No 5

World of MODEL ENGINEERING

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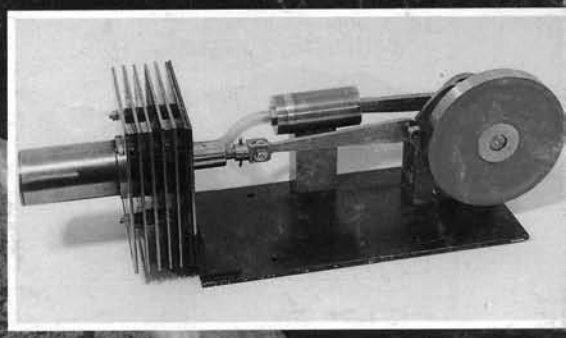
- SMALL TOOLS FOR THE WORKSHOP
- A HERO'S ENGINE FROM SCRAP
- AN EASY HOT AIR ENGINE
- WORKSHOP VISITS AND EXPERT TIPS
- COMPREHENSIVE SUPPLIERS LISTING
- PULLOUT WORKSHOP WALL CHART



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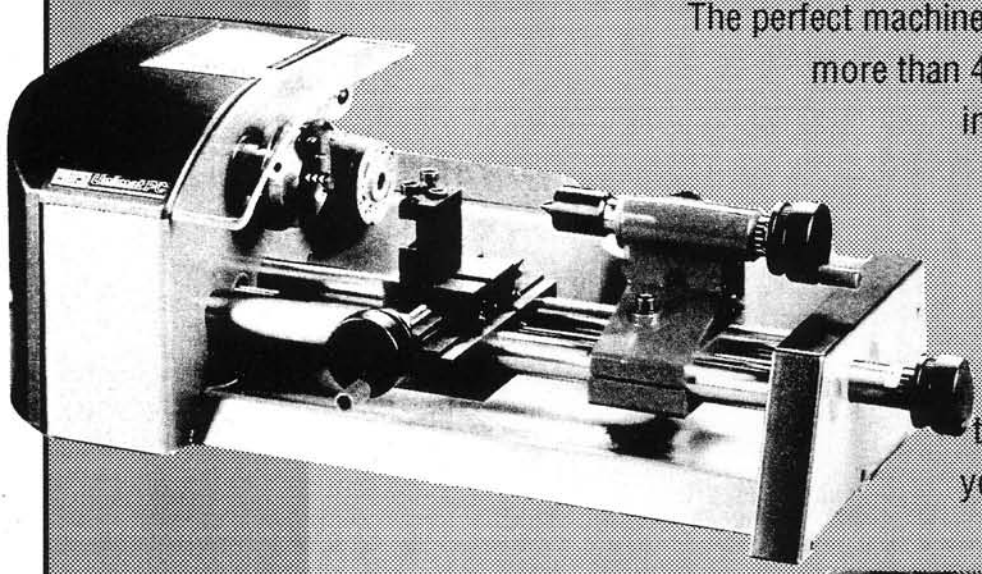

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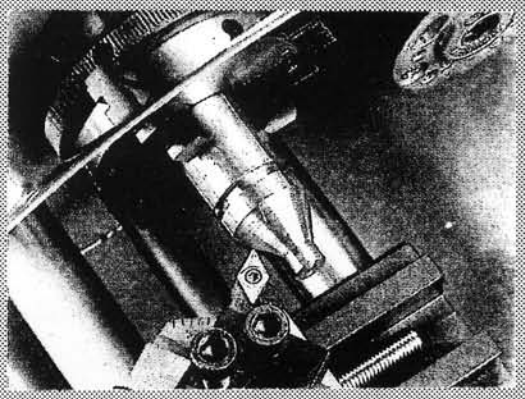
SWING OVER CROSS-SLIDE	56mm
SPINDLE BORE	10.1mm
SPEED RANGE	130-2200rpm
NUMBER OF SPEEDS	6



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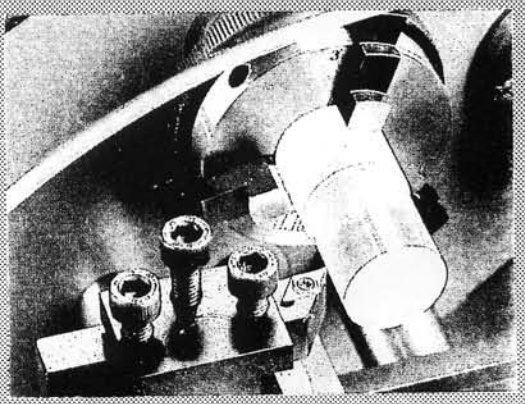

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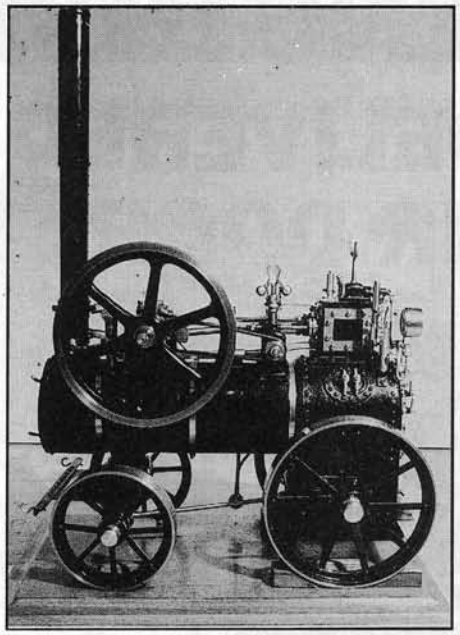

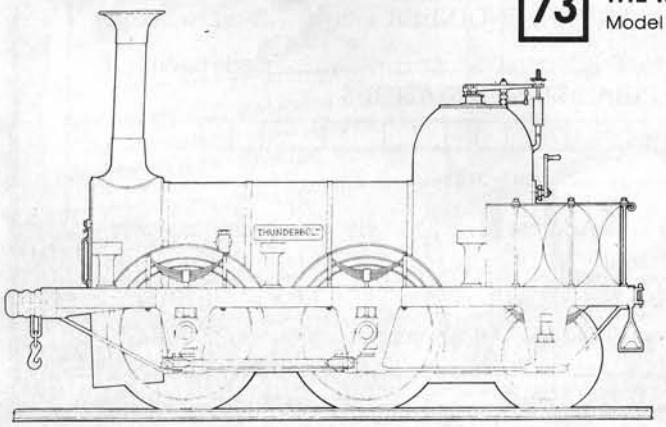

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AN ARGUS SPECIALIST PUBLICATION

World of MODEL ENGINEERING

Since the last issue of *World of Model Engineering* was published in 1990 there have been many requests for another. It is indeed gratifying to know that it has, in the past, proved so popular and is to be hoped that this issue too will supply something of interest to all readers.

As in the past we have a general mix of subjects relating to the hobby which in itself is very wide-ranging. Some are covered in an explanatory form to help those who wish to get started in that side of the hobby, others have constructional articles associated with them so that there is something to be made and a good excuse to slide off into the workshop, and possibly get out of the washing-up.

In a single magazine such as this where a very wide range of subjects is to be covered it is not practical to have too many highly detailed constructional items and so, again as in the past, readers will find some, such as the chapter on clocks, where details are given of a construction which the individual can sort out for him or herself without too much difficulty. A similar idea exists in the chapter on tramcars.

There are many drawings and quite a few of these give the measurements of the full-sized artifacts. There is nothing more satisfying than building a model from such a drawing as it becomes entirely individual. With this in mind the opportunity has been taken to include the tables compiled some years ago for us by Dr Mark Phillips giving scale measurements. This time, however, they have been included as part of the wall chart so that they are readily to hand in the workshop as needed, instead of having to thumb through the magazine each time they are referred to.

No *World of Model Engineering* would be complete without we sneak into some unsuspecting person's workshop! Yes, they really usually are unsuspecting, their wives tell tales of how, after receiving a telephone call, there is a rush to get out there and clear up some of the junk!

Before closing I would like to thank all those who kindly wrote after the last issue and, in particular, those who sent photographs of projects they had made from the magazine. It is very rewarding to know that one's work has been so much appreciated. It is my sincere hope that this issue, too, will bring a great deal of enjoyment to all readers.

Stan Bray

OSCILLATING ENGINES

Beginners start here! Oscillating engines are among the easiest of working model engineering subjects, and popular with newcomers to the hobby as a result . . .

Without doubt the easiest model steam engine to make is the oscillating engine. It is an ideal project for a beginner, it is useful as a power plant for model boats, it is cheap to build, fascinating to watch in action and, in fact, can generally be built from any scrap material that happens to be to hand in the workshop. The basic form which is known so well to modellers is not actually the way such an engine was used in full-size as then the oscillating action would often be used to drive a slide valve — or if not the valve would be separate from the cylinders.

Single cylinder single acting engines

Just for now let us think about the simple basic engine and see what is required to make one. It will consist of a cylinder sliding on a port face, which more often than not will double as the frame which supports the engine. One hole in the cylinder is designed to match two holes in the port face, one of these is connected to live steam and the other to exhaust. The cylinder is pivoted somewhere near the middle and a pivot pin passes through a hole in the frame or port face, being held in contact with a spring. The piston is connected to a simple crank and, as the crank rotates, the cylinder oscillates and the single port alternately matches up with the live steam and exhaust. Depending which side is which will decide the rotation of the engine.

