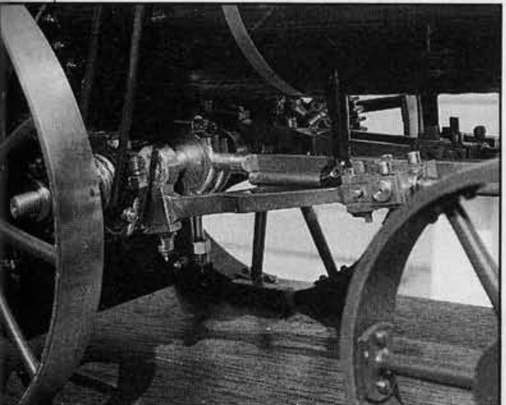
At top left, the displacer and power piston of the in-line hot air engine described. in the text. Above another view of the finished model. Give it a try – it's an excellent way of improving your model engineering skills.

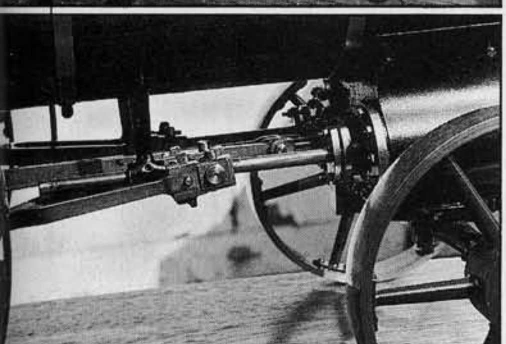
THE FARMERS ENGINE



In these studies, notice particularly the working governor, ornamental dome, superb backhead details and the wheels which are constructed in true prototypical form. Beautifully fashioned steering gears driven from an overhead shaft can be seen clearly in the front view close-up picture at bottom right and tiny water gauge and spring-operated safety valve at immediate right.





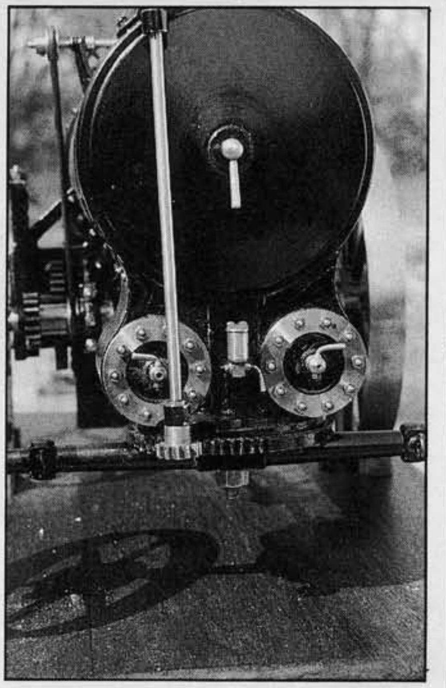


Note cotter pins retaining the knuckle joints on the piston rod and the divided connecting rod.

A beautiful example of an unusual subject by Louis Harling

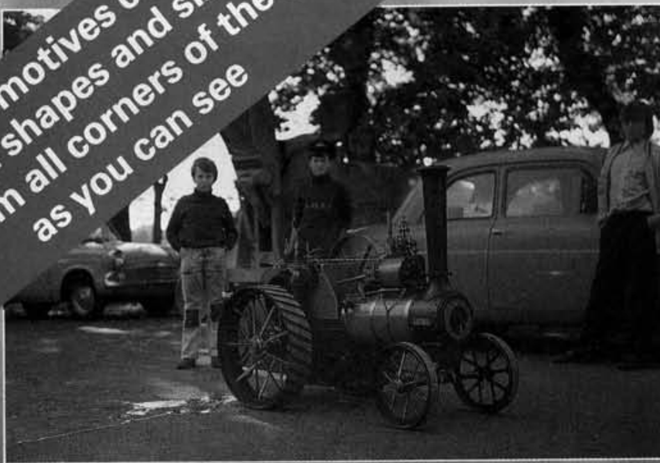
The farmers' engine was the forerunner of the traction engine and the first attempt, as far as is known, to develop a steam powered engine that would run on a road or in fields. The engine was too flimsy for practical purposes and after a while, following constant wheel breakages and other mechanical breakdowns, the engine was broken up. All that remains are a couple of drawings in technical books of the period.

