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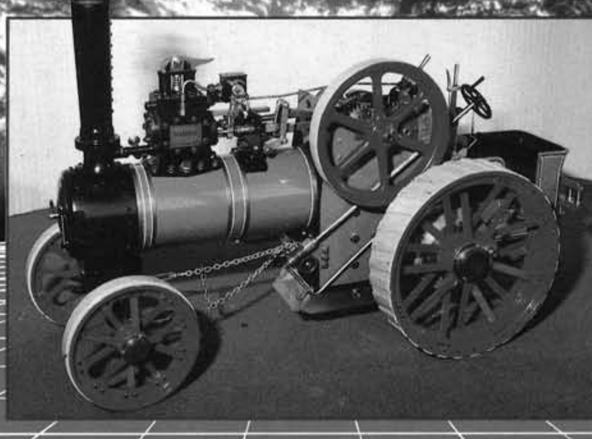

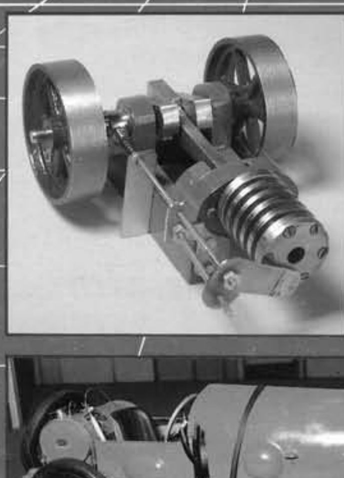

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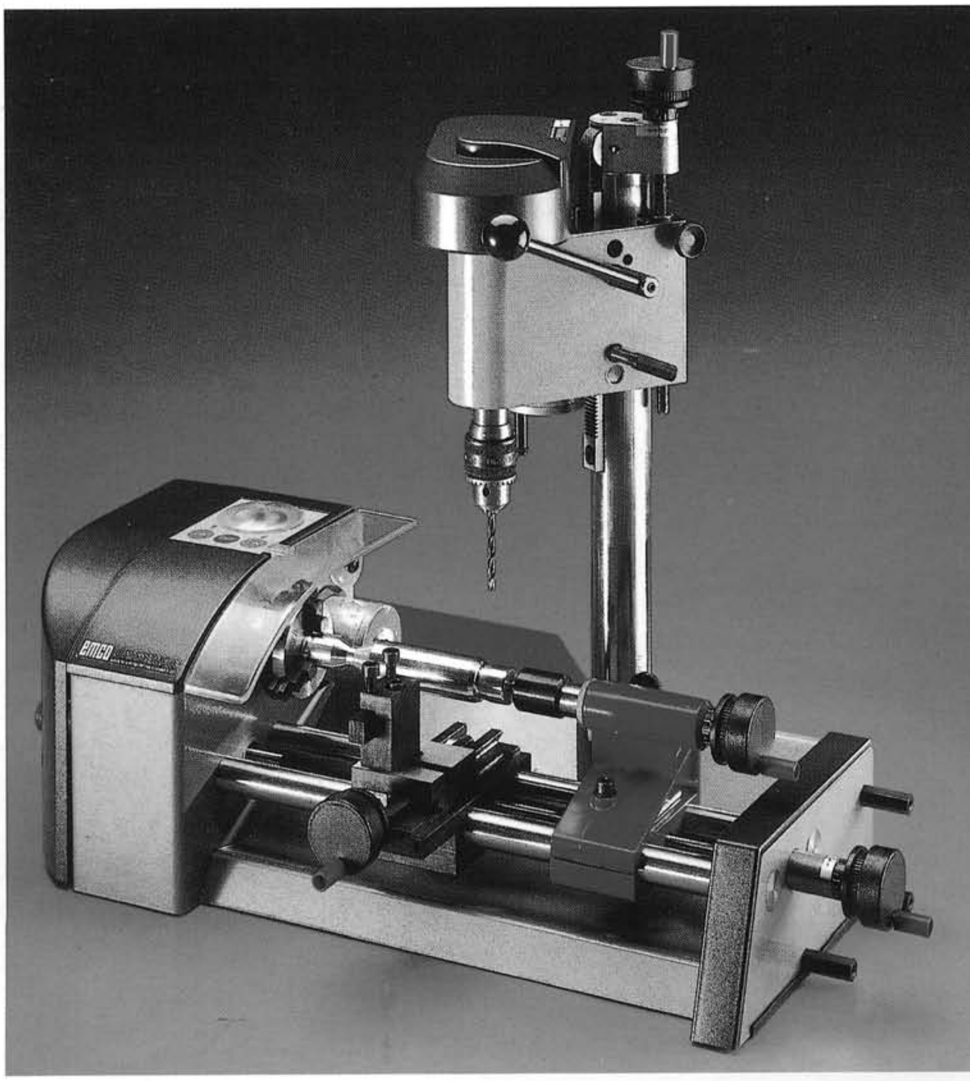
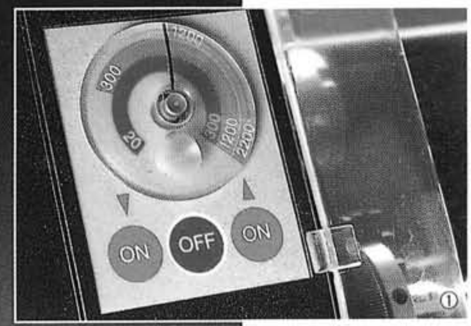
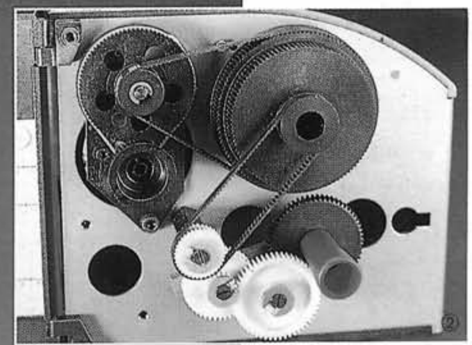
AN ARGUS SPECIALIST PUBLICATION

emco Unimat PC

MODEL ENGINEERING FOR THE 1990'S







① *Electronic speed controller*
② *Transmission with gear quadrant*

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The extremely quiet motor drives the machine through toothed belts. The machine can even be operated in your living room owing to the integral chip tray and chip guard.

TECHNICAL DATA

Centre height	*54 mm*
Distance between centres	*196 mm*
Swing over bed	*110 mm*
Cross slide traversing path	*68 mm*
Spindle nose	*M14 x 1, sim. to DIN 800*
Spindle bore	*Ø 10.2 mm*
Speed range	*20–2200 rpm*
Tailstock:	
Sleeve strocke/sleeve Ø	*28 mm/18 mm*
Mains voltage	*42 V DC*
Nominal current	*2.6 A ± 20%*
Motor rating continuous	*95 W/47 W*
Direction of rotation	*cw/ccw*

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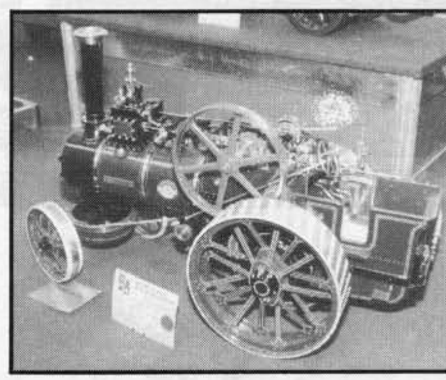

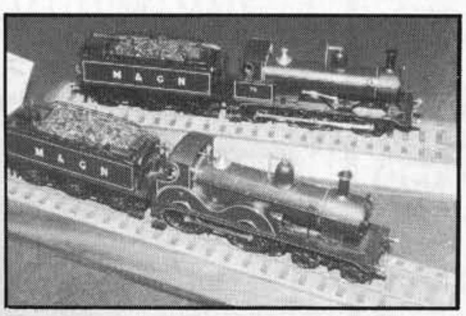

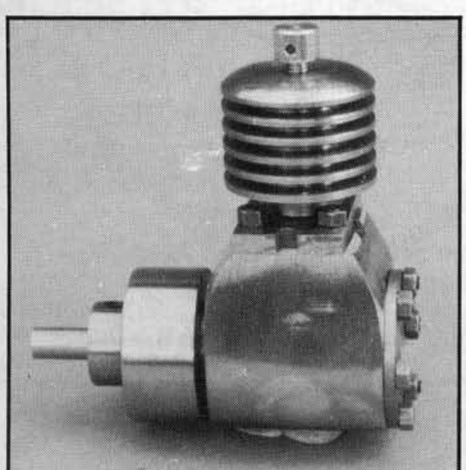

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ADVERTISEMENT MANAGER: **Angela Farrell**

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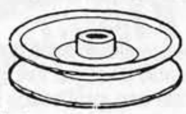

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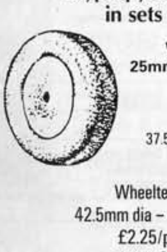

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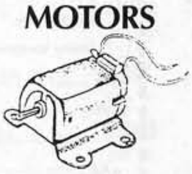

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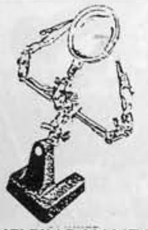