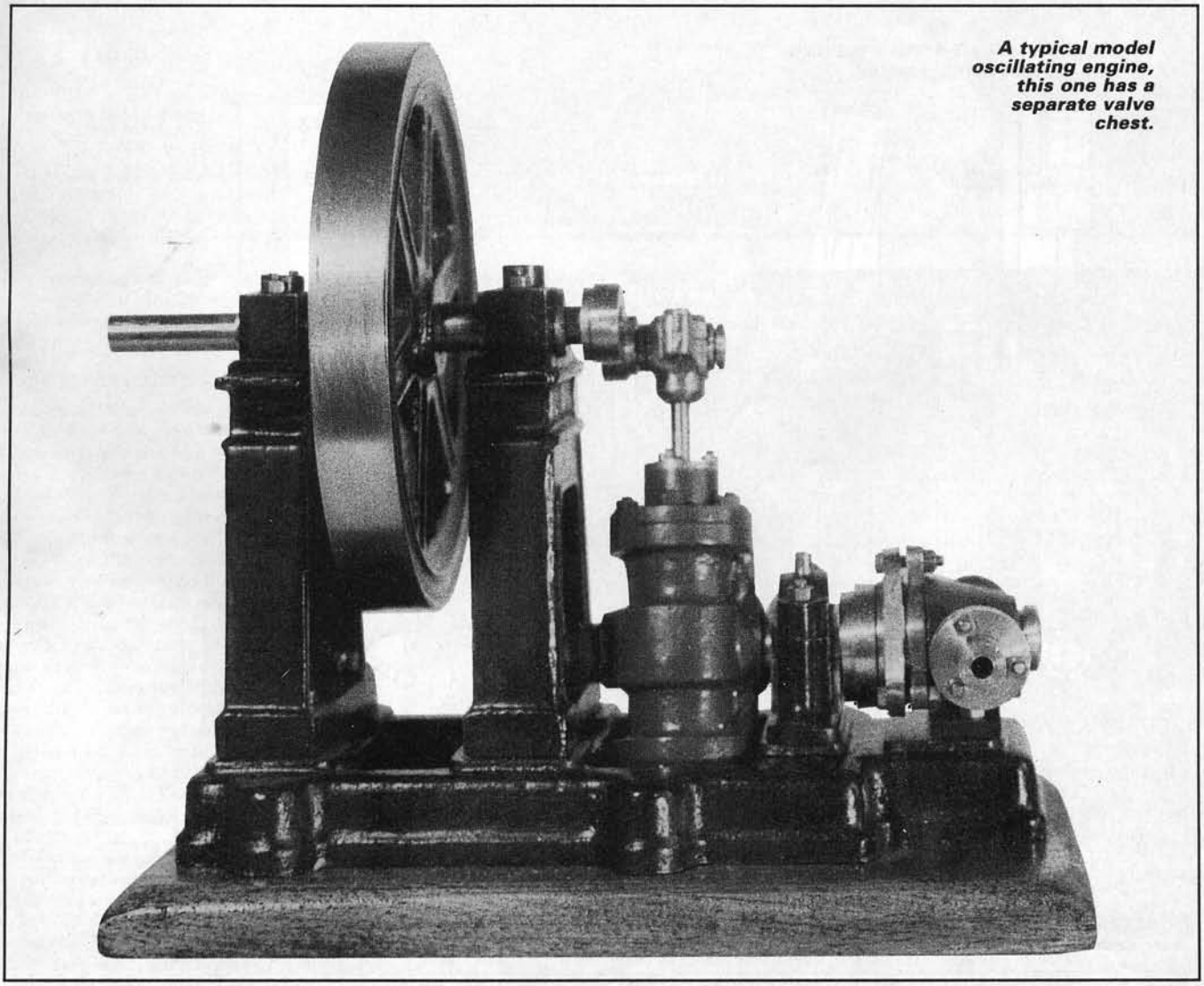
Making it self-starting

If there is a snag it is that a simple single cylinder engine like this will almost certainly stop on top or bottom dead centre and so will not start again unless nudged. A flywheel is fitted to keep rotation going but this does not help when it stops. Nasty habits should, where possible, be cured and if we put a light spring on the cylinder and take it to somewhere on the frame. This will pull the cylinder sideways as the engine stops and it will not be on top or bottom dead centre and will thus be self-starting.

Single cylinder double-acting engines

From our simple single cylinder, single acting engine it is possible to progress to a single cylinder double acting type. We just need another hole in the other end of the cylinder, which must now be sealed, and two more holes in the port face. We now get to the position where, as the piston reaches the bottom of the stroke, live steam will enter and push it back up — in theory at least — giving double the power.

In the case of twin cylinder engines the cranks are set at ninety degrees and this



A typical model oscillating engine, this one has a separate valve chest.

means the engine should be self-starting. In fact it should not even need a flywheel to keep it running.

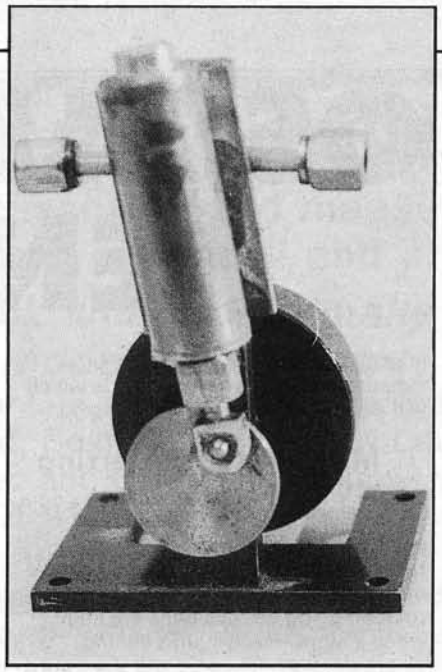
Multi-cylinder engines

Further progression will take us to multi-cylinder engines and these can be built in various forms depending on the interests of the constructor. The basic principles remain the same for each cylinder but, whilst we use a spring attachment to keep the cylinder assembly on its port face for the simple engine, it may be necessary to devise some other means of so doing on some multi-cylinder types.

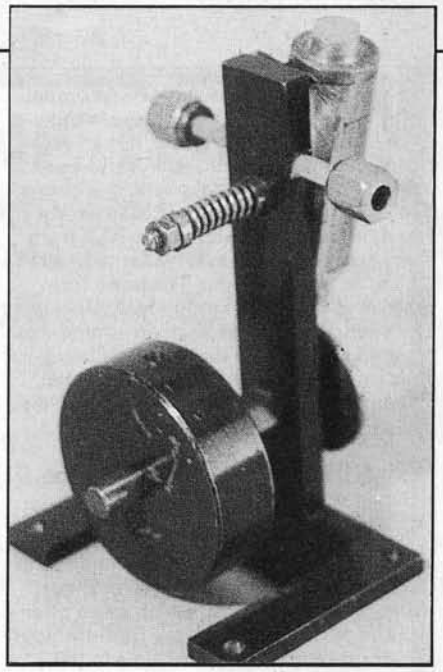
Materials

The cylinders can be made from brass or bronze. A common way is to make a round cylinder and sweat it to a backplate, the alternative being generally to use square bar, which whilst quite efficient does not look as good as it might. When using round cylinders the temptation is to use a piece of tubing rather than bore out round bar. This is all very well but tubing as bought is most certainly not smooth in the bore and so if used without machining will cause indifferent running of the engine.

Therefore if tubing is used it must be machined along the bore. Frequently the port face and frame is a piece of brass and



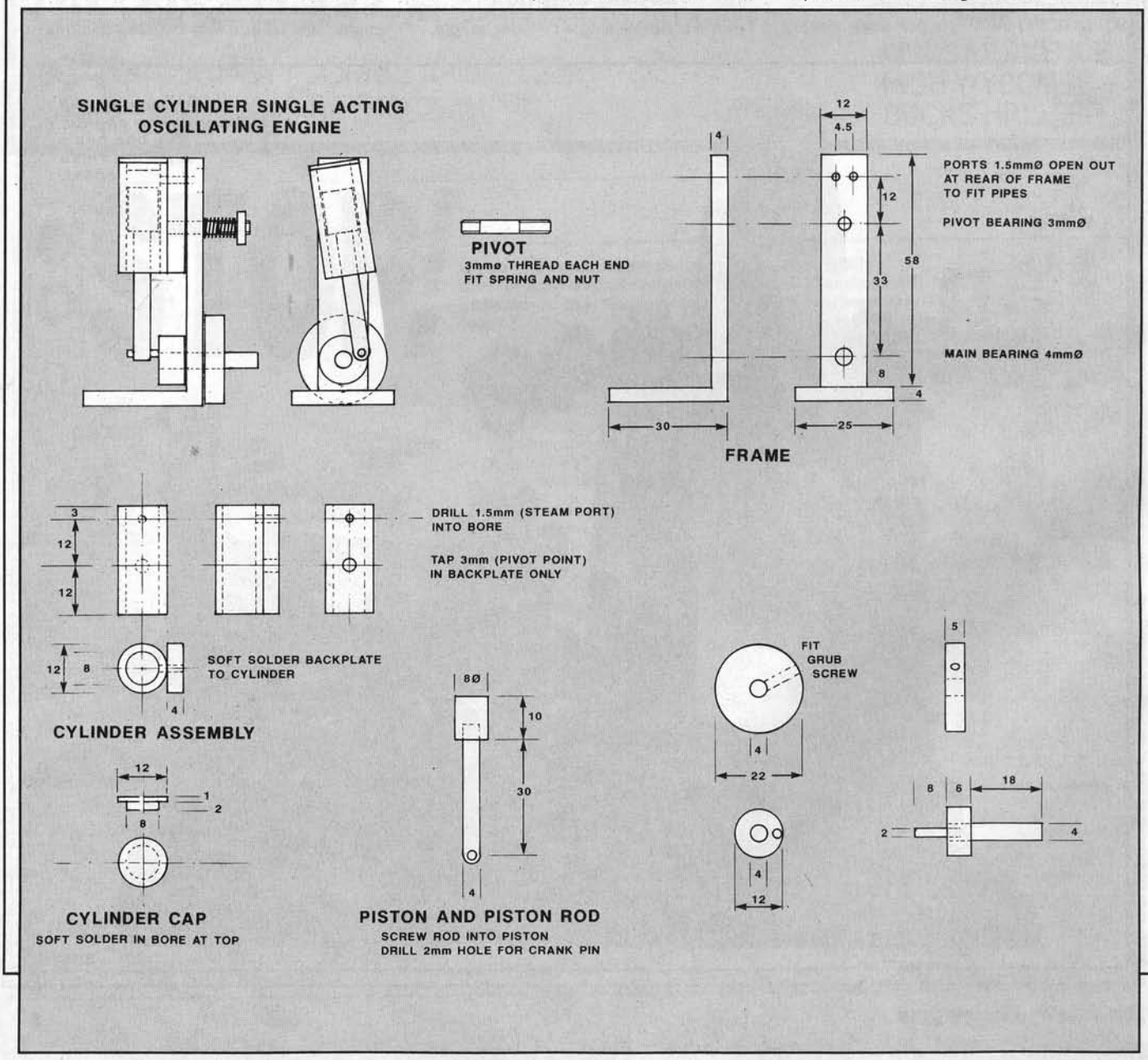
A single cylinder double acting engine seen from the front. The steam pipes have been brought from the sides of the frame.

