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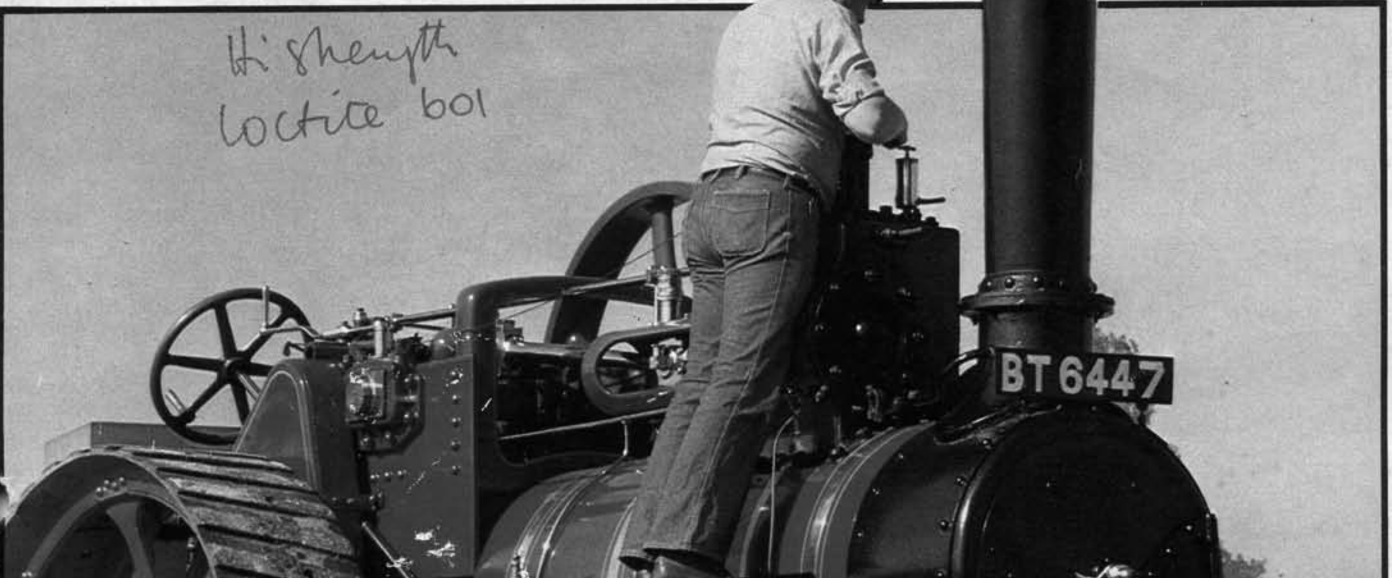
Model Mechanics

MAP HOBBY MAGAZINE



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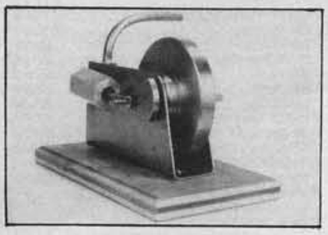
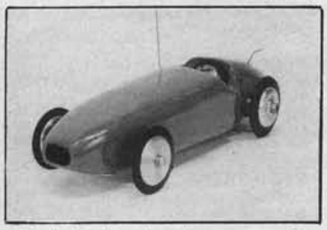
Model Mechanics

VOLUME 1 Number 1 FEBRUARY 1979

Cover picture: A fine subject for a working model. 1923 7hp Marshall Agricultural Traction Engine, owned by Mr P. C. Bath, of Roxton, Bedfordshire. *Photo by Alan Neale Picture Agency.*



Oscilating engine for the beginner—page 10.



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Editor's Chat

Welcome to *Model Mechanics,* the new magazine published for those who would like to become model engineers but lack the knowledge, skills, or workshop equipment necessary. No engineer was ever born with an inherent knowledge of engineering although some certainly take to the subject with a greater natural aptitude than others. There are a few, fortunate people who have a workshop readily available but until they have been taught to use it they are no better off than those with only basic equipment.

Whether you have already learned the elementary skills of engineering or are just beginning, whether your workshop consists of a few hand tools or the latest thing in machinery, *Model Mechanics* is designed to give you the necessary assistance to enable you to join one of the most rewarding of all constructional leisure activities — that of model engineering. You may already know of the magazine *Model Engineer.* Now published for over 80 years, this magazine has a well-established record, and is read in every country where model engineering is practised. It offers constructional and instructional articles on a wide variety of models and techniques written by the world's foremost exponents in the art. Why then have the publishers of *Model Engineer* decided to launch this new magazine? Very simply because our experience has shown that a need exists for such a publication. Many letters to *Model Engineer* have requested the type of article which to the more experienced readers would have, regretfully, been seen as a waste of space.