The engine caught the fancy of Louis Harling, a very fine model engineer who likes to make unusual subjects and who made this lovely one-inch scale model. The model is of particular interest because of the incredible detail that has been put into such a simple machine and shows how care and attention to detail can



lead to a very fine model. No castings were used, the whole engine being fabricated by Louis, a man who specialises in accepting this sort of challenge!

Locomotives come in all shapes and sizes – and from all corners of the globe, as you can see

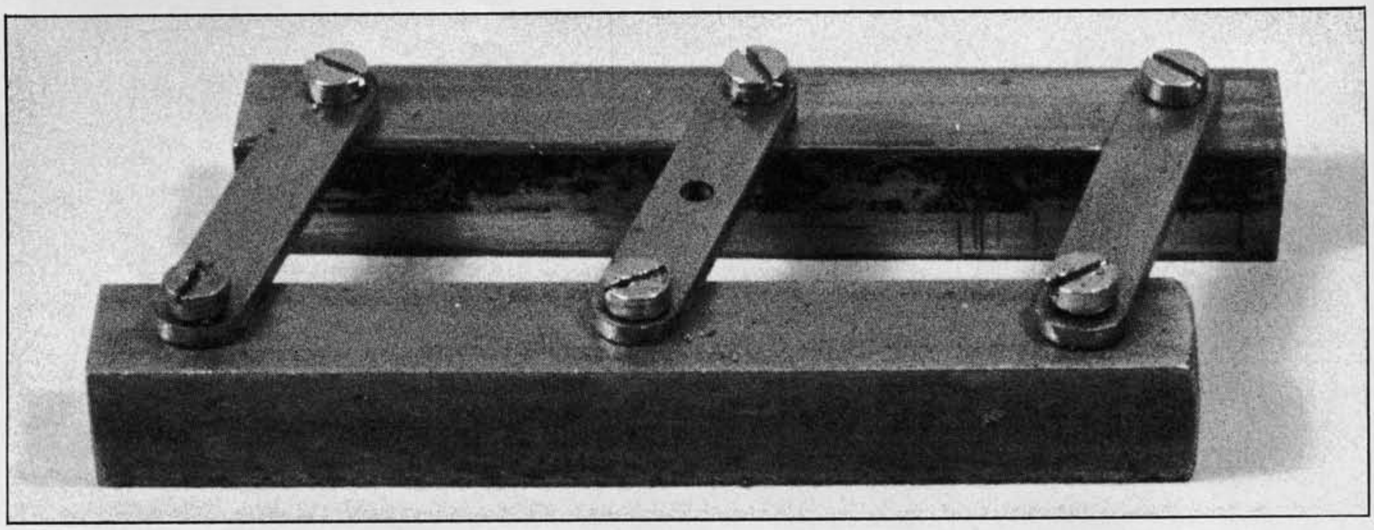


LOCOMOTIVE KALEIDOSCOPE

Previous page: Traction engine modelling (top left) is more popular in Britain than anywhere else, and this 4½ gauge model is truly massive – 2 inch gauge is more practical for the more common type of workshop equipment. One of the most popular designs worldwide, is 'Rob Roy' (bottom left) and this design by Martin Evans can be built with the minimum of equipment. On miniature railway tracks which operate at ground level larger models are desirable (like this Hunslet in 5 inch gauge at top right) in order to gain access to the controls.
Bottom right, a typical German locomotive in 5 inch gauge.
This page: While steam locomotives are by far the most popular, modern prototypes are not neglected. Above is a 5in gauge French electric locomotive and above left is a British Railways diesel type. Finally, left is a Hunslet narrow gauge model, typical of types that would have been seen on light and industrial railways all over the country.

The main picture shows a 2-4-0 tender engine, a popular British prototype. It was designed by the late LBSC to run on 3½ inch gauge track, and is named 'Petrolea', since many of the original locomotives were oil fired.

CROSS DRILLING



Drilling accurately across a round bar is not an easy proposition without some form of guide, yet it is something that we constantly need to do during our modelling activities. Whilst it is quite possible to centre punch the work and then line it up in the machine vice to be drilled, there is every danger of things going wrong. If for any reason this method has to be resorted to then the best way is to start lightly with a centre drill applying the merest touch of the drill then examine it carefully to see if it is straight or not. If not, turn the work in the vice and again make the slightest touch with the drill when it can be seen whether it is lined up correctly. It may be necessary to make several starts before getting it near enough right, but even then absolute accuracy cannot be guaranteed.