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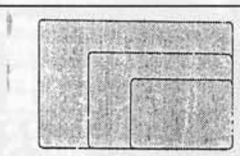

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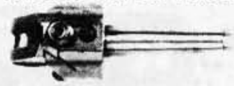

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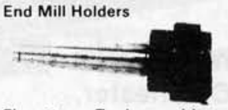

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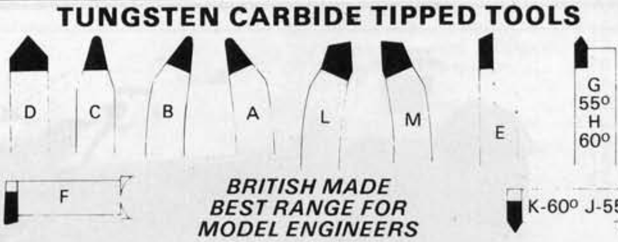

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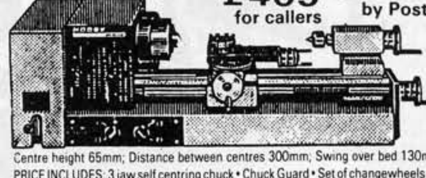

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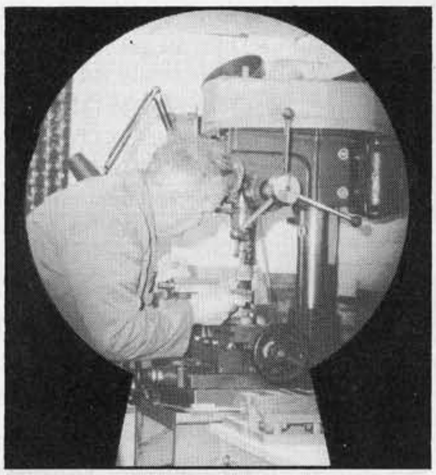
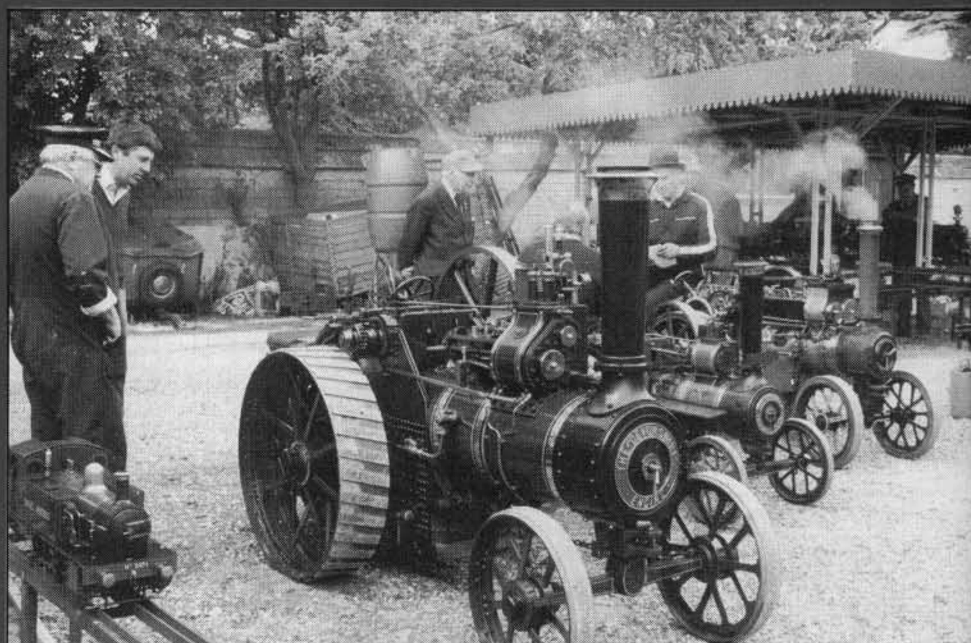
WELCOME TO THE WORLD OF MODEL ENGINEERING



Danger, man at work! A peek through the keyhole of Stan's workshop.

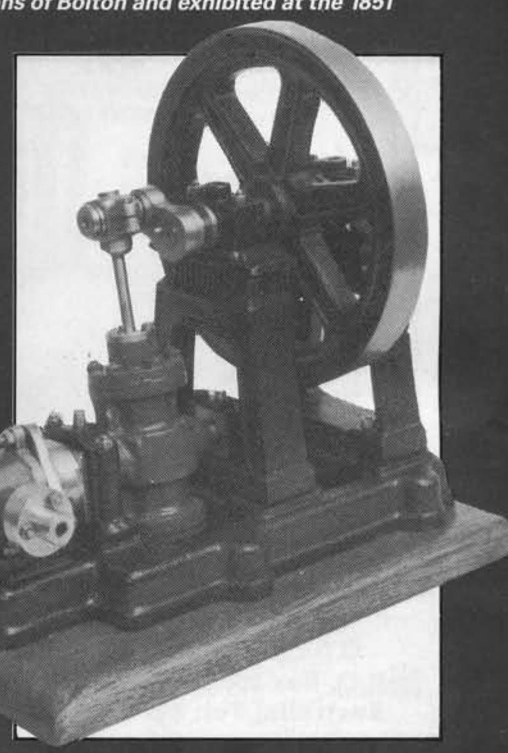


Above, a delightful study of three traction engines of differing scales (3, 4 and 6 inches to the foot). Below, author's recently completed stationary steam engine model of a full-size machine by Hick and Sons of Bolton and exhibited at the 1851 London Exhibition.

Model engineering is a truly international activity; Stan Bray introduces this fourth 'Special' with a 'global' view of the hobby in all its variety

Model engineering is a hobby enjoyed throughout the world and it is one in which the interest continues to increase. I believe that I am correct in thinking that about a hundred years ago when it started to be recognised as a hobby it was prominent only in the English-speaking world and, in particular, in Great Britain. From this country it rapidly spread throughout the countries that were once part of the British Empire. We can see this by looking at the names of the older societies in those countries. They have a close resemblance to the early British ones. Many have the name of the place or district followed by the title 'Society of Model and Experimental Engineers'. This follows closely that of 'The Society of Model and Experimental Engineers', based in London and the first known society.

In the United States of America societies also came into being. The fact that these would largely be based on the operation of miniature locomotives meant that many of their societies carried such names as 'Live Steamers'. There were differences too in the track gauges used in the United States. Whilst in Great Britain we tended to use $2\frac{1}{2}$, $3\frac{1}{2}$, 5 and $7\frac{1}{4}$ inches, in the USA in place of the 5 and $7\frac{1}{4}$ inch gauges the use of $4\frac{3}{4}$ inches and $7\frac{1}{2}$ inches was more usual.



Meanwhile, on the European Continent the hobby seems to have been carried on largely by individuals rather than by the formation of societies. In recent years this has changed and there are societies in all western European countries and, in all probability, in Eastern ones as well. Certainly there are some very fine individual modellers in eastern Europe even if societies do not yet flourish. Unfortunately, whilst we in Great Britain enjoy a considerable exchange of information with the English-speaking world enthusiasts, we do not enjoy the same exchange with western Europe and

Big and beautifully built and finished, this $^1/_4$ scale steam lorry simmers gently at one of the many rallies held each year by the many scores of model clubs in the UK.

virtually none with eastern Europe at all.

Other parts of the world do not seem to have taken so readily to the hobby. There are model engineers in South America and some in various African states. In the far east, the hobby is very popular in Japan and to some extext China. Hong Kong has a society which consists mainly of people working there on contract. The so-called 'third world' countries seem not to have any such interests but then this is understandable as it is a hobby that reflects a great deal of what we found familiar in our younger days and so one would expect it to be more popular in countries that were industrialised earlier.

Thus the hobby has spread throughout the world, mainly in the form of the running of miniature railways but, of course, the hobby goes a lot deeper than that. Castings for stationary engines are sent all over the world, and the private sales of small lathes suitable for model engineering are also worldwide so obviously there are far more enthusiasts than we can estimate from the number of societies. Perhaps it would be a good thing if we ceased to be so parochial and tried to establish more contact with enthusiasts elsewhere as do amateur radio enthusiasts . . .

The mainstay of the hobby would indeed appear to be the model steam locomotive and here there is a very wide range of interests. For many years $2^1/_2$in gauge models and the smaller gauges such as 'O' and '1' were the most popular by far. Then slowly $3^1/_2$in gauge models also became very popular. Larger models than this took some time before the interest increased. The reason is not hard to see; locomotives need tracks on which to run unless they are to remain as showcase models and, whilst some individuals managed short up and down tracks in their gardens, the majority ran on club tracks, which were few and far between. Few people had motorcars and so locomotives were transported on trailers behind bicycles or, for the very lucky ones, in a motorcycle sidecar! Such a method of transport did not really lend itself to the carrying of large model locomotives. Now models in five inch gauge and $7^1/_4$in. gauge are all equally popular but most people have their own motorised transport.