ORIGIN IN HISTORY

To some readers the title may have a vaguely familiar ring. In 1946, against the problems of a paper shortage, *The Model Mechanic* was launched by The Drysdale Press. A few months later the car section had grown to such proportions that it was decided to introduce *Model Cars* as a separate publication. Late in 1950 the two magazines reunited under the title of *Model Maker* which eventually joined Model & Allied Publications and ultimately became *Model Boats.*

Thus the titles *The Model Mechanic, Model Cars* and *Model Maker* were lost to the enthusiast and were not completely compensated for by the other magazines. The time is now ripe for the situation to be rectified. Although model tether car racing has lost its fantastic following of earlier years there are sufficient numbers of enthusiasts — both experienced and otherwise — to justify inclusion in *Model Mechanics.* Hopefully the seeds of this fascinating sport may be sown in the new readership and the successes of the 1950s may be repeated.

Although in full size practice the use of steam power is now almost confined to turbines, its charm has endeared it to young and old alike. *Model Engineer* owes much of its popularity to the steam engine — mostly in locomotives. *Model Mechanics* will not deviate from this trend but nor will it ignore all other forms of power. In short, whatever your interests are in the model making world, we would like to think that *Model Mechanics* will go a long way to meet them. Most of the work involved will be in metal because we feel that other materials are adequately covered by other magazines, but where a project requires the use of non-metallic materials we will not hestiate to incorporate them.

Nor will electronics be excluded. In this age of computers the use of electronics cannot be overlooked. Many models, even those powered by steam, are now radio controlled — cars using this method of operation have reached a high degree of popularity and we are fortunate in having 'Dickie' Laidlaw-Dickson, managing editor of *Radio-Controlled Model Cars* writing for us.

It was, in fact, Mr Laidlaw-Dickson who founded *The Model Mechanic* over 30 years ago and we are extremely pleased that he is associated with the re-birth.

SKILL BY STAGES

Step-by-step, *Model Mechanics* contributors — among them craft teachers from some of the country's most modern schools — will assist the reader in understanding the basic principles of steam power, internal combustion and hot air engines, workshop practice, including soldering, welding and blacksmithing, electronics and the construction of many models from a simple stationary oscillating engine to a 2½ inch gauge steam locomotive, from a simple racing car to a highly powered competition model.

Those who prefer the layouts of smaller railways will have regular articles by Cyril Freezer, editor of *Model Railways.* If we have missed anything we would welcome your letters and suggestions.