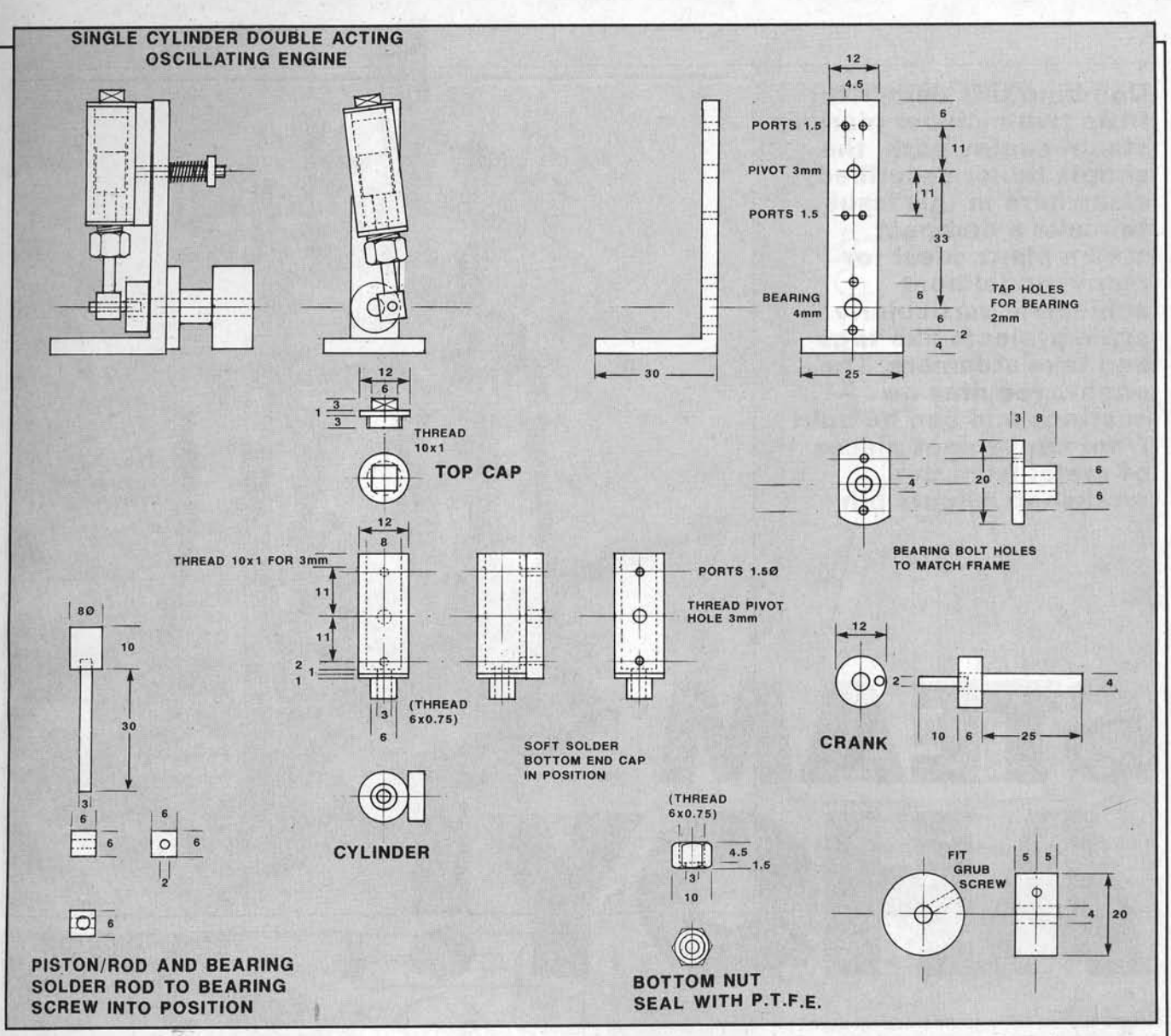


A rear view of the same double acting engine; note spring tensioner clearly visible in this photo.

there is little wrong with that. Steel could be used but there will, after a time, be some corrosion and stainless steel would be better. The piston and piston rod should, where possible, be stainless steel.

Certainly the rod must be but the piston could be brass or bronze and screwed to the rod. The crank and crankpin can be of mild steel as can the crankshaft and flywheel. The bearing that fits on the





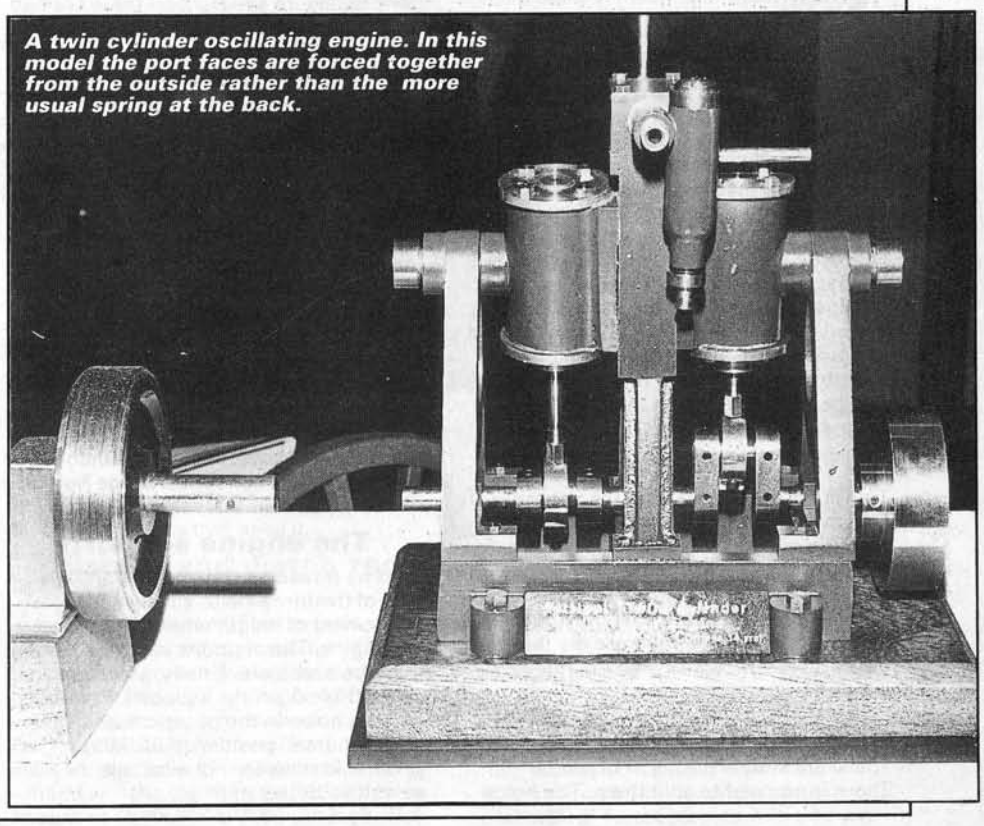
crankpin can be a piece of bronze screwed on to the piston rod. On really simple engines it may just be a hole drilled in the rod itself.

Measurements

Sizes are of little importance, the only critical factor being the distance between the two holes in the port face, or the two holes at each end with a double acting engine. This is gained by drawing a line between the crank throw at ninety degrees, through the pivot to the position where the ports are to be placed. The crank is then rotated so that it is ninety degrees the other way and this will give the position of the second hole.

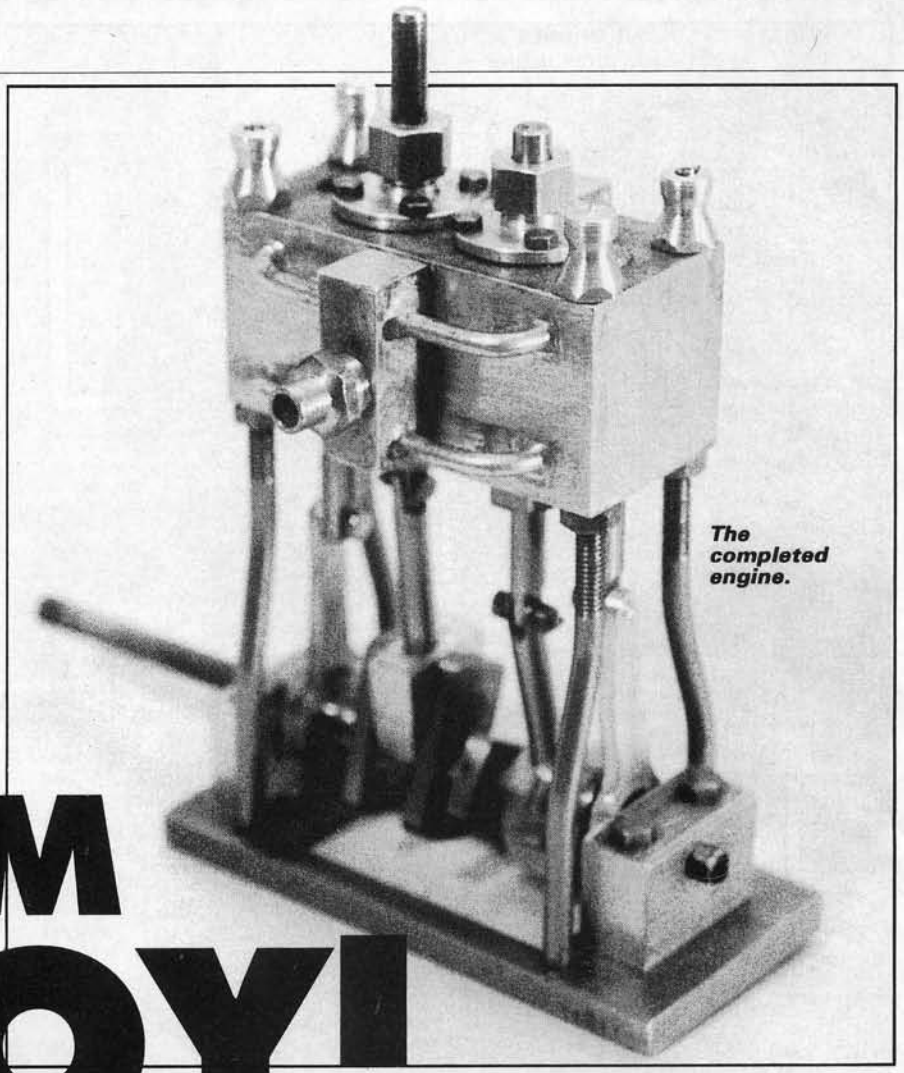
The aim should be to get these holes no more than the distance of one diameter apart (if the holes are 3mm diameter then there should be 3mm between the edges of each or 6mm between centres) in order to get an easy-starting engine. If the distance works out rather further than that, small countersinks will help matters out allowing earlier entry of steam and exit of exhaust.

There are many other ways to improve the performance of such engines but it would take a whole book to describe them. Sufficient to say: try making a few engines and experiment with them. You will be surprised at the fun you can have.



A twin cylinder oscillating engine. In this model the port faces are forced together from the outside rather than the more usual spring at the back.