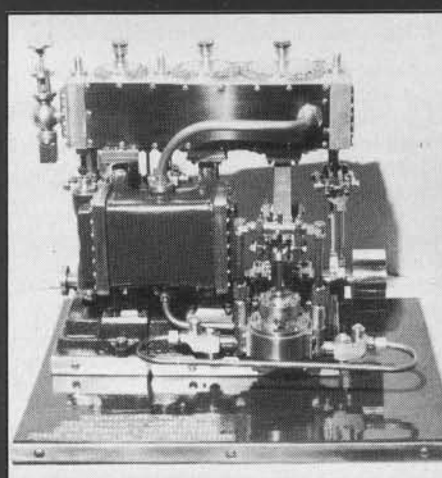
Stationary steam engines have long been favourites with model engineers and they remain so today. The reason for their popularity may well be that such models are usually not too cumbersome for display purposes and it is possible to start with a comparitively simple model and build more complicated ones as skill at machining techniques is achieved. We therefore see in the stationary engine a whole range of models from the very simple type from commercial castings to the very complicated machinery scaled down from original engines or old salvaged drawings.

Model boat building is a very popular side of the hobby and international regattas attract entries from individuals from all over the world. Some people would not class model boating as model engineering and yet, for many years until a special magazine became available, it was catered for in *Model Engineer*. Quite a large number of those involved in that side of the hobby build their own power-plants to operate on either steam or oil-based fuel.

Many model aircraft enthusiasts also build their own engines and this brings them also into the scope of the hobby. We must not forget either the scale-car enthusiast . . .

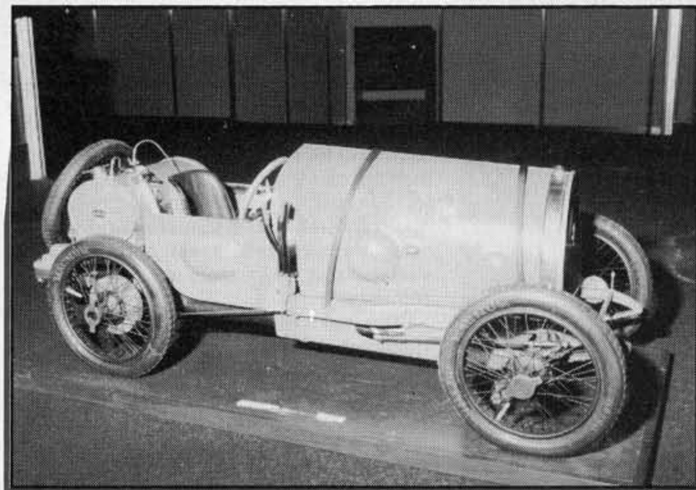
Added to all these are those modellers who like to build their own tools, make hot air engines or any other type of model, not to mention those who just enjoy messing about with machines, which makes it, to say the least, probably the hobby with the widest range of interests if not the most participants! But what of the second part of the title so boldly given nearly a hundred years ago to 'The Society of Model and EXPERIMENTAL Engineers'? Sadly we do not seem to see as many experimenters as we used to. Or do we?

The days of brilliant mechanical inventions seem to be virtually over – if, in fact, they ever existed. Today everything is developed from something new. But then this is what always happened and

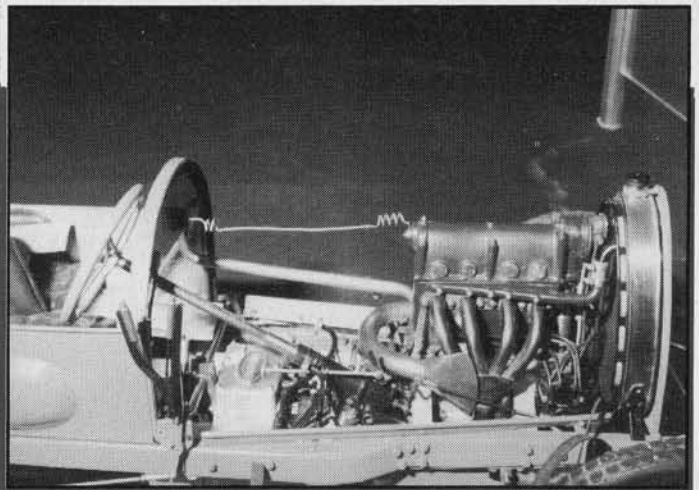


A triple expansion engine with condenser, typical of the more advanced stationary engine model.

Model boat-building of this quality can justifiably be described as 'model engineering'; level of detail makes it hard to distinguish from the real thing.



Model cars fascinate many model engineers; John Stubbs is the builder of this fine example.

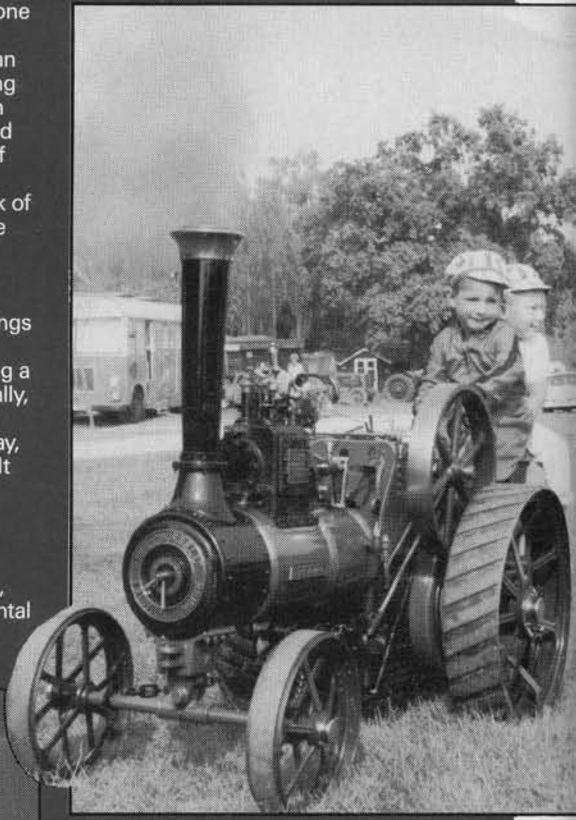


A bonnet-off view of John Stubbs' lovely $^1/_6$ scale Le Mans Bugatti reveals breathtaking engine detail.

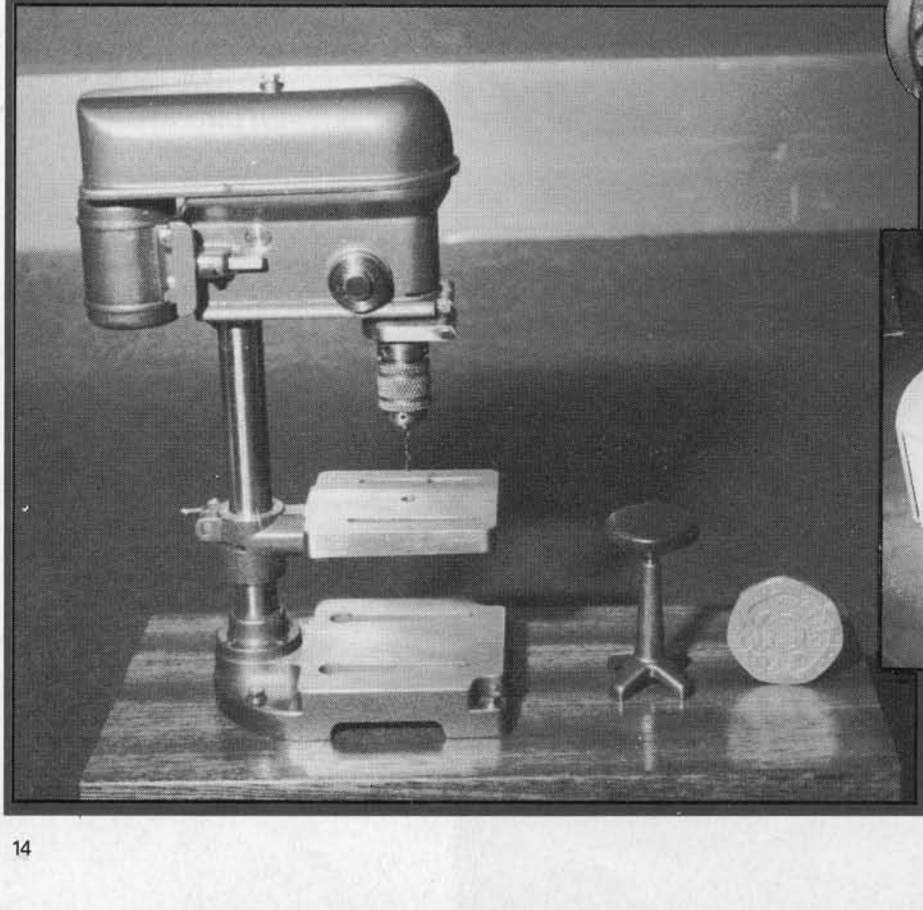
experimenting came, as a rule, in developing ideas started by others. The stories we were taught at school were never accurate. We were told (at mine and many other schools) that James Watt invented the steam engine because he watched steam lifting the lid off a kettle. This, of course, is not true at all. As a brilliant engineer in his own right he improved on what others had done before him. The story merits telling as a good way to make a child realise that steam gets power from its expansive properties; it definitely is the thing that made *me* realise the power behind it. We were also told that George Stephenson invented the railways. This too is not so but he deserves being remembered for the developments he carried out.