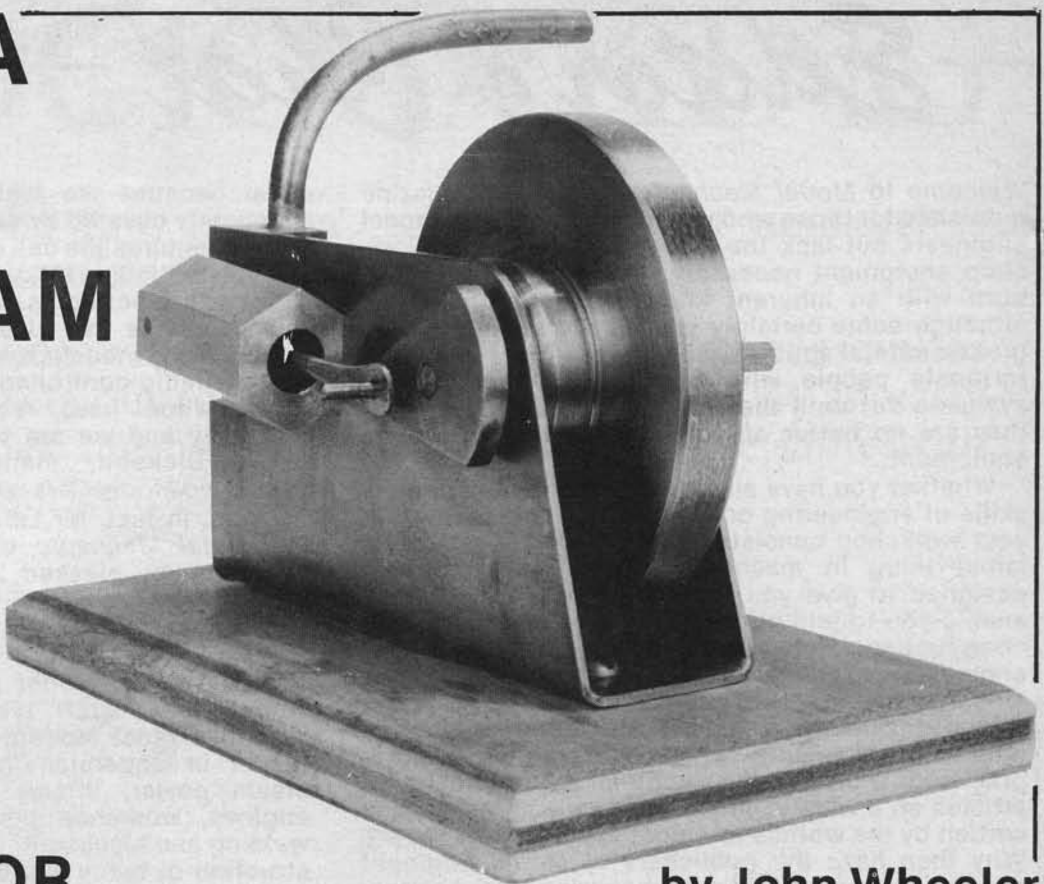
All the constructional articles will be aimed towards those readers with limited workshop facilities and where a lathe is required, one of the several small machines will be quite adequate. But we will not forget that many of you will have access to larger machines and also that many will eventually graduate to one of these precision lathes and a few words of explanation and encouragement on the finer points of workshop practice will be given from time to time.

Lastly we must not forget full-size practice. Although it is true to say in many cases models were built before the prototype was born, it is nowadays more accurate to accept that models are built to represent already operational machines. This is particularly true of steam where, regretfully, most of the full-size vehicles or engines are no longer with us. For this reason we are indebted to the preservation societies and museums for retaining — many in working order — samples of magnificent machinery which would otherwise be denied us. The full size article will therefore appear under several headings — perhaps through "Jim King's Travels", or even a "Prototypes Worth Modelling" page.

All that is left to do now is wish you happy modelling and a long, rewarding association with *Model Mechanics.*

Editorial Director R. G. MOULTON
Editor LES PORTER
Managing Director GOSPATRIC HOME
Group Advertisement Manager M. GRAY

MAKE A START IN STEAM



A SIMPLE OSCILLATOR

by John Wheeler

THIS ENGINE CAN easily be built using the minimum of machine tools — in fact except for the flywheel which requires a small lathe, it could be built using hand tools only.

Why is it called an oscillating engine? Because the admission and exhaust of steam to and from the cylinder is controlled by the oscillation of the cylinder which opens and closes the inlet and exhaust ports.

Look at Fig. 1, steam entering port 'A' pushes on the piston, turns the crankshaft and therefore the flywheel in the direction of the arrow. The piston descends in the cylinder and on reaching its lowest position, referred to as Bottom Dead Centre (B.D.C.) the energy given to the flywheel by the initial push keeps the flywheel turning in the same direction and helps the piston to rise in the cylinder; at the same time the cylinder has moved across (an oscillation) to close the inlet port and begins to open the exhaust port. The rising piston drives out the used steam through the now open exhaust port until the piston reaches Top Dead Centre (T.D.C.) when the ports are again closed. Once more the stored energy from the flywheel helps the piston pass T.D.C. and as the cylinder moves across, the inlet port begins to open letting steam in to start the power stroke again.

Of course if the inlet port was exposed as shown in the exhaust stage of Fig. 6, incoming steam, which is under pressure, would quickly vent off to the air and all the steam from the boiler would be lost. So we have to make sure that the inlet port at least is always covered by the cylinder port face at any part of the oscillation. For ease of assembly, and as ports are often made to be symmetrical, the exhaust and inlet ports are always covered by the cylinder in our design by the cylinder port face. At least we can then reverse the rotation of the flywheel by interchanging the inlet and exhaust pipes.

Two disadvantages of the simple oscillating engine are:

1 It cannot be classed as self-starting because it requires an initial push to the flywheel.
2 High pressures of steam cannot be used as they require excessive pressure from the pivot spring to seal the moving faces. In fact the spring acts as an excellent safety valve, letting the port faces lift apart if ever the steam pressure becomes too high.