Combine this delightful little two-cylinder marine steam engine with the simple boiler described elsewhere in this issue to make a compact steam plant, ideal for many model boat subjects – particularly scale projects like tugs and lake steamers. The engine requires no castings and can be built from convenient pieces of metal from the workshop offcuts bin



The completed engine.

STEAM AHOY!

This is a fairly easily made model of a two cylinder steam engine. It has been designed primarily for use in a boat which is one of the range marketed by Deans Marine, the pre-formed hull of which can be make into a variety of models and this engine is suitable for them all.

It is basically a piston valve engine but the whole of the valves are not used, steam passing right through passages instead. This results in a remarkably economical engine. It is double-acting but the need for slide bars has been avoided by fitting a piston rod that passes through the cylinder and is thus supported top and bottom. The result is a fascinating model to watch as both piston rods and valves can be seen working on the top of the engine.

Cylinder block

This is a simple piece of brass or bronze 3/4 in. square. Care must be taken when marking out and it is as well to make a start with the cylinder and valve holes. These should be machined on the lathe to ensure they are square. The only other holes needed at this point are the four in the corners which take the engine supports.

The bearings

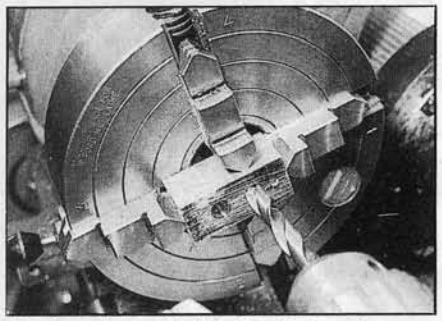
These are simple pieces of brass bar. There is no need to split them. The holes for the crankshaft should be bored on the lathe to ensure squareness; there are two holes in each for bolting to the base plate. These are best drilled tapping size and then opened out to clearance later on.

The base

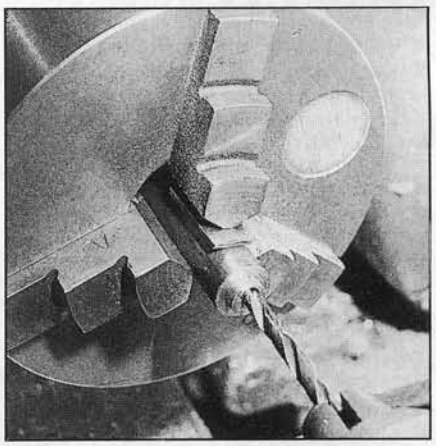
A piece of 1/8th in. mild steel suffices for this and a rectangular hole is cut to clear the big end bearings as the engine rotates. Four holes are needed for the engine supports and any bolt holes to hold the engine down that the builder may wish. Finally, stick the main bearings in place with super glue and then spot through them ready to drill and tap for securing them in position. The bearings will come off with a smart sideways tap and whether or not this is done at once or left until the holes have been drilled through is a matter of choice. When the bearings have been removed the holes can be tapped for the holding bolts.

The engine supports

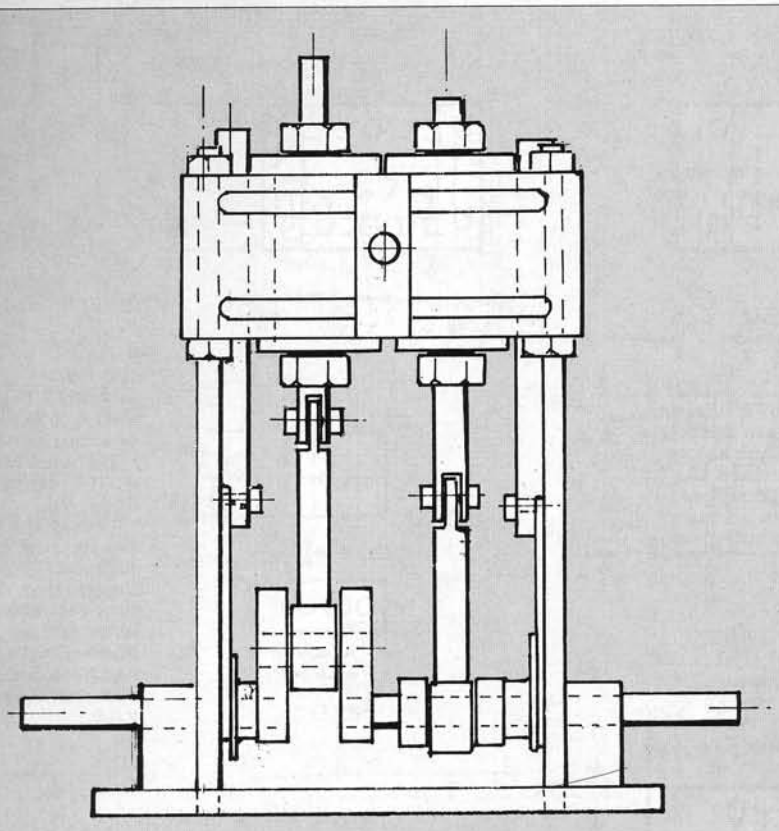
Start by threading the top portion. The idea of the thread is to allow some adjustment of height when assembling the engine. The supports can then be bent to fit the baseplate. Finally, assemble the cylinder block on the supports. Put them into the holes in the baseplate and silver solder them in position. If facilities for silver soldering are not available they can be soft soldered.

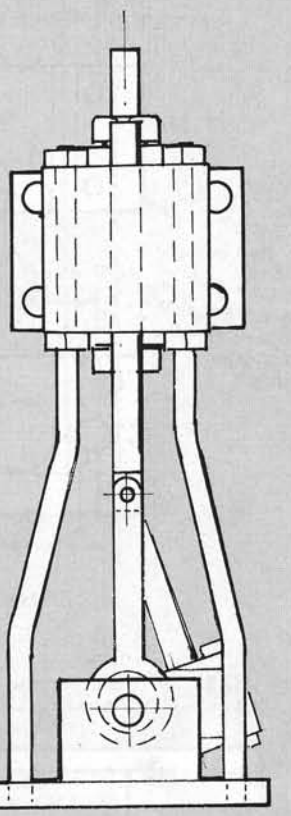


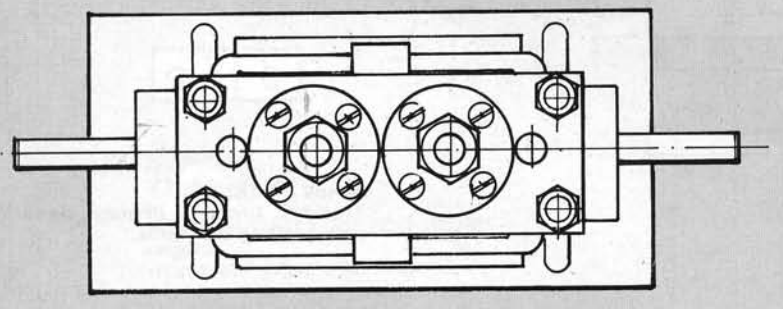
Boring the cylinder block for the marine steam engine.



To machine the eccentric, put a piece of 1\16" sheet steel in one chuck jaw.







GENERAL ARRANGEMENT DRAWING
Engine is double-acting and has been designed for use with many of the Deans Marine kits. However, it is suitable for powering scores of scale subjects from about 25" to 40" overall length.

The ones shown were held temporarily with screws whilst adjustments were made, the screws being sawn off and filed flush after. This is a good way of ensuring they remain in the correct position when heated up for soldering, although originally it was only done as a means of experimenting with the amount of bend required.

The crankshaft

This was fabricated from mild steel strip and rod. Drill the holes in the strip, ensuring they are in line. Use one as a jig to drill a piece of angle and then transfer the holes to another piece of angle. Pass rods through the holes in the strip — there will be three pieces required. This is then put in the holes in the angle and will hold the shaft rigid while the pieces are silver soldered in to place. Use 1/4 in. wide strip to get the spacings right. Saw of the pieces not required and clean up the shaft.

Big ends

These are split bearings. Soft solder two lengths of brass strip together. Mark the position of the bearing holes and the holes used later for bolting the parts together, as well as the one to take the connecting rod. Drill all the holes, remembering that some will be clearance size and some tapped when they come to be bolted together. Saw off the two lengths required, heat up to separate the parts, clean up with a file and tap the parts that need it.

Pistons and piston rods

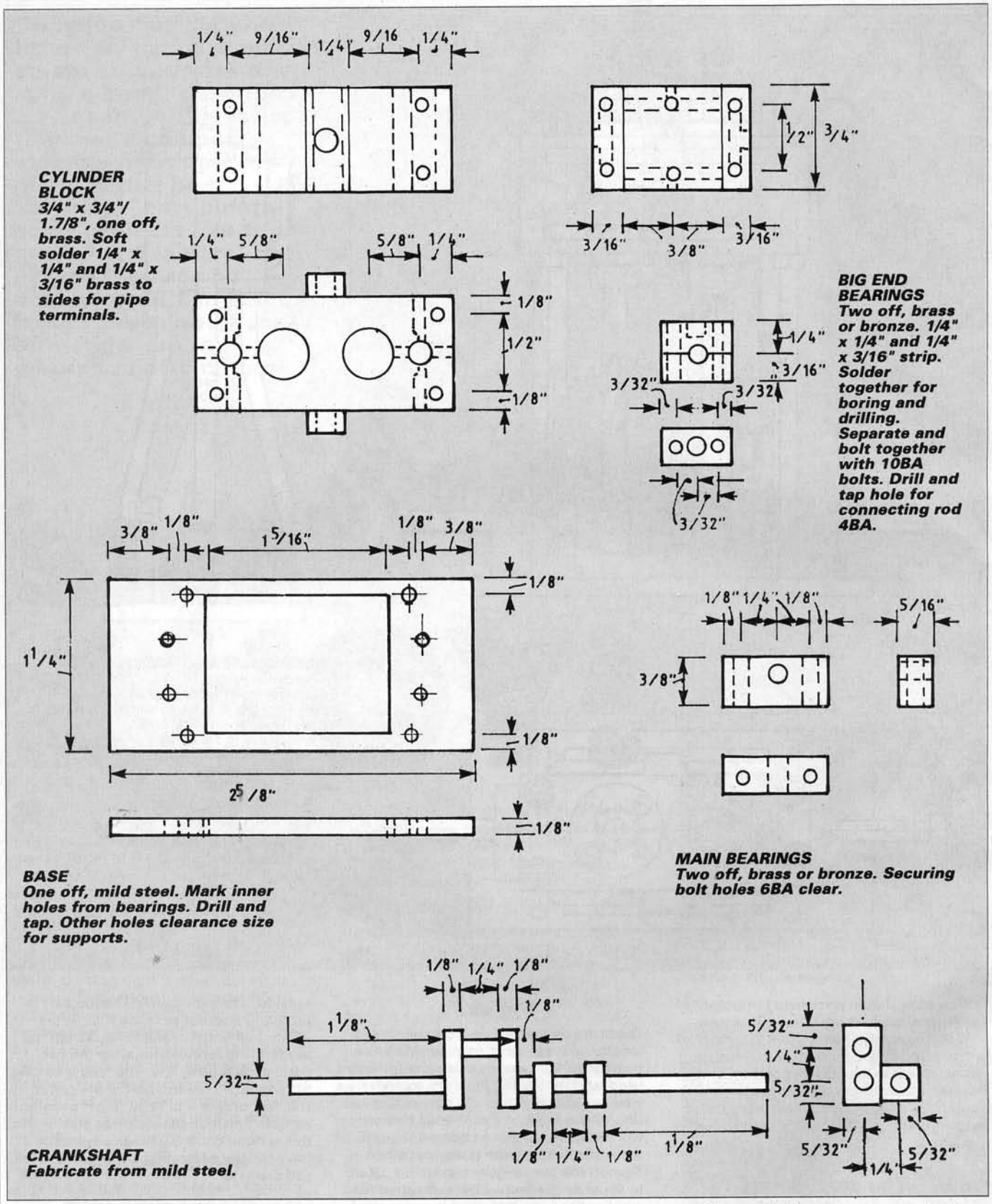
Here we start to get into a more unorthodox method of construction. The piston is machined to the correct diameter and a small groove put in it to accept soft packing. It is drilled and tapped 5BA half its length, then turned round and tapped 4BA for the rest. The piston rod is in two bits. The bottom is filed to a fork and cross drilled and the top drilled 1/16th in. for a length of about a quarter of an inch. The outside is threaded 4BA. The top part is turned to a spigot to fit the hole in the lower half and threaded 5BA. When the assembly is screwed together the two parts should be in line. The idea is to save turning down the top part of the piston rod. Not only is it difficult to get a really smooth finish on the stainless steel when this is done but it is also an advantage to have the larger bearing surface of the full rod diameter.