It is far better to use some mechanical means of lining the work up and there are many ways of doing this. Possibly the simplest is to make a pointer to fit the drilling machine chuck. Set a vee block on the table and line the pointer up with the bottom of the vee. Clamp the vee block in position. The work can then be held in the vee block and the drill will go accurately through the work.

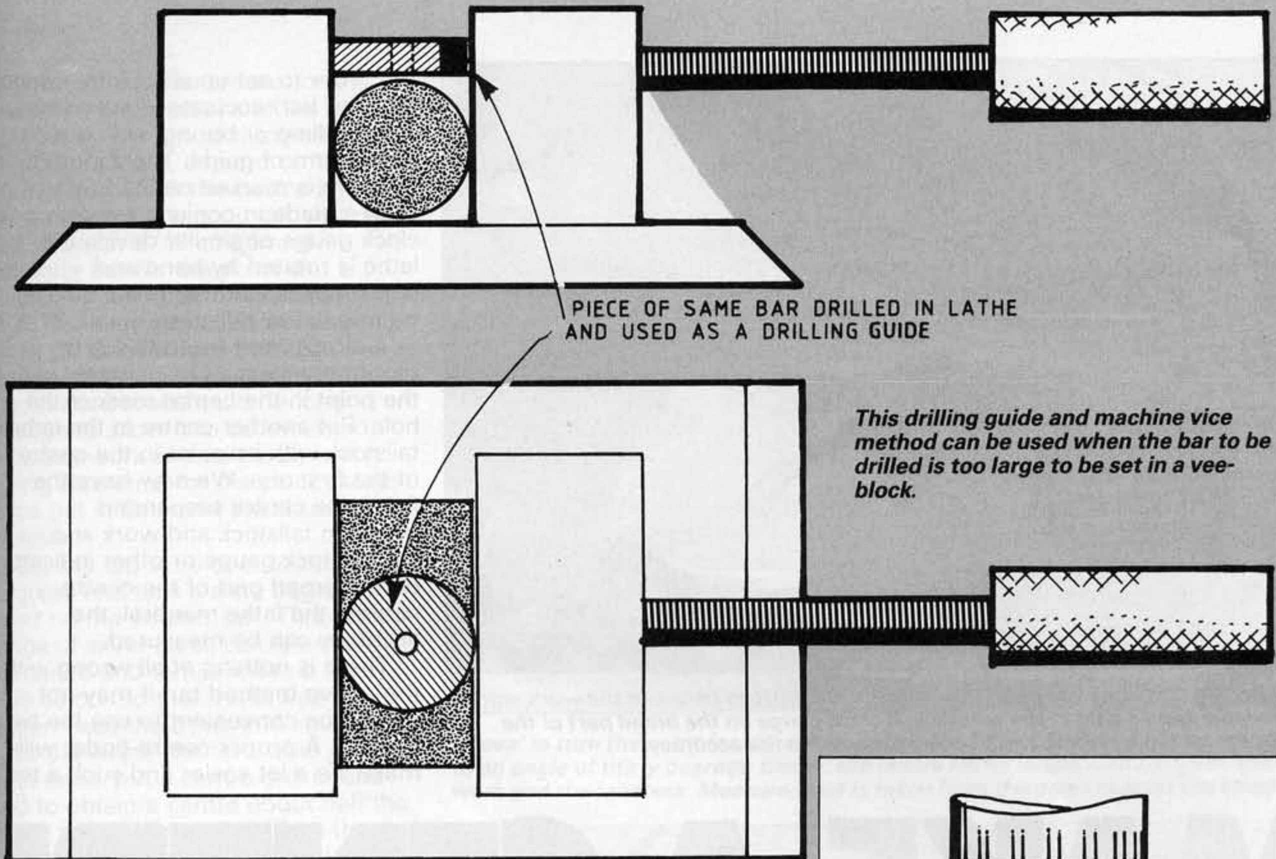
If for any reason (such as the work being too large) it is not possible to set it in the vee block then a way of achieving success is to take a slice of metal of the same diameter as the work and drill it centrally in the lathe. This can be put on top of the work in a machine vice and will act as a guide.