This spring should be adjusted to give just sufficient pressure to hold the port faces in contact whilst running. Excessive pressure will increase the friction and slow the engine. Note how the cylinder port face on the design is filed away around the pivot spindle to reduce the contact area and therefore friction.

Mainframe Fig. 2

Mark out the shape on a piece of mild steel sheet, you could make up a cardboard template and draw round that but it is more workmanlike to mark out direct on the steel using a rule, scriber and centre-punch. It helps if you coat the steel with some marking out dye or layout fluid, then the lines really show up bright. Don't, however, use the scriber on the bend lines, here a pencil will be good enough to show the position of the bends. Now go all around the outline with light centre punch marks about ten — 15mm apart, closer on curves; these are called witness marks, often made with a light, sharp punch called a Dot Punch and will show the true position of the lines when you are filing to shape. You file to the half dot position indicating you have reached the line. Whilst the steel is on the flat, it is easy to drill the three marked holes 4.5mm dia. Centre punch first and remove the burrs afterwards using a twist from a countersink. The two holes between the lines AA and BB are to secure the frame to a wooden base using round head wood screws, and the third gives us the first position for the crankshaft bearing.

Hacksaw close to the line, don't use tinsnips or a guillotine as you will probably bend the metal, and remember hacksaw work is easier than extra filing, so hacksaw as close to the line as possible without cutting into the main shape and then file to the lines.

Now here's where those witness marks come into their own, as you file closer to the line, the line becomes part of the edge and the only indication you have on reaching the line is seeing *half* those dots still on your metal. That's why they should only be light punch marks, we don't want to see a pock marked edge. Finally go round the edge using a smooth file, finished by draw-filing to get rid of all those horrible cross scratches, and remove that burr! Now we can bend to shape, first along the line AA by clamping to the bench with a strip of wood up to the

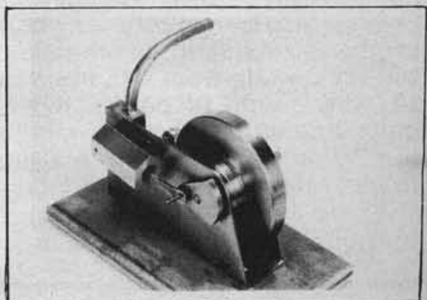
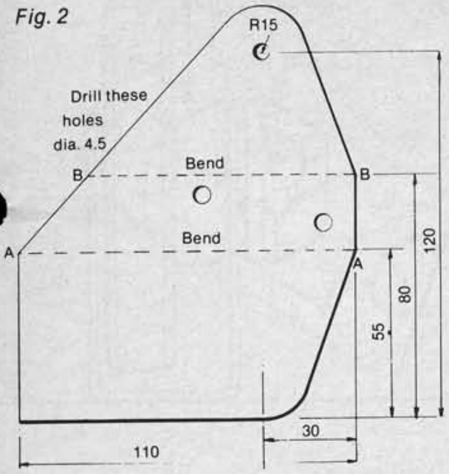


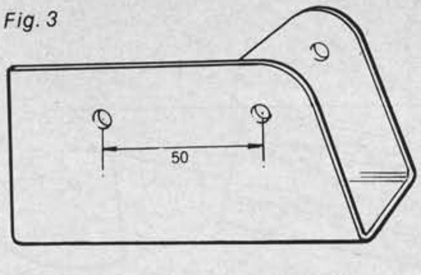
Fig. 2



line or using folding bars if available. Use a wooden or rawhide mallet to move the metal towards a right angle bend, cover the bend with a second piece of wood and some strong thumps with a heavy hammer should give you a sharp right-angled bend. Find another piece of hardwood 25mm thick, position to give the second bend BB, clamp in a vice and bend.

Whilst you have the 25mm thick piece of wood in place, use the already drilled 4.5mm dia. bearing hole as a guide to drill out the opposite side to 4.5mm dia. Check here for squareness and truth with the bottom face. Mind you, a vertical power drill will make life very easy here, but with care it can be done using a hand drill, not a hand held power drill, unless you want to end up with a flying mainframe and a broken drill bit, caused by the drill 'snatching' on breaking through the thin sheet. Now follow up with a 5.0mm dia. drill which should give a fairly accurate round hole. A good practice is to drill slightly undersize and then out to size for fairly accurate round holes. Mark out for the other 5.0mm dia. hole as shown in Fig.