Connecting rods

This is a straightforward threading job at one end and a filing and drilling job at the other. The flat for the fork should be a nice free fit, whilst at the same time trying to avoid any sideways movement.

Eccentrics and straps

The eccentric is fairly easy. Put a piece of mild steel rod in the three jaw chuck leaving about three quarters of an inch protruding. Turn a step on it to take the



CYLINDER BLOCK
3/4" x 3/4"/ 1.7/8", one off, brass. Soft solder 1/4" x 1/4" and 1/4" x 3/16" brass to sides for pipe terminals.

BIG END BEARINGS
Two off, brass or bronze. 1/4" x 1/4" and 1/4" x 3/16" strip. Solder together for boring and drilling. Separate and bolt together with 10BA bolts. Drill and tap hole for connecting rod 4BA.

BASE
One off, mild steel. Mark inner holes from bearings. Drill and tap. Other holes clearance size for supports.

MAIN BEARINGS
Two off, brass or bronze. Securing bolt holes 6BA clear.

CRANKSHAFT
Fabricate from mild steel.

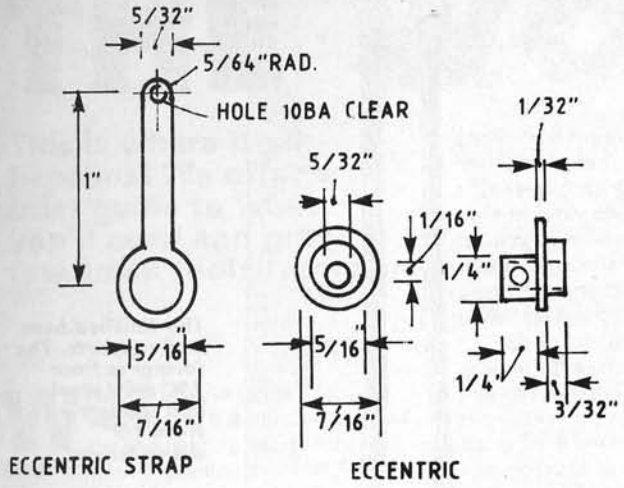
strap. Still using the three jaw chuck, put a piece of 1/16th in. mild steel strip in one jaw and centre drill and drill through sufficiently for the hole to pass right through when the job is complete.

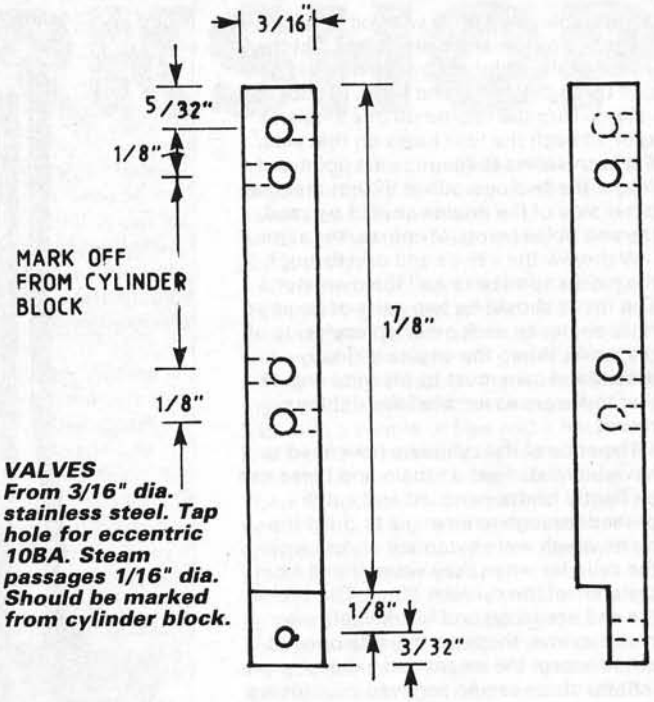
Use a parting tool or something similar to turn down the portion that will accept the grub screw and then part off. The first few cuts with the parting tool will be intermittent and care must be taken. Fortunately, when the tool reaches the hole, the work will be running true to the tool tip and so there is no real danger of it catching. The final job it to drill and tap for a grub screw.

The strap is made of brass or bronze and can either be filed to shape or made in two parts by drilling and parting off a piece of rod and then silver soldering a strip to it. Either way will work.

The valves

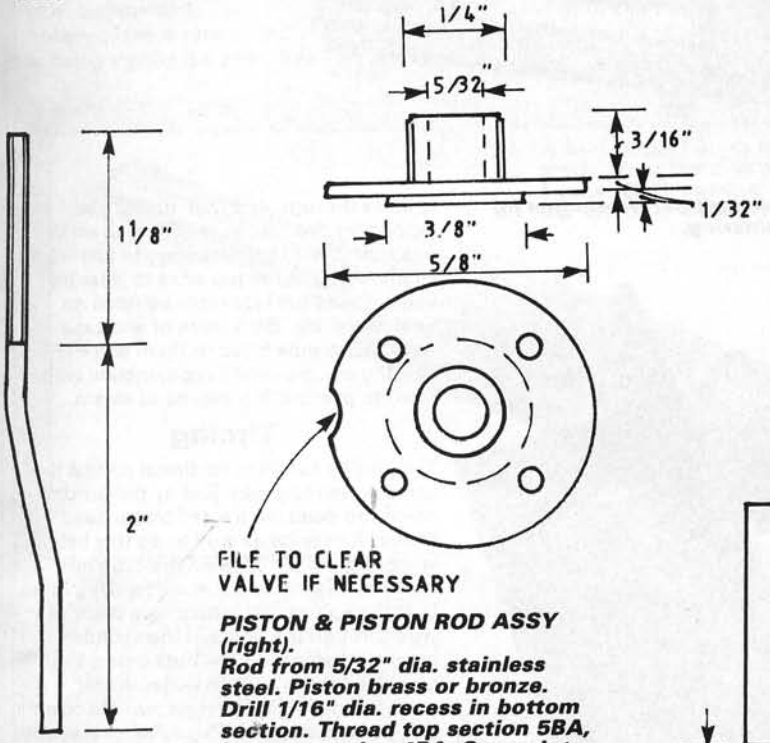
The first part of making the valves is easy enough. Simply part off a length of stainless steel, file a flat on one end and then drill through to match the eccentric strap. Before going any further it will be necessary to drill the cylinder block. Start by drilling the two holes at each end right through into the valve chamber, and just a fraction further towards but not into the cylinder. Then mark off and drill the four holes at each end on the side of the block. These should be exactly in line with the first holes and should enter the valve chamber.



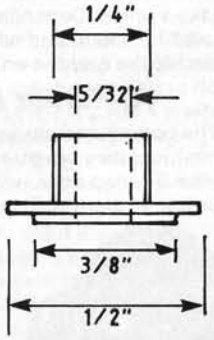


CYLINDER SUPPORTS (below)
Four off. Bend from 1/8" dia. mild steel. Thread 5BA. Silver solder to base.

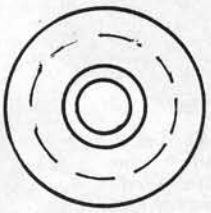
VALVES
From 3/16" dia. stainless steel. Tap hole for eccentric 10BA. Steam passages 1/16" dia. Should be marked from cylinder block.



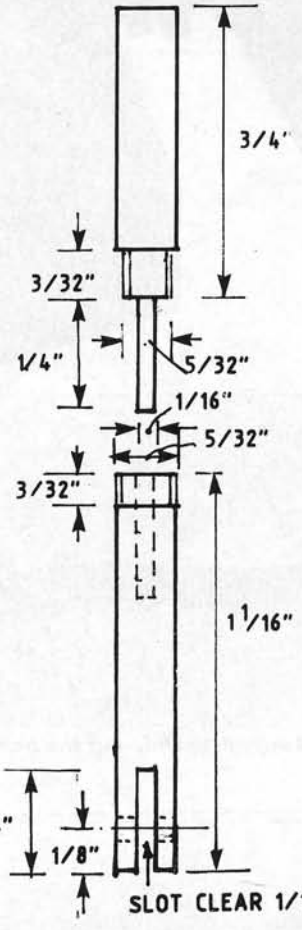
TOP CYLINDER COVERS (left)
From brass. Thread 1/4x40. Fit standard union nut, seal with ptfe. Four bolt holes on 1/2" pcd for 10BA. File recess to clear valve if required.