Cross drilling round bars can be harder than it sounds. There are ways, however, to get over the difficulties

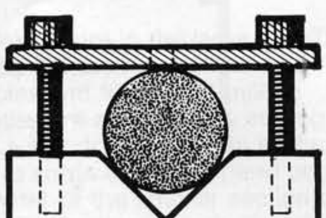
A permanent type of jig is far and away the best idea and will quickly repay the time spent making it. A home-made vee block with a plate in which a central hole has been drilled and which clamps on the block is useful and quick to use. The making of it depends to a large extent on the equipment available and the skill of the operator. If the hole in the top plate does not line up accurately with the bottom of the vee then the work will not be accurate either.

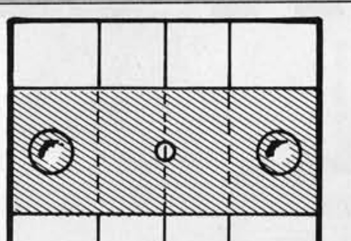
A simple cross-drilling jig that can easily be made by anyone is shown in the sketches. It consists of three parallel bars pivoted on two runners. These can be any size depending on the work to be undertaken. For average work I would suggest the runners are from half-inch (12mm) square mild steel and the cross bars from $^3/_8 \times ^3/_{16}$ in (10x3mm) mild steel bars. The measurements for drilling the cross bars will have to be accurate but they only need doing once, so a little time taken in getting things right will repay itself a hundredfold.

In use, the device is simply put in the machine vice with the work between the runners and, as the pivots allow the jig to close, so the centre hole will be exactly over the centre of the work. It can also be used for drilling flat or square bar accurately, of course. The vice jaws will ensure that the jig is parallel. Another use for this little jig is to make up a scriber point to fit the drilling hole and, if the need arises, to scribe a line centrally along a metal bar.

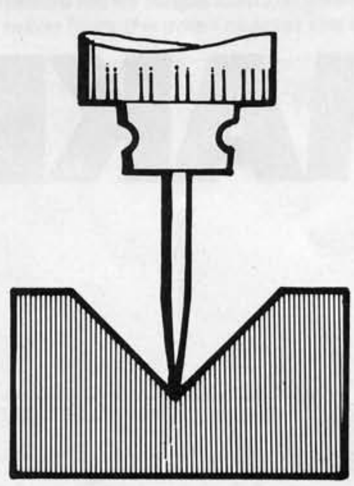


This drilling guide and machine vice method can be used when the bar to be drilled is too large to be set in a vee-block.



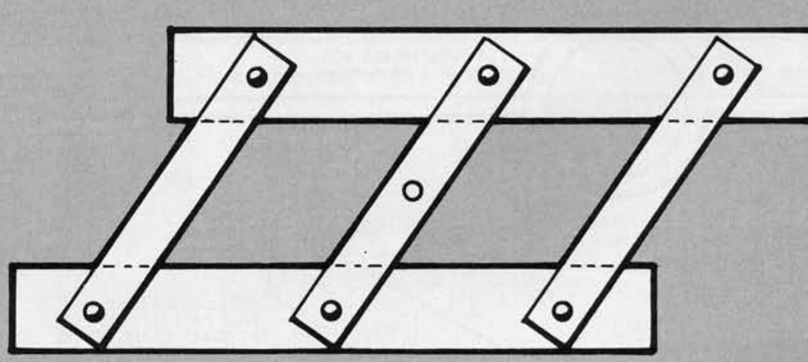


This type of permanent adjustable jig will quickly repay the time spent making it, but it is essential that the hole in the top plate lines up perfectly with the centre of the vee block – if it does not the jig will be useless.



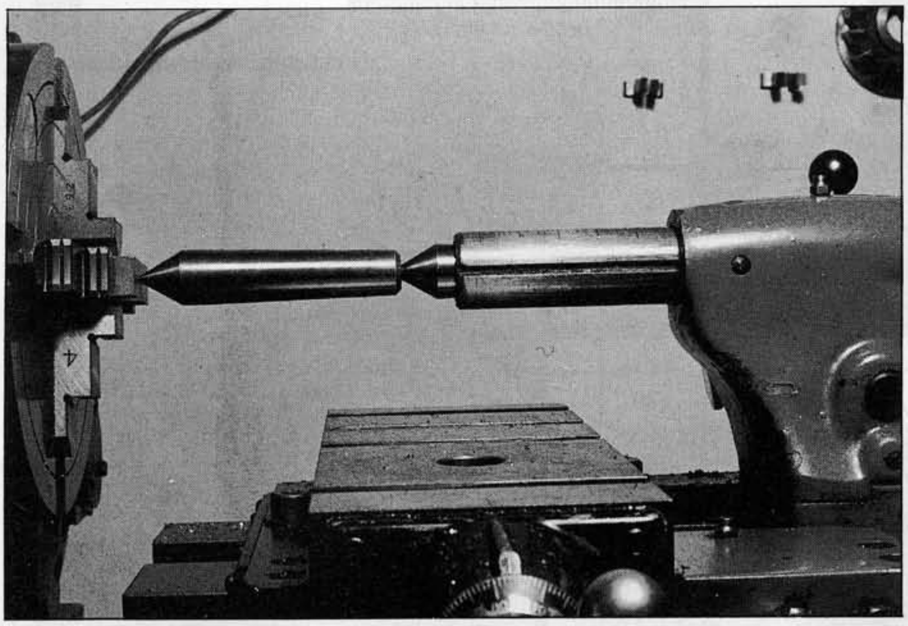
If a jig is not used, a simple method is to hold a centre in the chuck of your drilling machine and line it up with the centre of a clamped vee block.