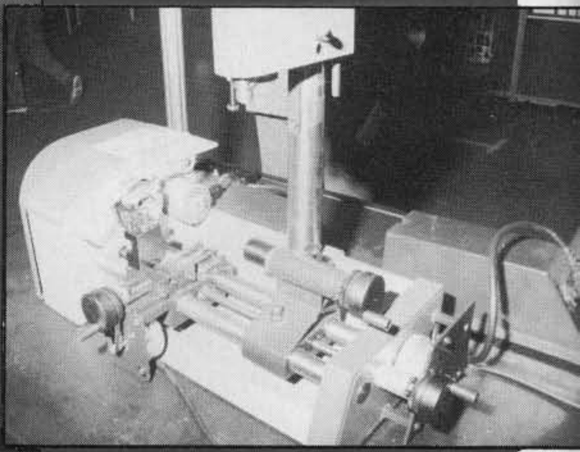
This is where the word 'experimental' comes in. Large numbers of model engineers still ponder away at home trying to find different ways of doing things. They do not intend to make discoveries which will alter the world but just to find out for themselves how and why things happen, and to develop their own ideas to improve something originally designed by someone else. Experimenting can mean incorporating one's own ideas rather than dreaming up completely new engineering projects. That is the way industrialisation progressed and *improvements*, not brand new ideas, were mainly the inventions of the nineteenth century. James Watt experimented and improved on the work of others. George Stephenson did the same and so did all the great pioneers of the time.

So, many model engineers still are experimenting, and trying to find out things for themselves. This is what makes the hobby so absorbing – if one way of doing a job does not work then try another. Equally, if an operation is described on a set of instructions and you cannot do it that way, or think you can find a better way, try it! It could work and if it does then what a discovery you have made with your experimenting. One thing will lead to another and so ability improves. Then, when someone asks what your hobby is, tell them proudly, "Model and Experimental Engineer!"

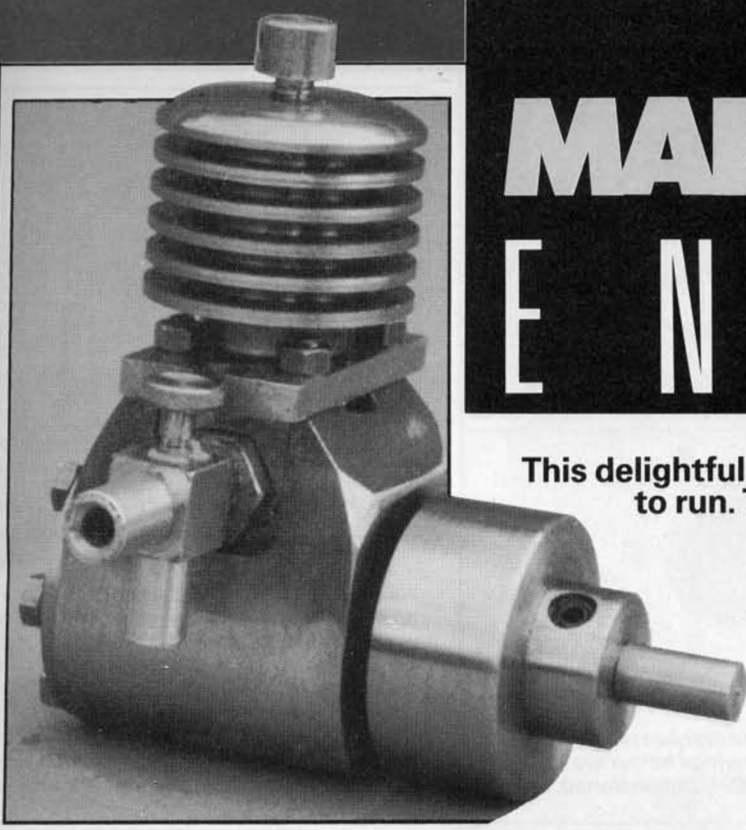


And when you've made it, you can enjoy riding on it – like these two youngsters!



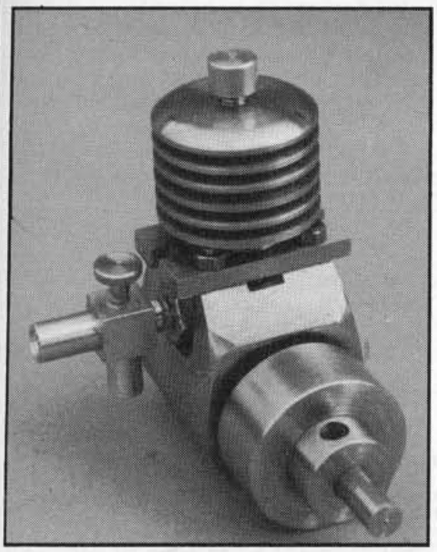


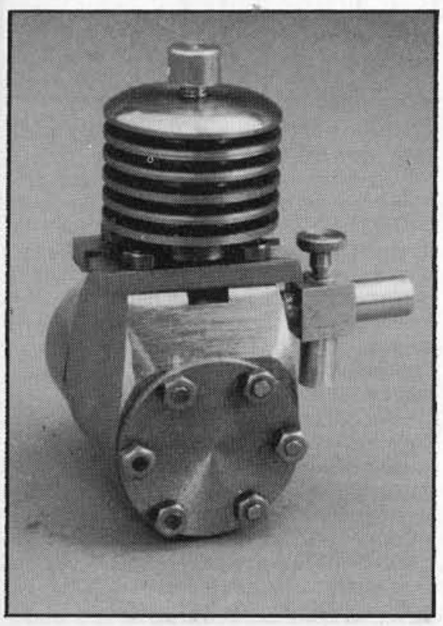
Left, an unusual model of a pedestal driling machine, fully working in small scale. Above, latest technology in lathes is this Unimat PC which can be operated in conjunction with a home computer.



MAKE AN I.C. ENGINE

This delightful little 'diesel' is simple to make and fun to run. Try it!





The internal combustion engine has been with us now for many years and basically has altered very little in all that time. We are all familiar with it as the motive power for our motorcar as well as knowing that it is the force used to power public transport vehicles, ships and some aircraft. In fact only in the air has it really been surpassed as a form of power.

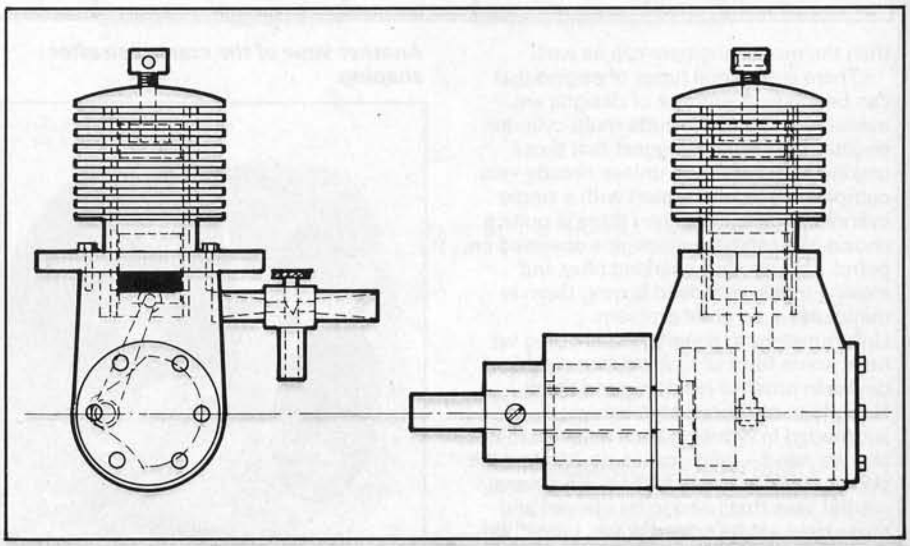
In spite of this, we do not see many models of internal combustion engines in comparison with say, steam models. One can understand the fascination of steam, particularly where a locomotive is concerned where the miniature power can be used to haul heavy loads. Nevertheless, I often wonder why it is that so few modellers make internal combustion engines in comparison with, say, a stationary steam engine.

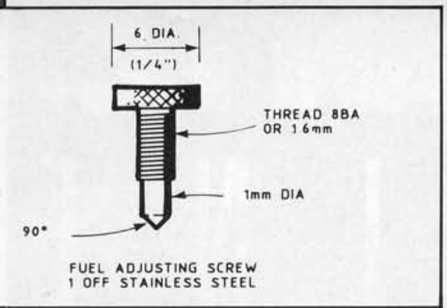
Diminutive diesel shown at actual size in drawing below is approximately .5cc capacity. No special materials are required to make it and it's an ideal subject for construction on a small lathe.