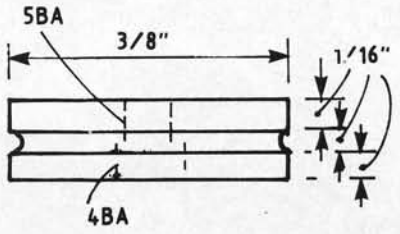


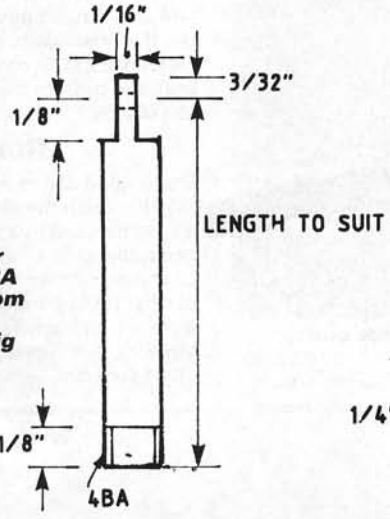
BOTTOM CYLINDER COVERS (right)
From brass.. Thread 1/4x40. Fit standard union and ptfe sealing tape. Solder to cylinder.



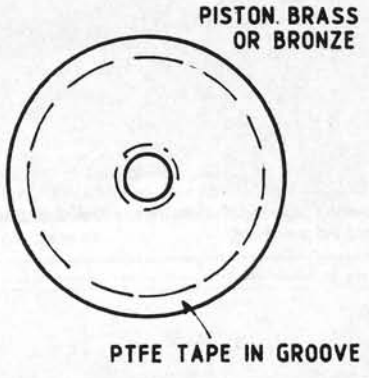
PISTON & PISTON ROD ASSY (right).
Rod from 5/32" dia. stainless steel. Piston brass or bronze. Drill 1/16" dia. recess in bottom section. Thread top section 5BA, bottom section 4BA. Screw into piston and soft solder. Pack piston with ptfe. Slot bottom of con rod.







CON ROD
5/32" dia. stainless steel, pivot to lower piston rod with 10BA screw. Thread bottom end (when length checked) 4BA for big end.

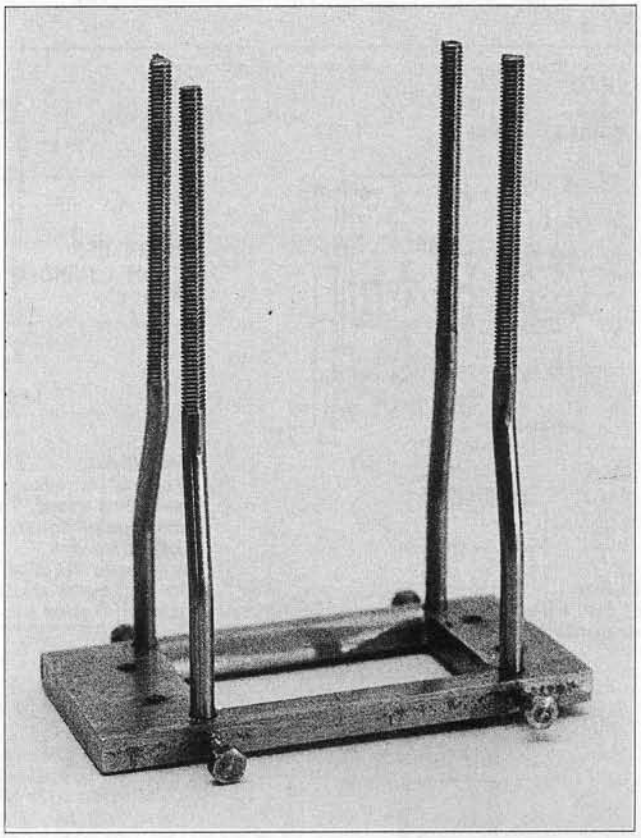


Assemble the engine without at this stage the piston and piston rods. Set the valves at their highest point and pass a drill through all four end holes to spot the valves. Turn the engine on one side and spot through the four holes on that side. Set both valves to their lowest point and repeat the two operations except that the other side of the engine should be used, the end holes being, of course, the same.

Withdraw the valves and drill through the places spotted to half the diameter. The result should be two pairs of holes at right angles to each other on each side of the valve. When the engine is finally assembled care must be taken to ensure that these are assembled the right way round.

The ends of the cylinders now need to have tiny flats filed on them and these can be lightly centre punched and a drill passed through at an angle to meet the holes which were extended on towards the cylinder when they were drilled from the ends of the cylinder block. The four at the end are taped and blanked off with brass screws, those on the side opened out to accept the steam and exhaust pipes.

Brass strips can be screwed or soldered on the sides with suitably placed holes drilled to accept the pipes and passages drilled to pass the steam through the strip to a hole in the centre which is taped to take a union. Depending on which side is used for steam and which for exhaust will decide the way the engine will run.



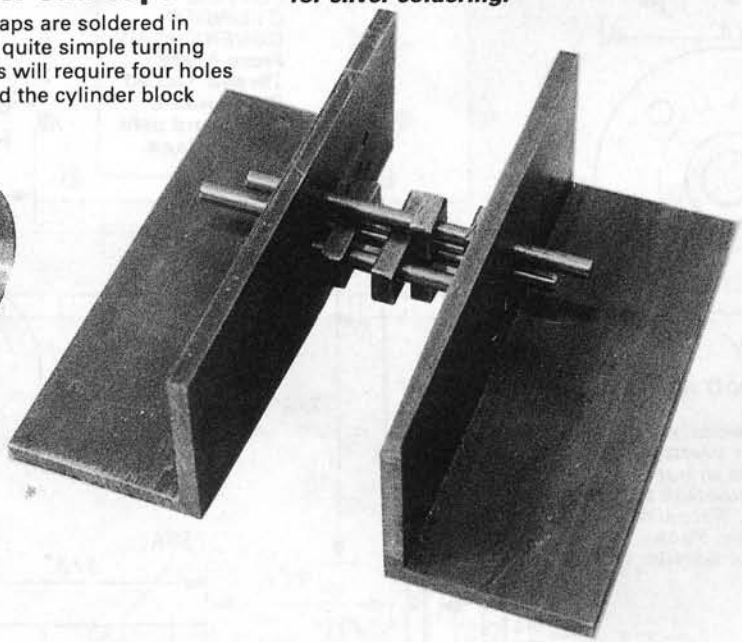
The finished base and supports. The former is from 1/8" mild steel and the latter from 1/8" diameter rod.

Cylinder end caps

The bottom end caps are soldered in position; they are quite simple turning jobs. The top ones will require four holes drilled in them and the cylinder block spotted through and then drilled and tapped for the screws that hold them in position. It may be necessary to just file a slight recess in the top ones to clear the valve. Paper gaskets must be fitted on final assembly. Both pairs of end caps have union nuts fitted to them and PTFE packing can be used in conjunction with them to prevent the escape of steam.

Above, close-up of the finished eccentric.

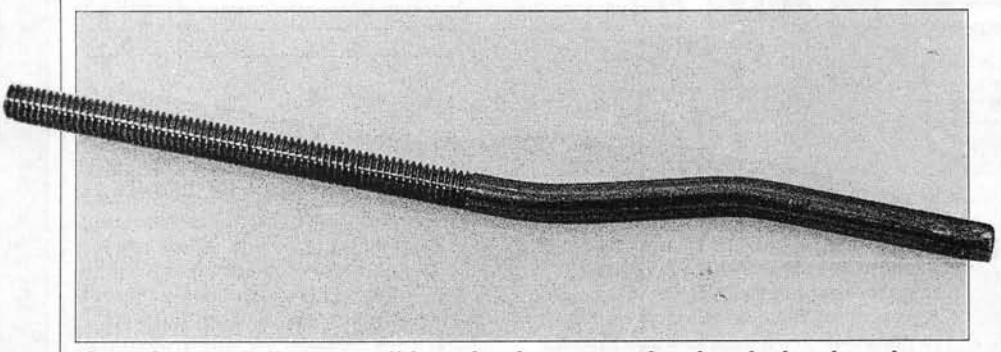
Below, crankshaft parts held in a jig for silver soldering.



Timing

The engine needs to be timed so that the valves open to steam just as the pistons reach top dead centre or bottom dead centre. It may be as well to do this before soldering in the pipes on the cylinder block as otherwise it means working blind. Line the valves up by putting a piece of wire through the holes in the cylinder block and adjusting the nuts below the block to get the best position. When everything is right, slacken two of the nuts and put either some Threadlok or a spot of paint on the thread and do the nut up again. When it is dry do the other two threads and this should mean the engine is set as it should be.

As a point of interest, fancy brass nuts were made for the trial engine to go on top of the cylinder block but ordinary ones will do. At this point they can be tightened up. If any difficulty is found with the clearance of the connecting rods, shorten both the bottom caps and the union nuts to get a fit.



One of the 1/8" diameter mild steel rod supports showing the bends and thread section.

Running

The engine will revolve according to the side to which the live steam is admitted. If it is to be used in a boat it may be desirable to fit a valve to reverse the flow of steam, similar to the type used with oscillating engines. It can be mounted on a pillar if one wishes or just fitted in the steam and exhaust pipes without any other support.

THE WORKSHOP

This is where it all happens! We offer a brief guide to what you'll need and present a few small tools to make

When thinking in terms of model engineering it is usual to think of the engineering side rather than other forms of modelling activties. We associate model engineering with metal working and, for this suitable facilities are required, which means a workshop. This does not mean that we need to start building a factory – far from it – but there is no doubt some form of suitable space must be provided.

Many of those recognised in the hobby as being among the best have very limited facilities. If room is not available there does not have to be a permanent space, small equipment can be used that can be packed away after use and the workshop need consist of no more than a board on which to mount things. Many fine models have been made and are still being made under such circumstances.

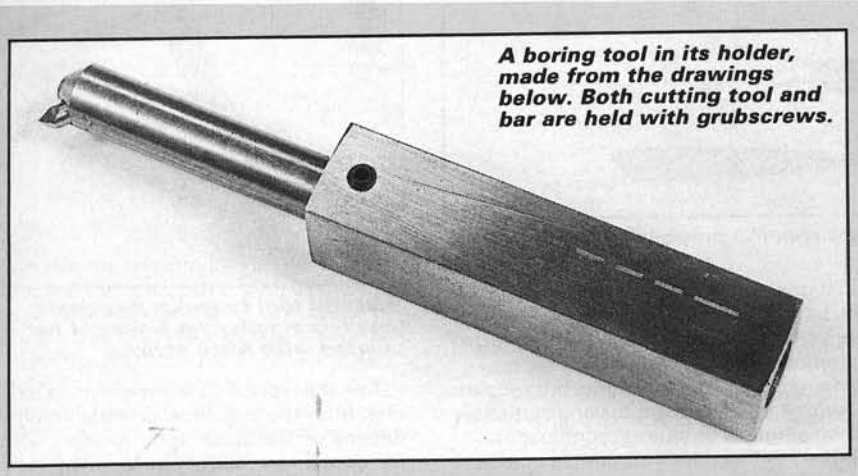
Most people wanting to get involved will wish to have somewhere permanent and this can take the form of a shed, spare room, the loft, etc. Even caravans and boats have been pressed into service. It is also possible to go without a workshop or equipment and join an evening class using the equipment available there.