Fig. 3

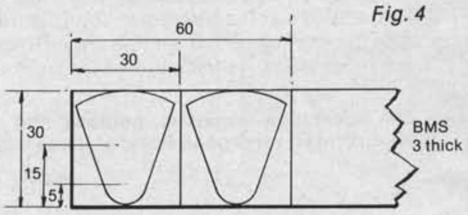


3 and drill as just explained. This will be a cylinder pivot and spindle hole. The main frame is now finished and should be screwed down to a polished piece of wood. Use brass round head wood screws, tighten down and arrange for those screw-driver slots to finish in line.

Crankshaft, crankweb and crankpin

Cut off a 60mm length of 5mm dia. mild steel rod, and square the ends with a file, that's the crankshaft, likewise for the crankpin, a piece of 15mm length steel, 3mm dia. The crankweb is a piece of flat mild steel about 3mm thick and 30mm wide, mark out two as Fig. 4, make two — it's just as easy and gives you a chance to improve the second one, always work the same piece first at each stage, that is the trial one, your second piece should then be spot on! Dot punch the outline and centre punch for the drilled hole positions. Drill the holes to match the crankshaft and crankpin diameters. Undersize first and then out to size. These holes are drilled whilst the metal is in the rectangular

Fig. 4



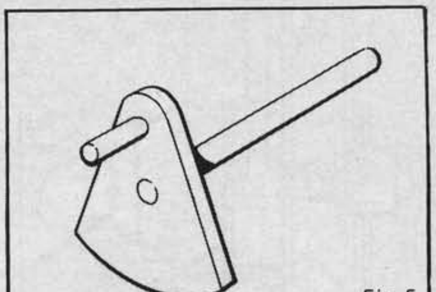


Fig. 5

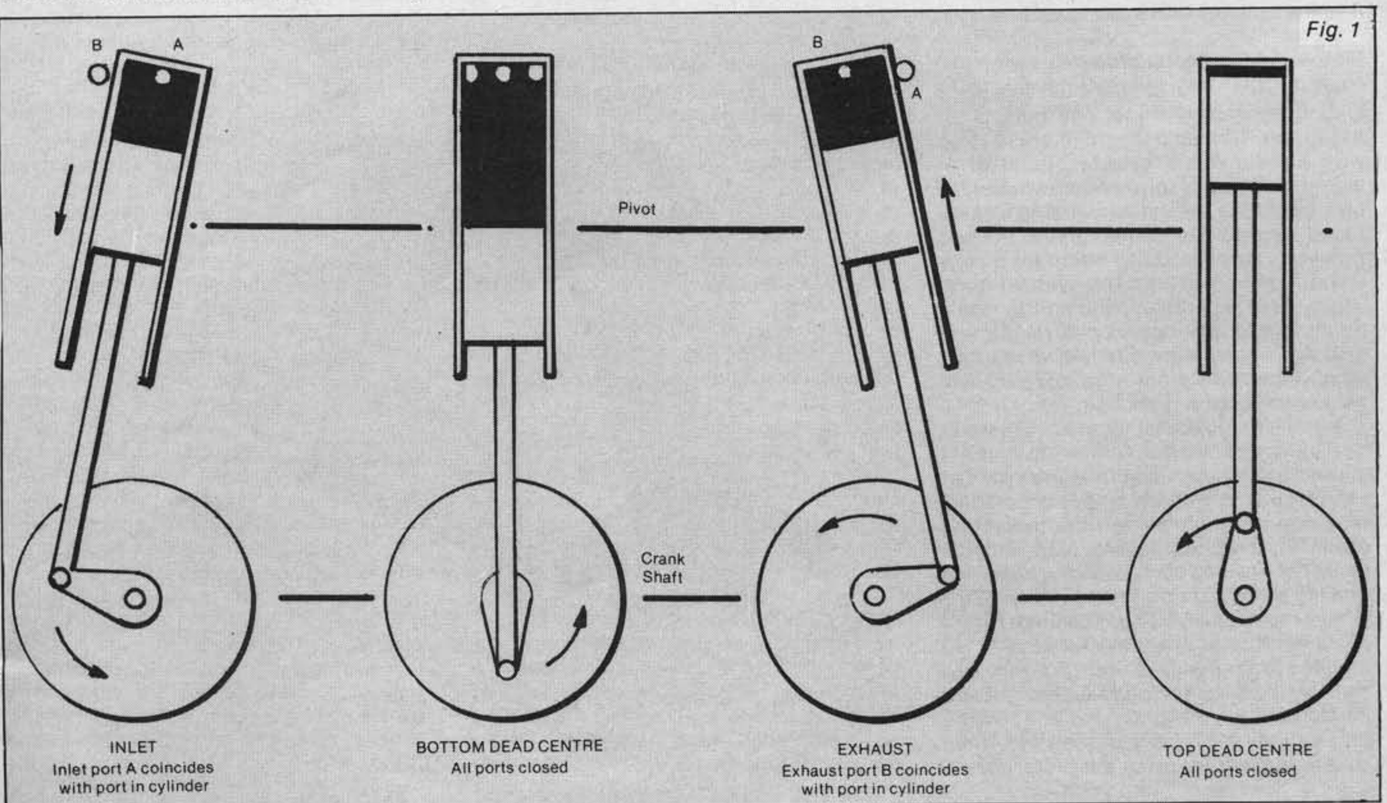
shape as it is easier to hold in the drilling machine vice; hacksaw and file to shape, clean up the edges. Fit the crankshaft and crankpin into the crankweb from opposite sides (Fig. 5) and soft solder in place or even use Loctite Super to hold in place, but clean off all traces of oil and dirt first. At least the crankshaft assembly should rotate in the mainframe and we are ready to make the cylinder.