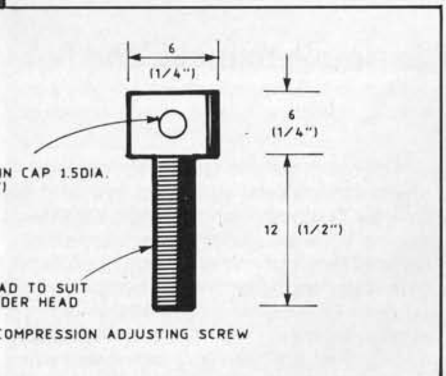
Operating a stationary steam engine, unless compressed air is used, is a far more difficult business than running a small i/c engine. With the steam model a separate boiler is required and this has to be filled with water and steam raised by spirit or gas firing, or possibly with coal. All that is needed with the i/c model is to fill the tank up with fuel and then give the engine a few turns to start it.

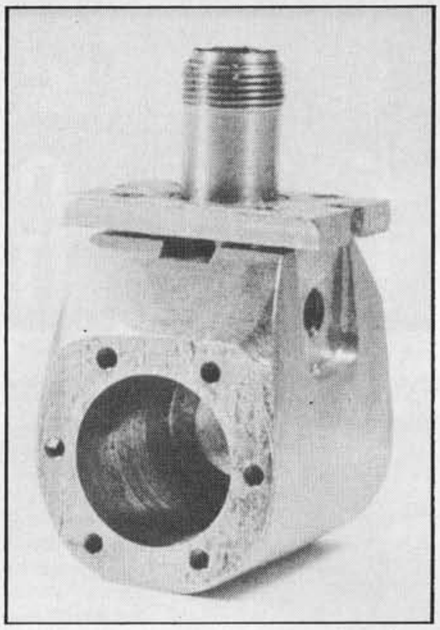
I believe that most modellers get somewhat anxious about making i/c engines because the tolerances involved are far tighter than those needed for steam. But if we have bought a lathe and hope to become skilled in its use then surely the thing to do is to make a model that taxes one's ability and so improve that ability! One advantage of the average i/c engine is that usually only a small lathe is needed for the construction. Also the amount of material needed is very small so, if mistakes are made, there is very little waste and the useless bits can be discarded and another one made. Certainly the tolerances involved are tight but they should not be beyond anyone – even a beginner – if care is taken.

It is quite possible to purchase a whole variety of ready-finished engines which enthusiasts use for powering model aircraft, boats, cars, etc. Someone has to make these and the equipment used is often little more than we will find in a home workshop. Perhaps the lathes, etc., do work automatically, but somebody has to set them to the required tolerance in the first place – so if the manufacturer can do it,

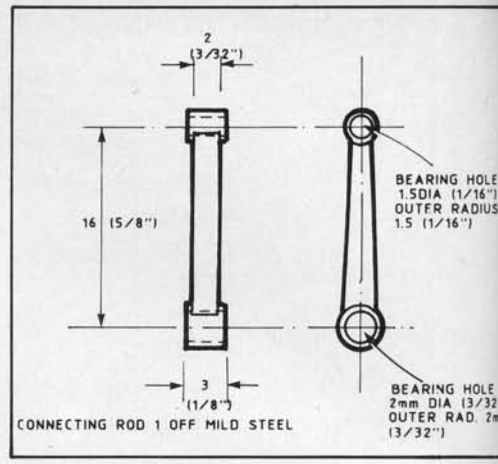




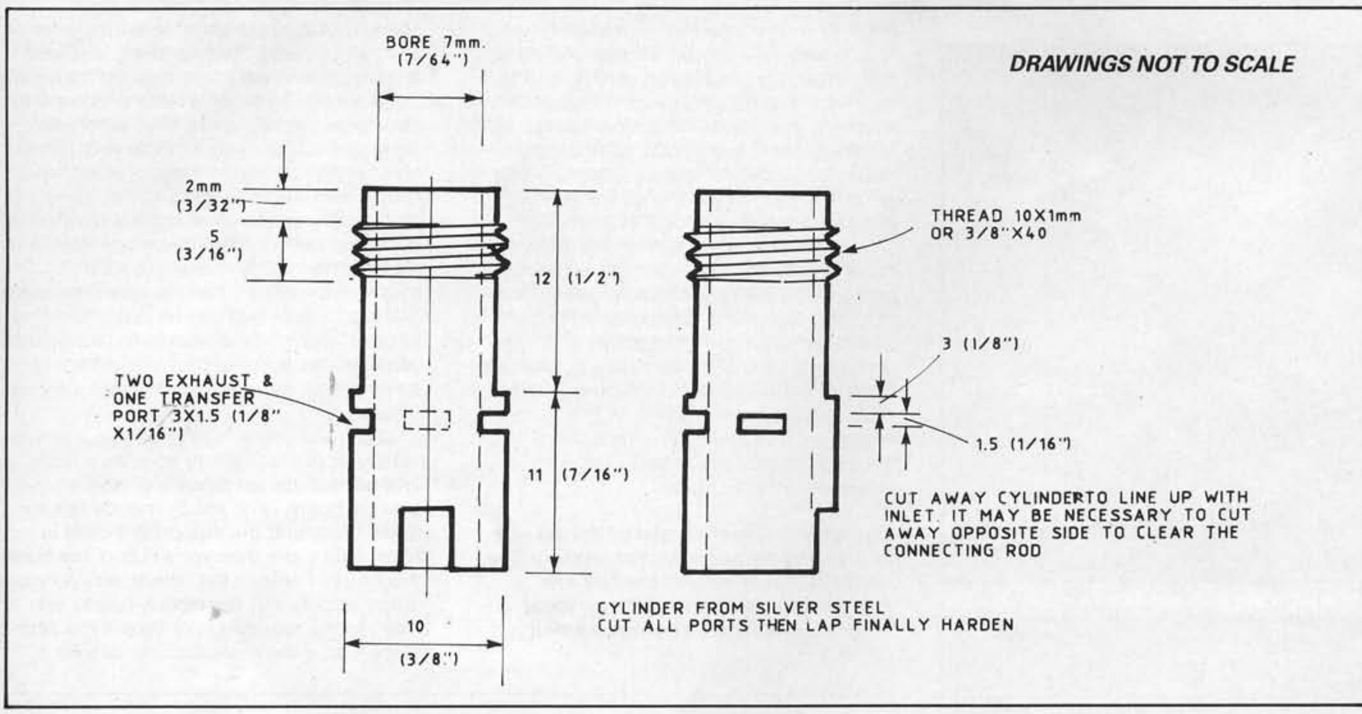




Close-up of the crankcase and cylinder assembly. Drawings below are not to scale but are fully dimensioned.



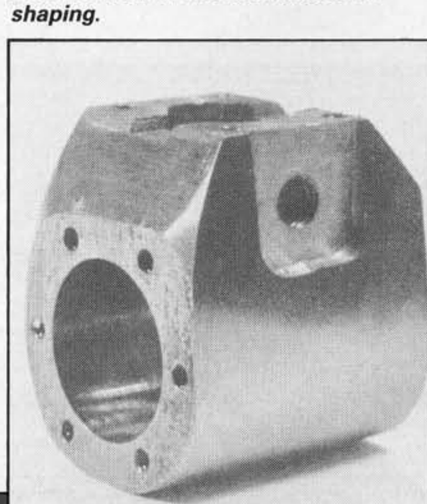
DRAWINGS NOT TO SCALE



then the model engineer can as well!

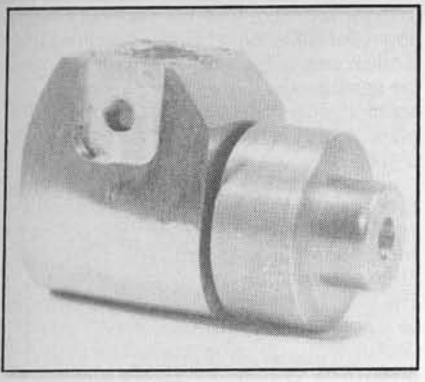
There are several types of engine that can be made. A number of designs are available and these include multi-cylinder engines but I would suggest that those making a first attempt, unless already very competent engineers, start with a single cylinder engine. Even then there is quite a choice. We can have an engine operated on petrol. This needs a sparking plug, but making those, or indeed buying them in miniature, is no great problem. Unfortunately, to go with a spark plug we need some form of high tension electrical device in order to create a good spark. Nobody to my knowledge has yet succeeded in reducing such a device to the size we need – not because no-one has the skill but merely because there are several natural laws that need to be obeyed and these have yet be scaled down. I am quite sure that the problem will be solved with advanced electronics, but not just yet. One way round this difficulty is to use a device known as a 'glow plug', and this really means that, to explode the petrol, a hot wire is placed in the cylinder head and this, combined with the compressing of the petrol/air mixture, causes an explosion and so drives the engine. Not a bad idea but we will need a battery which will be very much over scale to make it work.

Another view of the crankcase after shaping.