Assuming suitable space has been found then the first necessity is a bench and a vice. The bench must be firm and solid and the vice, too, should be of as good a quality as one can afford. It is also as well to get a vice that is as big as possible as, sooner or later, no matter how big it is something will come up for which it is not large enough! If this happens the vice will have to be extended with angle iron but it is not the most satisfactory way of going about things.

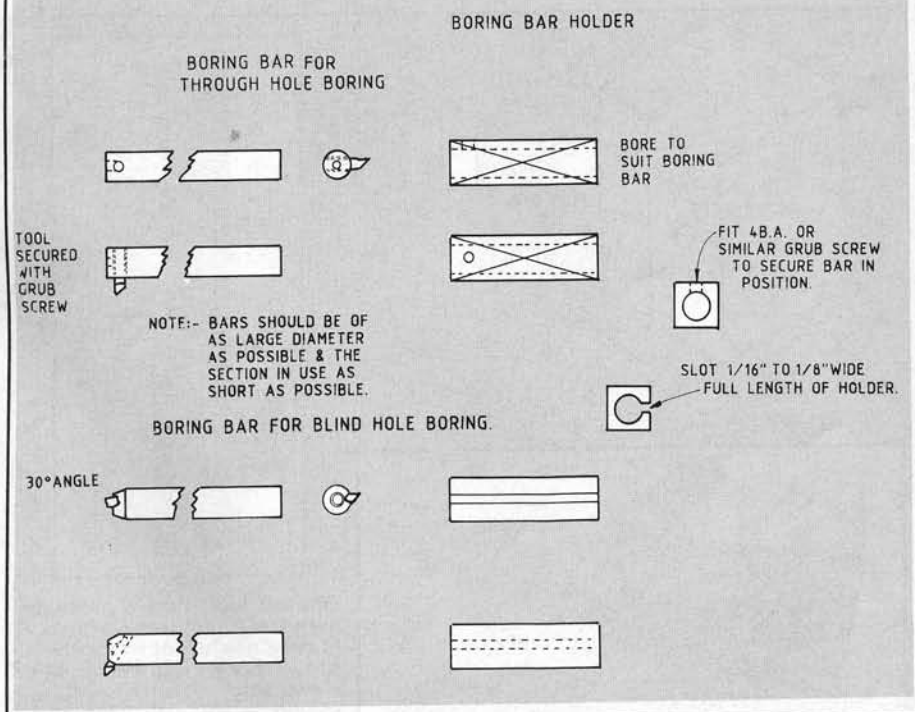
A few hand tools are needed, starting with marking out equipment. A good ruler, scriber, centre punch, plus a square and a pair of dividers will get us through to begin with, although there are additions that can be made at a later stage. A hammer, a couple of files and a hacksaw and we are in business. At some stage we will require some drills, taps and dies. There is no need to go mad and buy a whole set, just the immediate needs. If complete sets are bought, frequently the majority are never used.

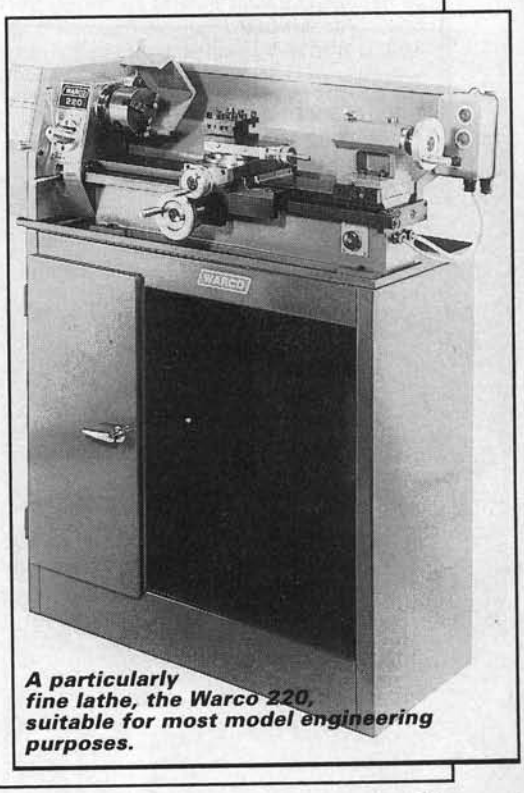
Finally we really need a lathe. It need not be new and it need not be large, it is always possible to stick to models of a suitable size for the lathe we have. With a little knowledge the lathe can be made to do a lot of work other than turning metal. It may sound a formidable list but, apart from the lathe, it is not too bad, the majority of things already being general household tools.

With the machine it is possible to make one's own tools and workshop equipment and this in itself is a satisfying thing to do. Some people seem to feel it to be a waste of time when tools can be bought. However, many of the things we can make, such as jigs, cannot be purchased and often it can be quicker to make a tool than to send away to get it if it is not readily available locally. Over the years the workshop equipment tends to enlarge. Such machines as drilling machines, band saws, and milling machines are obtained but they are not essential to the making of models. More marking out equipment will

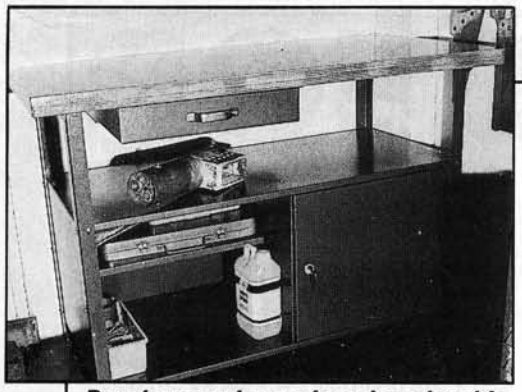


A boring tool in its holder, made from the drawings below. Both cutting tool and bar are held with grubscrews.

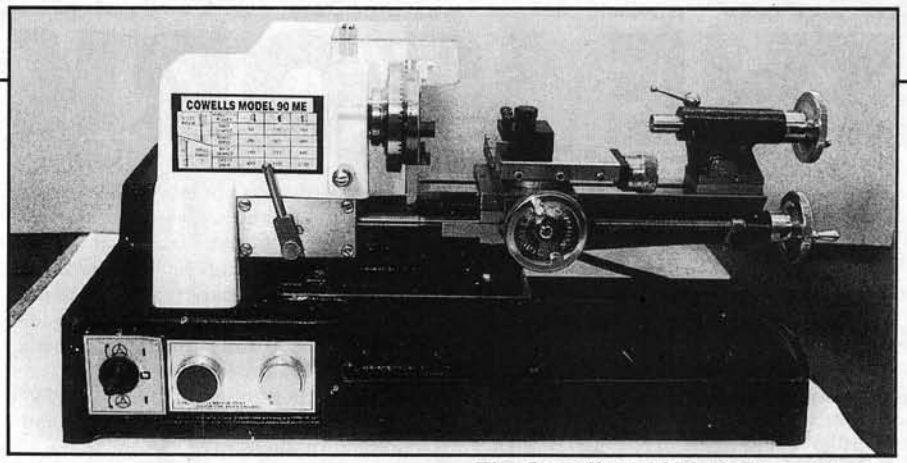




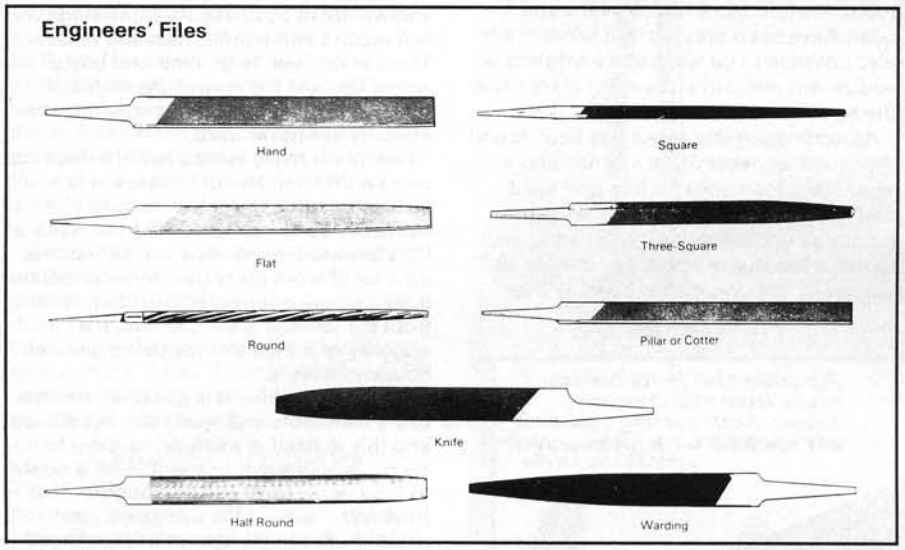
A particularly fine lathe, the Warco 220, suitable for most model engineering purposes.



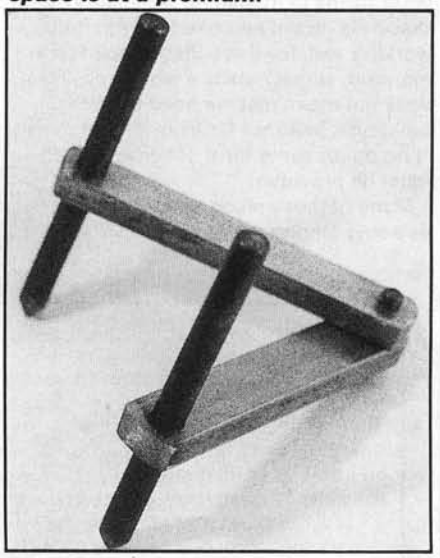
Benches can be made or bought; this sturdy unit is from Warren Machine Tools.



The Cowells 90ME lathe is an ideal machine for a small workshop where space is at a premium.



A useful range of files; although each has its specific purpose, it is not essential to have every type.