This kind of jig can be used for drilling flat and square bars as well as round. For normal work, $\frac{1}{2}$ in square bars for the runners and $\frac{3}{8}$ in × $\frac{3}{16}$ in mild steel for the cross bars is ideal, but, again, great care must be taken over the centre hole measurements.



MAKE A CENTRE FINDER

This centre finder project should make life easier – and is very simple to construct



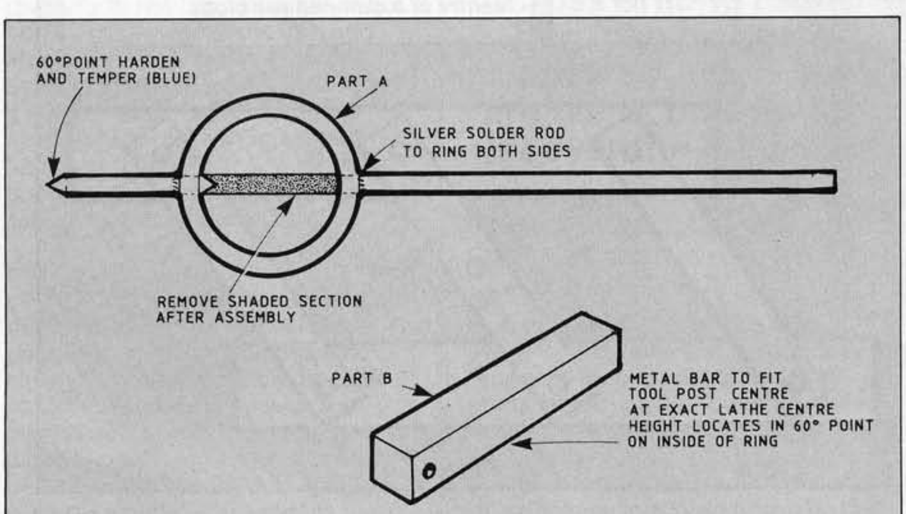
Centre finding can be done by suspending a lathe centre in between the work and another lathe centre held in the tailstock. A clock gauge on the broad part of the centre, nearest the mandrel, can be used to measure the accuracy.

In order to set up work (other than round bar) accurately in the lathe for drilling or boring, we need some form of guide. The centre of the bore is marked out and using such a gúide in conjunction with a clock gauge or similar device the lathe is rotated by hand and adjustments made until the hole will be true when drilled or bored.

A simple way to do this is to mount one of the lathe centres with the point in the centre mark of the hole. Put another centre in the lathe tailstock with its point in the centre of the first one. We now have the first lathe centre suspended between tailstock and work and, with a clock gauge or other indicator on the broad part of the centre nearest the lathe mandrel, the accuracy can be measured.

There is nothing at all wrong with the above method but it may not always be convenient to use the two centres. A proper centre-finder will make life a lot easier and such a tool is very simple to make. There are two types of centre finder. One is supported between the tailstock and the work and any deviation measured as near the work as possible, as we have done with the two centre method. The other type is mounted in the tool post and consists of a long bar but is not connected in any way to the tailstock. By using the end furthest away from the work for measurement the error can be exaggerated by any multiple that might occur with the length of the bar. This, of course, can give a highly accurate set-up to tenths of a thousandth of an inch.