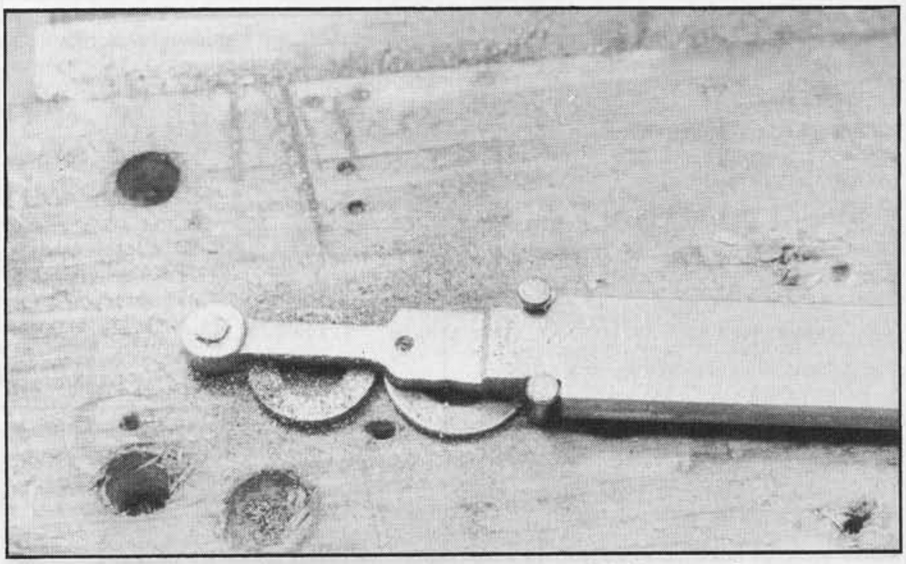
Compression ignition means putting a fuel under so much pressure that the heat generated by that pressure will explode it and so drive a piston. This is the principle that the diesel engine works on and it has the advantage for us that it needs no outside heat source to make it work. We do not use diesel fuel for such an engine in model form but a mixture of di-ethyl ether and benzine.

We can simplify the model even more by making it work on the two-stroke principle, which is frequently used for small motorcycles. For those not familiar with the system, let me explain. In a normal four-stroke engine, as the motorcar type is termed, the firing cycle is broken down into four phases. The fuel is drawn in as the piston goes down the cylinder, it is



Crankcase and flywheel; Stan starts the little engine with a pull on a string wound around.

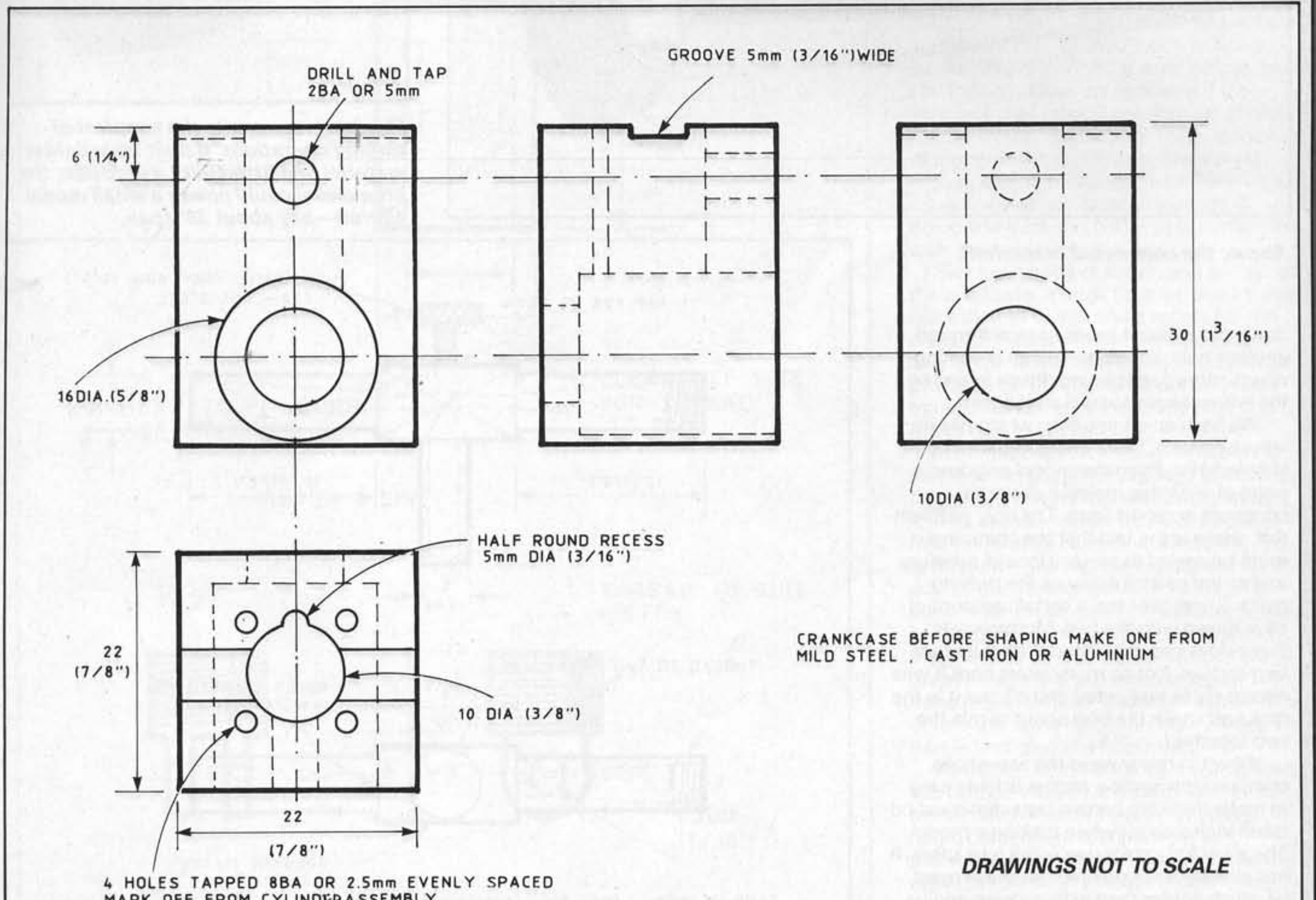
MAKE AN I.C. ENGINE



The partially finished connecting rod nailed to a piece of timber to make filing to shape a straightforward operation.

compressed as the piston goes up and it explodes at the top of the piston stroke, and then during the fourth phase as the piston goes down again the waste gases are allowed to escape to exhaust. The cylinder then is a sealed chamber and only when a valve opens can the fuel get in or the exhaust get out. This means that the crankshaft and bearings must be separately lubricated.

In the two-stroke engine the fuel is drawn in by the piston travelling down the cylinder and is forced into the crankcase. This is a sealed unit which holds the crankshaft, connecting rod for the piston and the various bearings. As the piston starts to rise so the fuel is sucked up with it through a hole into the cylinder where it is compressed and explodes. On the way



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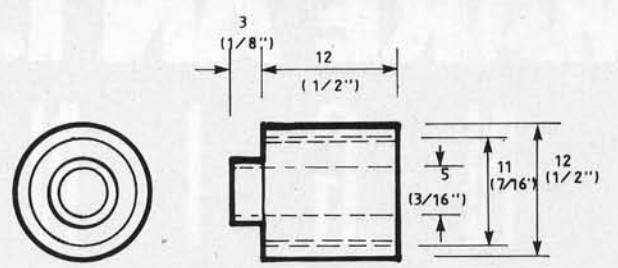
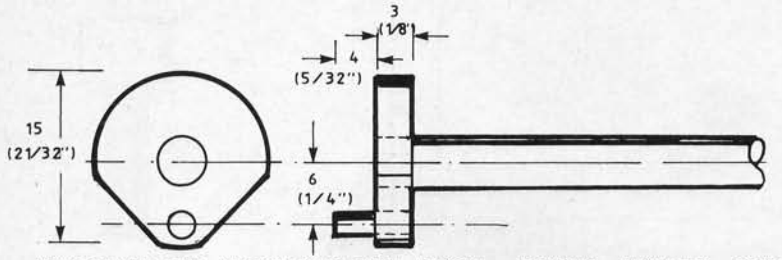
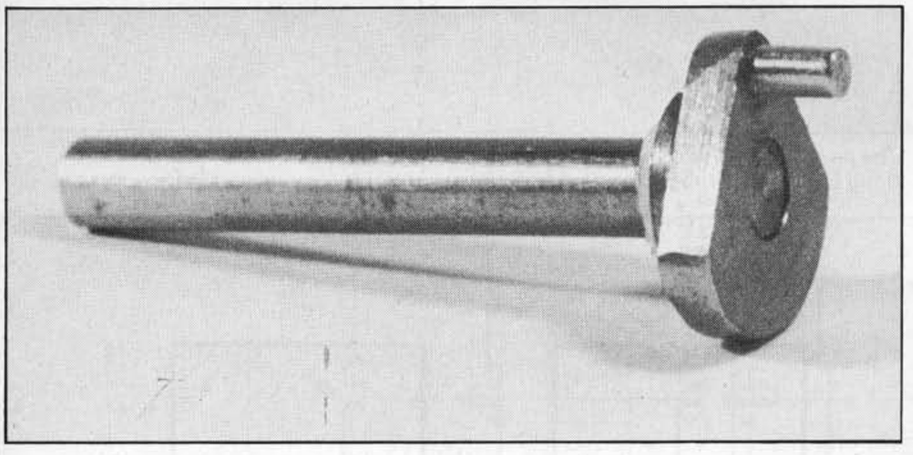


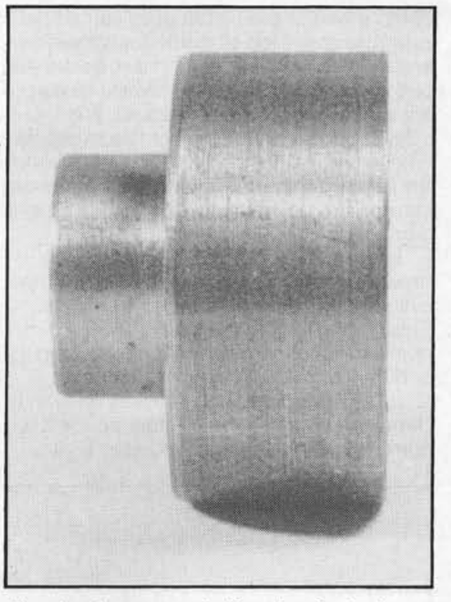
BEARING 1 OFF MILD STEEL WITH BRONZE BUSH
FIT 1.5 (1/16")THICK PTFE WASHER EACH END ON
FINAL ASSEMBLY. USE LOCTITE 601 TO SECURE TO BODY



CRANKSHAFT 5DIA. (3/16") MILD STEEL LENGTH :- BEARING+ FLYWHEEL+ DRIVE UNIT



Above, the completed crankshaft.