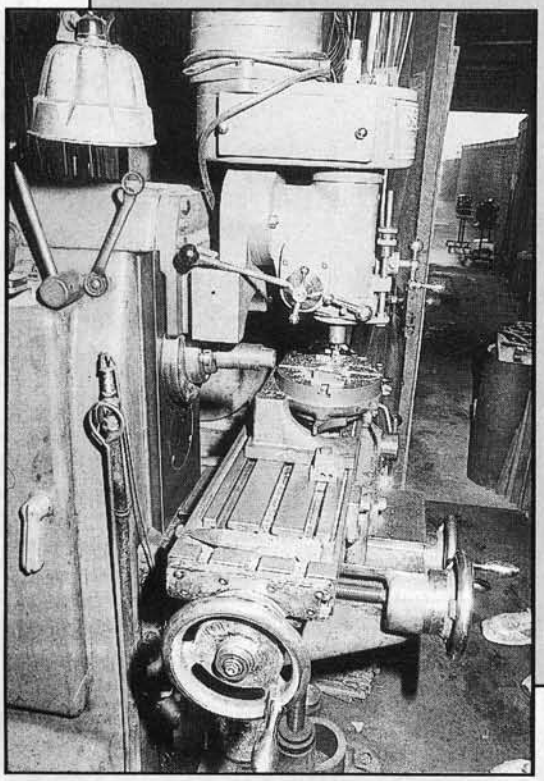
A useful tool to make; this depth gauge is simply two pieces of bar pivoted with Allen screws.

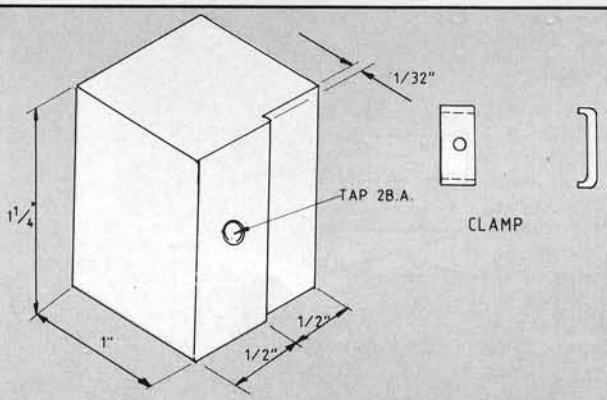
be required later in the form of micrometers and other aids to accuracy but, again, they are not absolutely essential although they make life easier in the long run.

Some form of heat equipment will also be needed at a later date as soldering and brazing is part of the hobby. Again, it is as well to start in a small way and build up to what one needs as time goes by. Not all model engineers will have the same needs. The person wishing to make large locomotive models will, if they are to construct boillers, need some big propane equipment. The person making stationary steam engines or internal combustion engines will require only simple equipment.

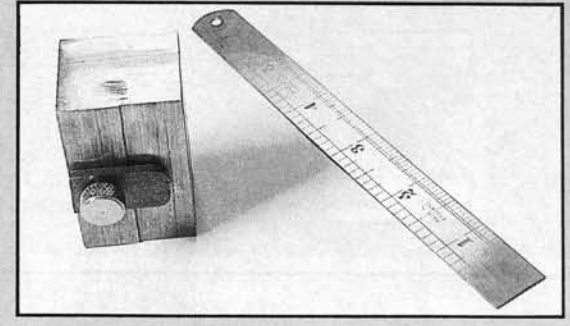
How the workshop is set out must be a matter for the individual and much will depend on the building being used, where the door and windows are situated, etc. Storage facilities should be placed in such

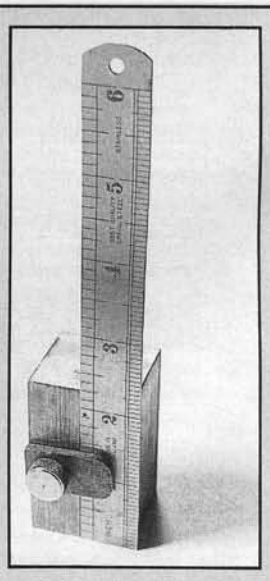
An example of a milling machine that might be obtained second-hand at a reasonable price.



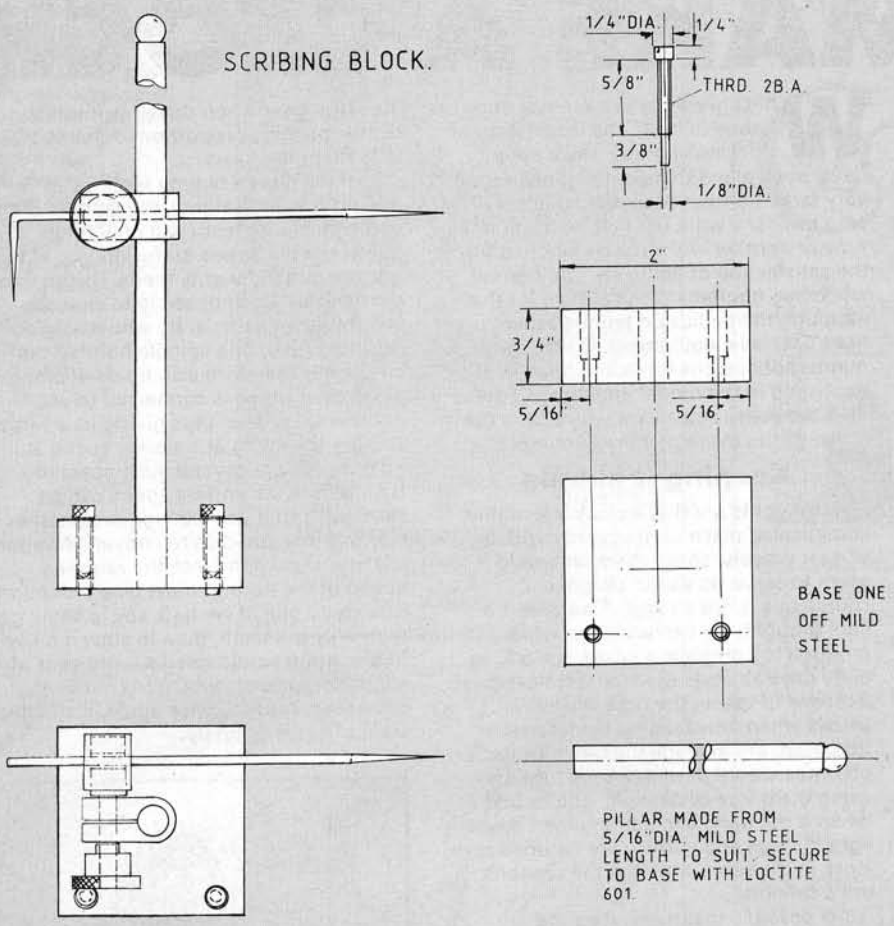


MARKING OUT RULE HOLDER.





One of the simplest tools to make, a rule-holder whick is very useful for marking out. t is a plain block of metal with a groove and clamp; with a rule clamped in it, the scribing block can be set to the correct height.



a way that the equipment stored is easily to hand at the place required. For example, it is no use having the lathe at one end of the room and the chuck keys at the other! Everything should be readily to hand as required. If a grinding machine is obtained to sharpen tools, etc., this must be kept as far away from other machinery as possible. Grindstones work on the principle of lots of tiny particles of abrasive material bonded together. As equipment is sharpened so the layers of abrasive come away to leave fresh material ready for use. The bits that come away as dust are still very sharp and likely to get into the bearings of machine.

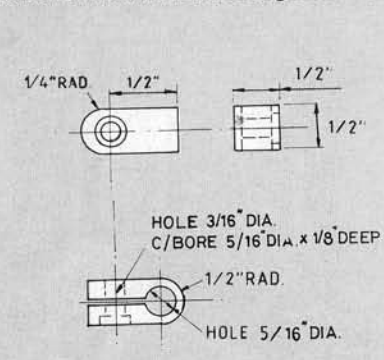
If any form of soldering or brazing equipment is to be used, then this should only be done with doors and windows wide open. Not only does the heat cause condensation but the fumes from flux are slightly toxic and can cause headaches and other difficulties, particularly for those with respiratory problems.

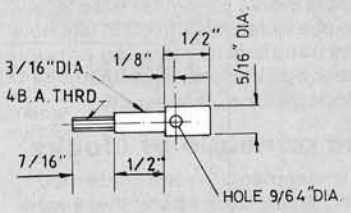
The same fumes can cause rusting of metal.

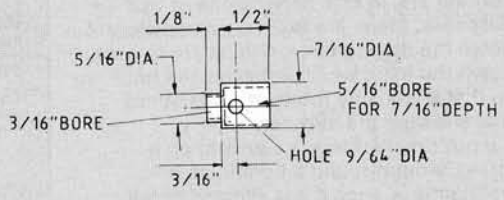
If there is no alternative then it is worth covering tools before soldering or brazing operations and ensuring that one's head does not go directly over the fumes. Rusting of equipment is inevitably a problem unless the workshop is well insulated and heated. Not a great deal of heat is required to keep it at bay and a simple small greenhouse electric heater will do the job. Gas and oil heating is not advisable as each causes condensation. Old blankets or clothing thrown over machines when the workshop is vacated is often sufficient to prevent the change of temperature which creates the problem.

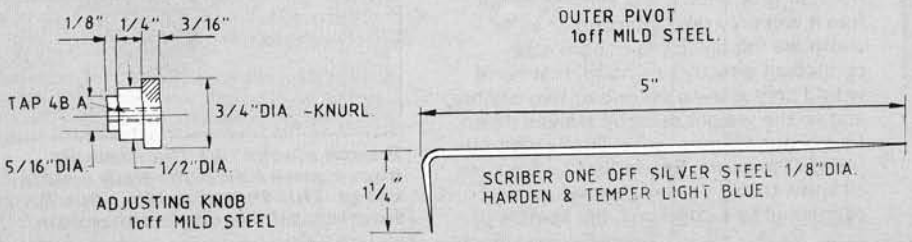
Safety is essential in the workshop and so do not wear a tie unless it is pinned firmly down as it might catch in revolving machinery. Wear good shoes as anything falling will invariably land on one's foot! Do not leave chuck keys in chucks – it is all too easy to forget them and start the machine. The result can well feel as if world war three has started. It is also advisable to invest in some safety glasses. Metal flying off machines is particularly dangerous to the eyes and such glasses are very cheap to buy; it is something that is just not worth taking a chance on. Make sure that floor areas are kept clear so that there is no danger of tripping over things and causing damage to oneself in that way.

A nice cosy workshop is a place of pleasure – a place to involve oneself in the chosen hobby and contemplate in peace and contentment as the world goes by.










The completed scribing block and scriber made from the drawings at left.