To make a simple version of the first type we need two lengths of round bar, one of a smaller diameter

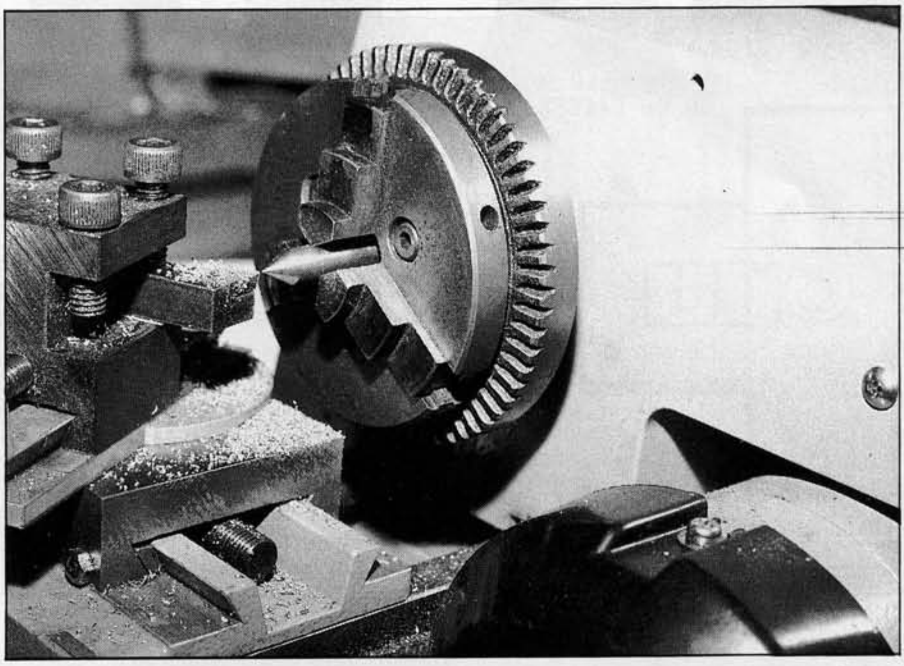


Left: assembly drawing for the centre finder and (right) the assembled tool.

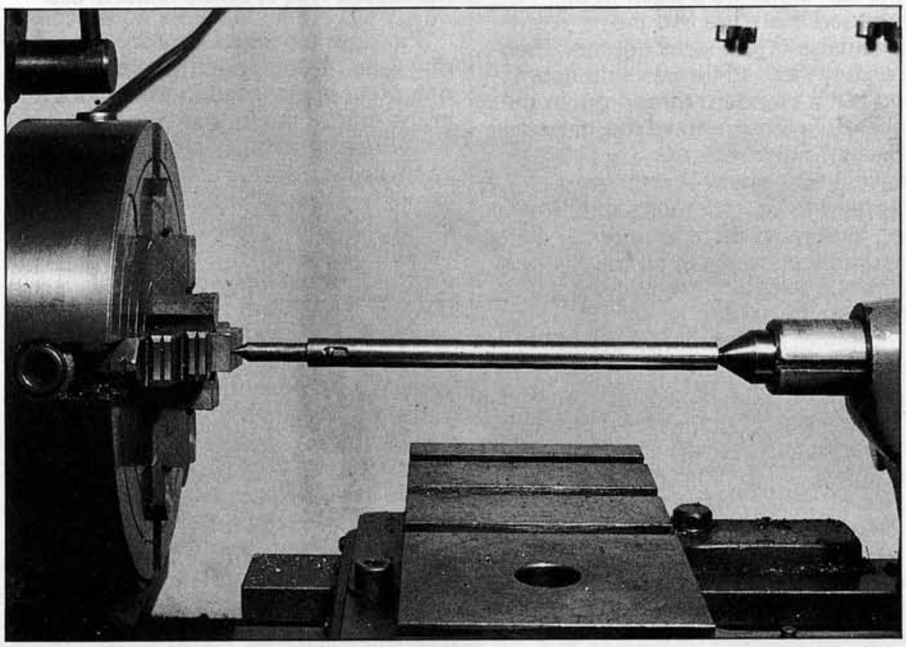
than the other. The smaller one should be silver steel and the other mild steel. The actual diameters will, to a large extent, depend on the size of lathe for which the device is being made but a good general rule would be for a $\frac{1}{4}$ inch (6mm) diameter bar for the point and a $\frac{3}{8}$ inch (10mm) bar for the tailstock end. The length of each will depend again on the distance between centres of the individual lathe but the finished tool should be long enough to allow it to be mounted between work and tailstock, whilst giving clearance for the clock gauge to be put in between the chuck and toolpost.