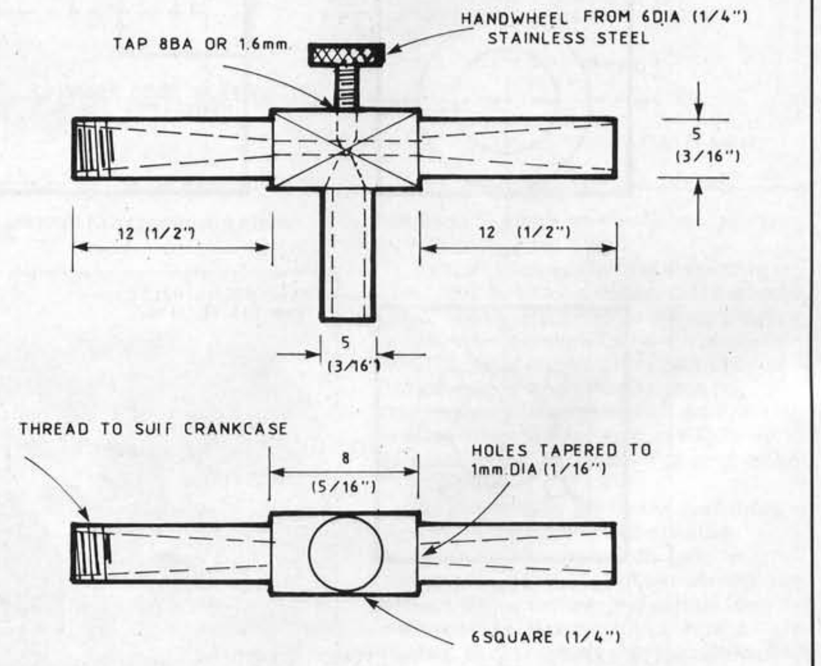
Flywheel represents the simplest of turning operations. If built from lighter material and fitted with a propeller, the little diesel could power a small model aircraft – say about 36″ span.

down the exhaust gases escape through another hole, but as the piston is coming down, more fuel is being drawn in and so the whole sequence will start again.

We have an engine then which has no valves as such, these being replaced by simple holes. From the model engineer's point of view this makes it easier to construct in model form. The only problem that arises is the fact that the crankcase must be sealed to prevent loss of pressure and so we cannot easily oil the moving parts. To get over this a certain amount of oil is mixed with the fuel. Motorcyclists these days can get a special mixture for two-strokes. Not so many years back it was necessary to buy petrol and oil, put it in the tank and shake the bike about to mix the two together!

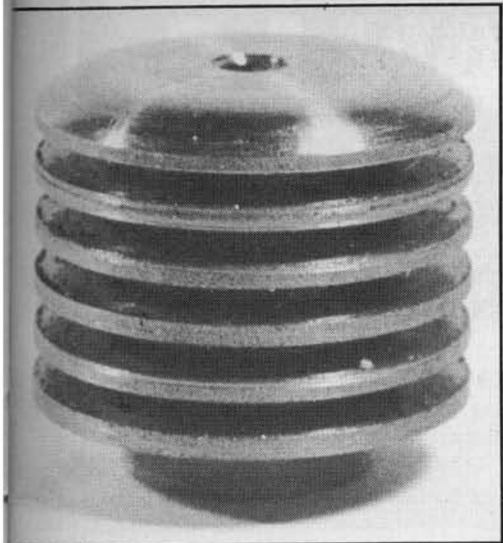
Whilst in many ways the two-stroke compression ignition engine is fairly easy to make there are certain facts that must be taken into account when making a model. The most important one is the tolerances. It has already been pointed out these must be much tighter than with a steam engine. The piston must be a good fit in the cylinder to ensure that fuel does not escape down the sides. With full-sized engines this is taken care of by using piston rings. With the small model these are not very practical, although some modellers do make them. We must, then, rely on the fit of the piston.

The crankcase, too, must be absolutely airtight or else the fuel will not get sucked into the cylinder, and in fact might not be sucked into the crankcase in the first place. There are two possible sources of leaks. The first and obvious one is where the cover fits the crankcase. It is not difficult to deal with this by using some form of gasket. The drive or crankshaft, however, which is also a possible cause of leaks cannot be dealt with in this way and so must be made an excellent fit in the first place to eliminate them.

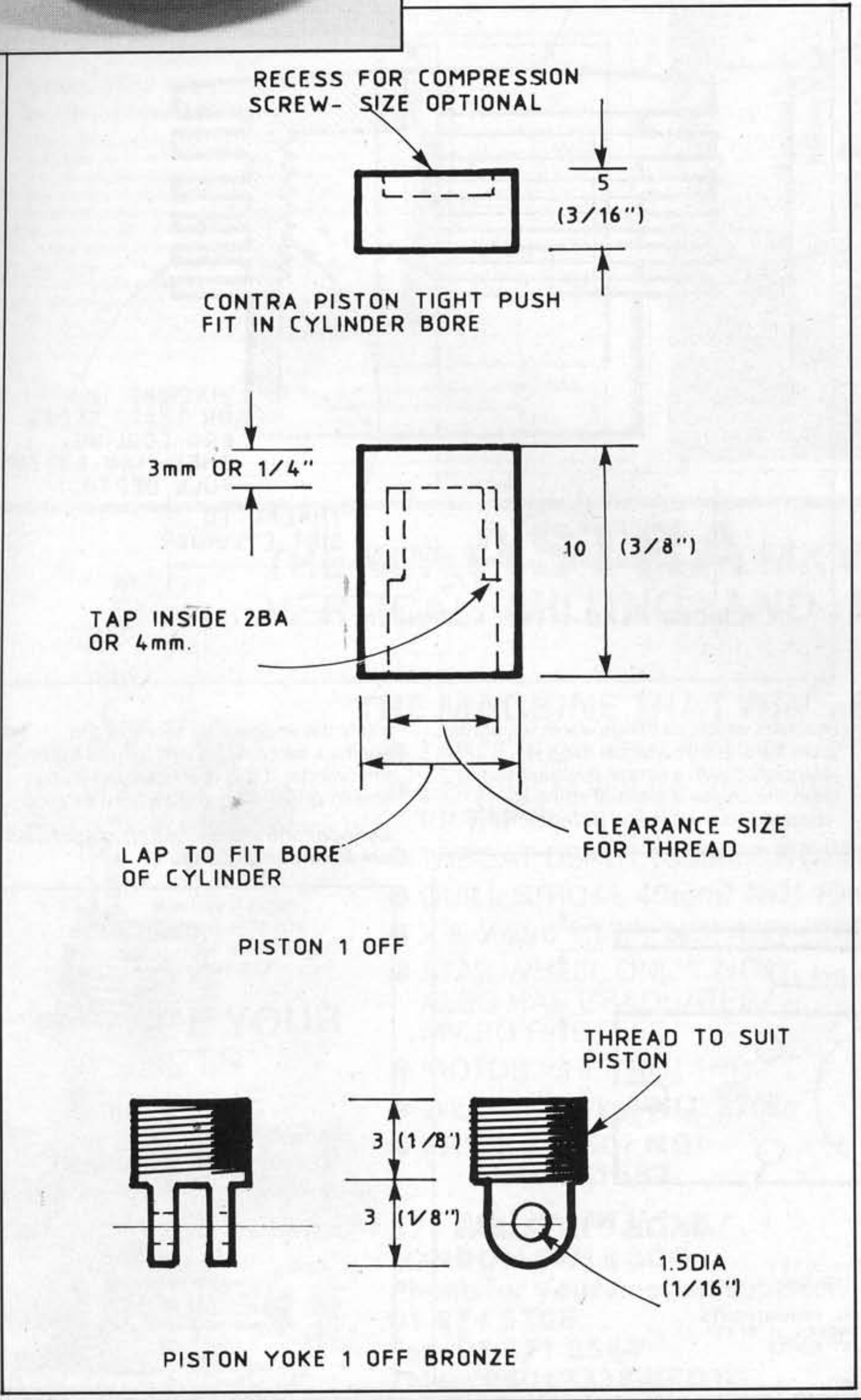


CARBURETTOR 1 OFF 6mm. (1/4")SQUARE BRASS

MAKE AN I.C. ENGINE



Cylinder head is finned for cool running and carries compression screw (not in place in this photograph).