Set the top slide over to thirty degrees and turn a sixty degree point on the smaller bar. This, being made of silver steel, can later be hardened and tempered to a dark blue colour so that it will wear better. Face the other end square. Take the larger bar and, after facing both ends, put a centre drill in one end to obtain a centre about half the depth of the centre drill. Turn the bar round and centre drill and drill it to accept the smaller bar, so that the smaller one will be a good sliding fit for a minimum of $1\frac{1}{2}$ inches (35mm). Flatten the end of the hole with a D bit.

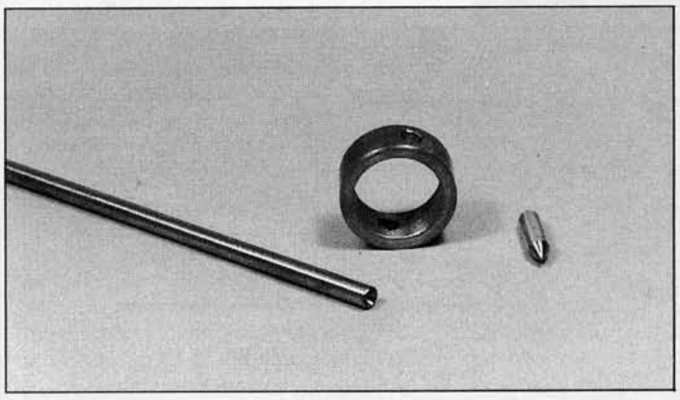
Make a slot in the large bar. This can be done either by drilling a row of holes and filing or, if milling facilities are available, by cutting it with a slot drill. The width of the slot will, to some extent, depend on the diameter of the smaller section but $\frac{3}{32}$ inch (2mm) or $\frac{1}{8}$ inch (3mm) are ideal sizes. Drill a small hole in the pointed piece as shown in the drawings and make up a peg to fit it.

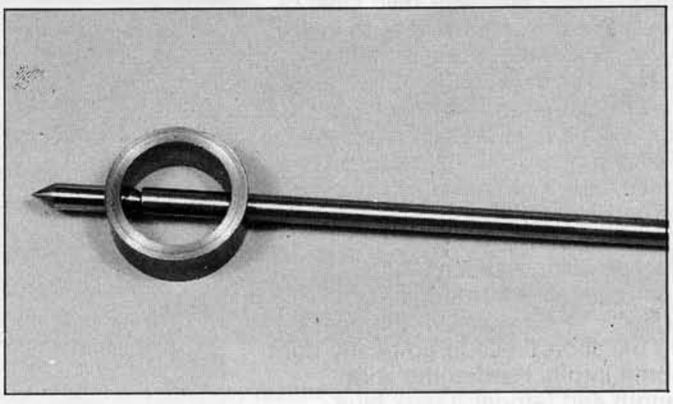


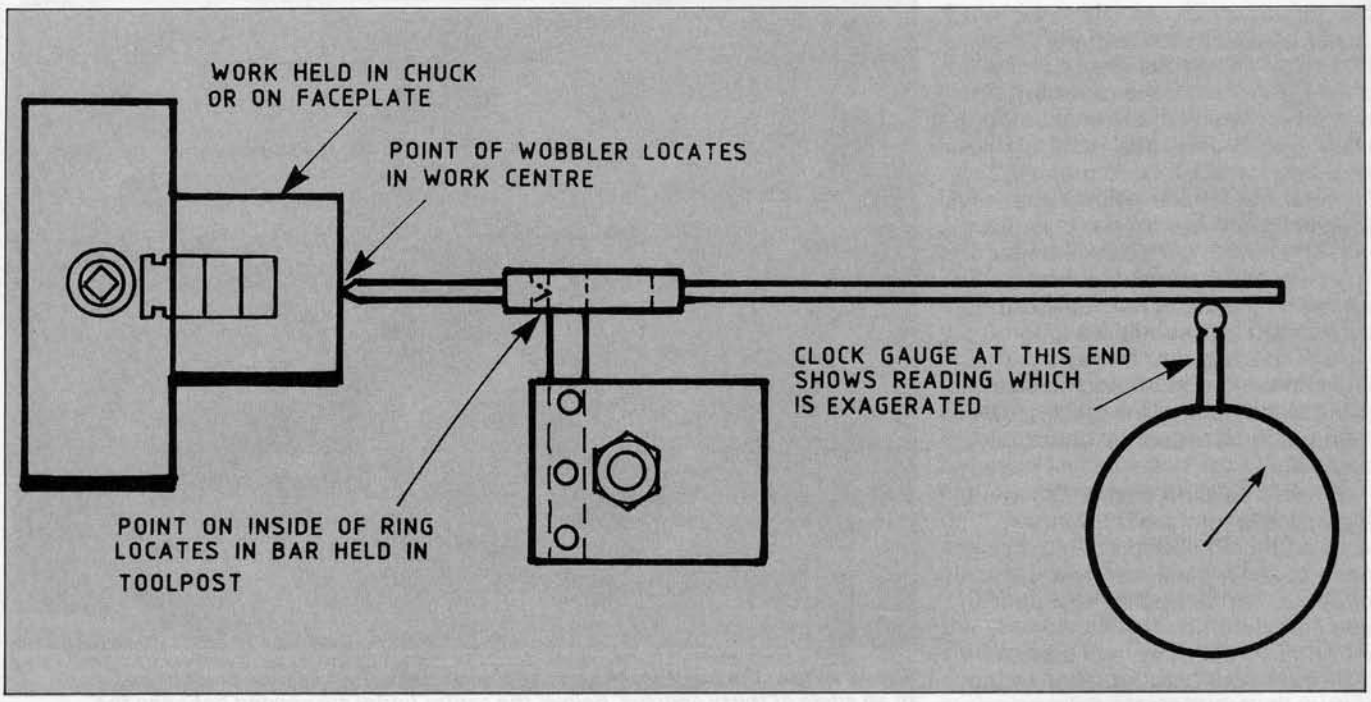
Above: to turn the point for the centre finder, the lathe top slide must be set over to an angle of thirty degrees. Below: the centre finder suspended between the work and the tailstock. Measurement is taken from the point nearest the chuck.



Below: the parts for the centre finder and (right) the assembled tool. All that is needed now is for the portion of the larger piece within the ring to be removed, and the centre finder is ready for use.







The second type of centre finder in use.

This can either be a push-fit or threaded. Here we see the advantage of the sizes quoted. They are easy sizes to turn an end down and put a standard thread on. In the case of $^3/_{32}$ (2mm) make the thread 8BA or 1.5mm. For the $^1/_8$th (3mm) make it 6BA 2mm. Do not be tempted to use an adhesive to fit the peg as it must be fitted after assembly and almost certainly the adhesive will stick the two parts together as well.

The tool is assembled with a spring inside the bore, and almost any suitably sized spring will do for this. The peg is then screwed or pushed into place and the tool is complete. The spring action allows it to be fitted easily between work and tailstock.

The second type of 'wobbler' or centre-finder is also easy to make, and a particularly simple version is described. Cross-drill a piece of 1 inch (25mm) diameter mild steel or brass bar making a hole $^3/_{16}$th inch (4mm) diameter. Put it in the lathe and drill or bore a hole $^5/_8$ inch or 15mm diameter. We now have a ring with a hole drilled across it. Select a nice straight piece of silver steel $^3/_{16}$ths inch (4mm) diameter. Cut off a length of about $^3/_4$inch (20mm) and turn a sixty degree point on each end. Put a centre in the other length far enough to allow one of the points on the short piece to go nearly right home into it. Harden the short length and temper it dark blue.

Put both pieces of steel in the ring, one through each side so that one point is recessed in the centre in the end of the longer piece. Silver solder them both in position. Next, cut away the section of the longer bar that protrudes through the ring as shown on the drawing. The result should be a ring with two ends protruding, both of which are exactly in line with each other.

A piece of square mild steel bar is placed in the tool post and a centre in the lathe chuck, the tool post being wound in so that the centre will recess into the bar in the tool post. This will be the setting-up piece. In use, this is set in the tool post and lined up with the lathe centre. The tool can then be used supporting the short end between the setting bar and the centre mark in the work. A clock gauge is put on the end of the longer section and any variation in the accuracy of the setting will be multiplied by the length of the long bar against the shorter end. For example, if the two points on the short end are 2 inches (50mm) apart and the end on the long bar six inches (150mm) from there, then the error will be multiplied three times.

It can be seen that the second method is very accurate but it is somewhat fiddly to use. The first method can be used for most normal situations but where absolute precision is required it is worth the extra setting-up time involved in using the second method. Both tools are very easy to make and will quickly repay the work involved.

Construction details for the spring-loaded centre finder.