These fits are not as difficult to obtain as one might think and there are various ways of getting things right. The most important factor, however, is care when machining in the first place. One must not be in a hurry to finish the component. If it means traversing the tool three times as often as normal then so be it. The end result will be worthwhile. Other fits need not be quite as accurate as these two, although there is no excuse for sloppy work and, as far as possible, all bearings, etc., should be made a very good fit.

There is no need for castings when making a small model engine. Making it from solid may not be as easy as using castings but if things go wrong little is lost. Any materials can be used, but if the model is for an aircraft then some form of aluminium alloy is obviously the best bet for lightness. Where such a material is used bearing bushes must be made so that excessive wear does not take place. Brass or steel are good materials to use for many parts. The cylinder must, however, be made of steel and if possible a steel that can be hardened. Case hardening will do but bear in mind that not all mild steels will case harden. The piston too should be hardened and for both these components if the engine is only a small one the use of silver steel is worth considering. There is a school of thought that the drive or crankshaft should also be hardened. Personally I doubt if there will be any great advantage in so doing and think it is better to use mild steel with bronze bearings.

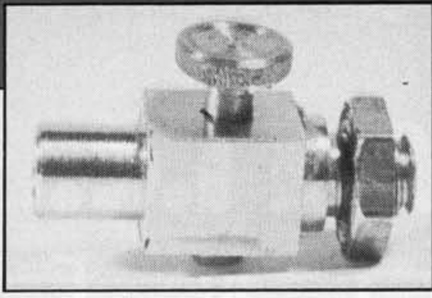
The main body of the engine will act as the crankcase. It must have a place for the crankshaft to fit into and a recess for the crank to revolve in order that the piston may go up and down. There must also be provision for the fuel to be drawn in and transferred to the cylinder. The hole that copes with the latter is known as the 'transfer passage'. It is usual to allow the fuel to travel along the passage left to clear the piston rod and this saves machining.

The cylinder needs three, or possibly four, holes at its base. One allows the fuel to be drawn into the crankshaft, the second acts as the transfer passage or port. The other is for exhaust. As the exhaust gases have a greater volume than the fuel and they need to be disposed of quickly we usually make two exhaust passages. The transfer and exhaust passages can be more or less the same height on the cylinder. The inlet is best placed a little lower.

At the top of the cylinder is a plug and this is fitted with an adjusting screw. Known as the 'contra-piston' this tight fitting component is adjusted after assembly of the engine in order to get the right compression to make it run.

There we are then, the only parts needed to make the engine are as follows:-

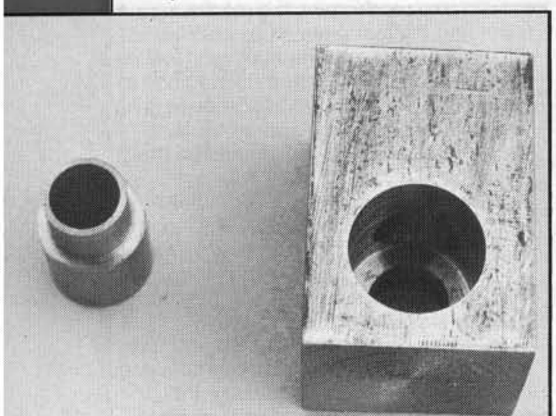
MAKE AN I.C. ENGINE

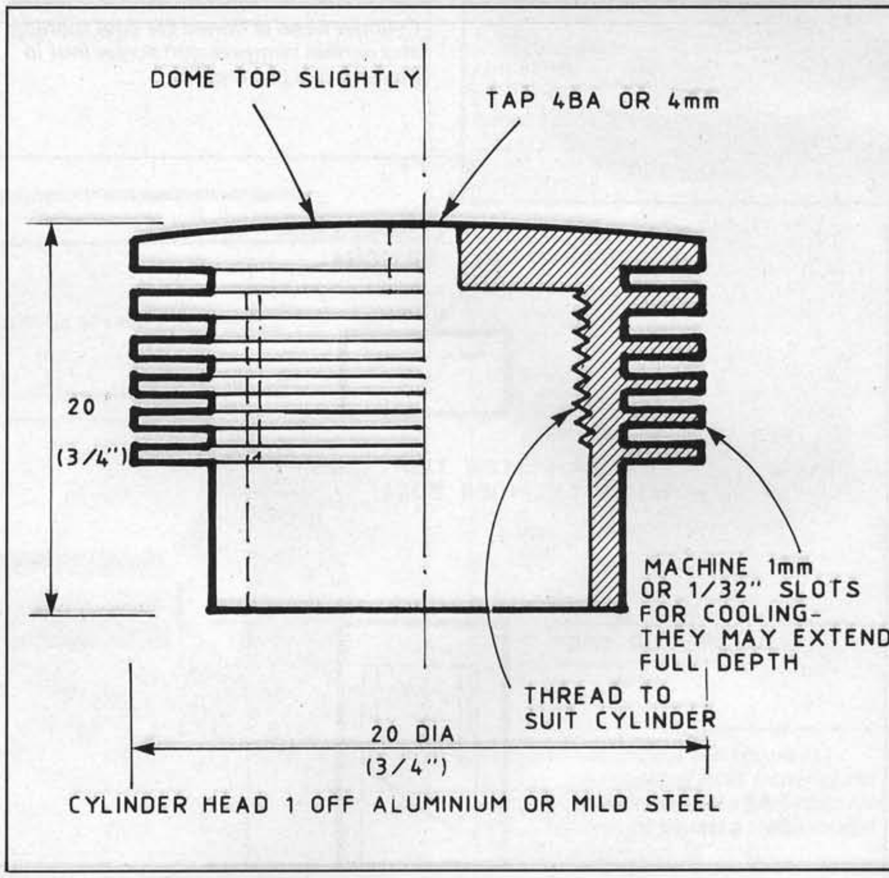


The fuel intake valve is basically a rudimentary carburettor.

Crankcase and cover, crankshaft, connecting or piston rod, piston, cylinder and contra-piston. We also need a cover for the cylinder to help cooling as the engine would otherwise run too hot. None of these are beyond the scope of the average amateur.

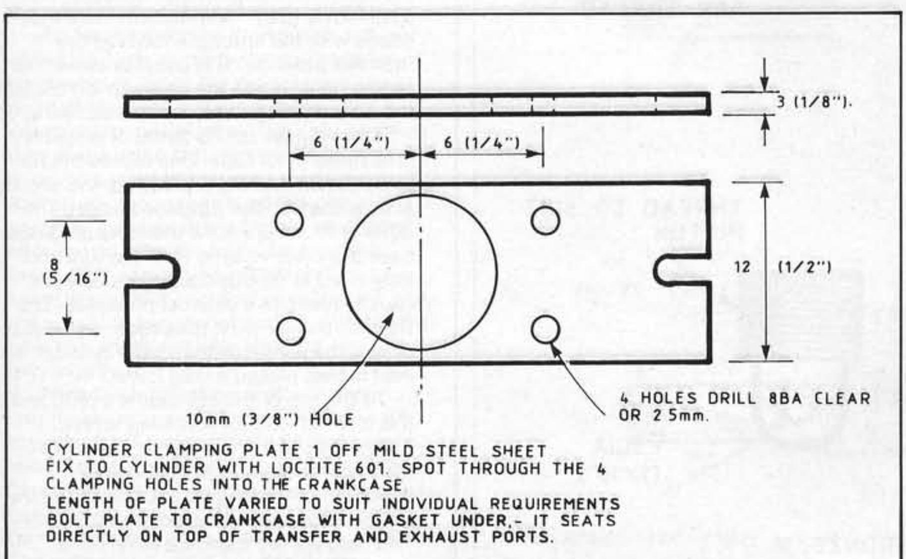
Crankcase is simply made from a piece of square bar.





The model shown has been made as simple as possible. Some two-stroke engines have a rotary valve to draw in the fuel but this one relies entirely on the suction created by the piston. The cylinder has three holes, two for exhaust and one to allow the fuel in. The cylinder is fitted to the crankcase with a clamping bar that is also used to secure the engine for working purposes. This clamping bar acts as a cover for the three passages in the cylinder, as well as holding the cylinder itself in position. The cylinder cover with its cooling fins which also houses the compression adjusting screw simply screws on to the cylinder.

Loss of fuel and compression through the crankshaft bearings is taken care of by a combination of good fitting and two PTFE washers which, as things warm up, tighten over the shaft. The whole thing is completed with a simple flywheel and to start the engine a piece of string is wrapped round this and pulled firmly to rotate the engine. The secret of the engine's success is a well lapped piston in the cylinder. If this is achieved, nothing should prevent the engine from running.



Cylinder and clamping bar; outer holes are for mounting engine.