Cylinder

A piece of hexagonal or square aluminium with sizes shown in Fig. 7 is required. Our piston will be of brass, but if only brass is available for the cylinder use aluminium or steel for your piston. These combinations work well together, don't be tempted to use the same metal for piston and cylinder as 'pick-up' and scoring of the cylinder will occur. That's the way to a sure 'seize-up'!

Cut off a 38mm length of your chosen metal, clean up the ends square to the length, here a lathe will help things along, but your filing should be up to this test. Mark out the centre on one end, set up vertically in the drilling machine vice, drill out to $\frac{23}{64}$ in. dia. and ream $\frac{3}{8}$ in. dia. or drill out to 9.7mm dia. and ream 10mm dia. Reaming is needed here to give a smooth round hole suitable to take a close fitting piston. If you have access to a lathe, hexagonal material is ideal for gripping in

Fig. 1



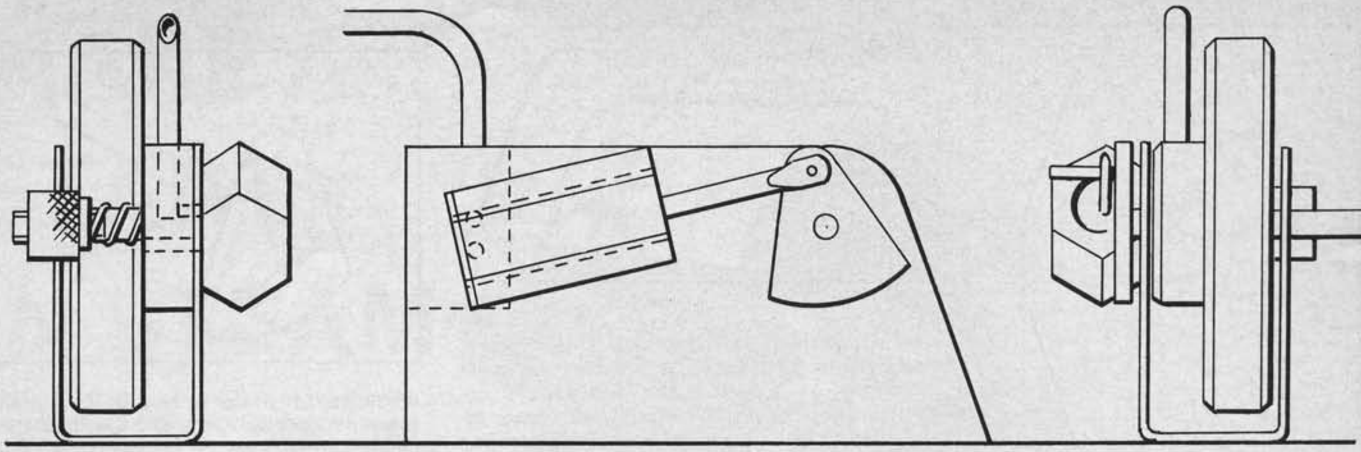


Fig. 6

the 3-jaw chuck, you can then face the ends, centre drill one end, drill through and follow up with the reamer. File off one flat face until its width is 14mm, aim for a smooth flat finish. Mark the centre of this long side, centre punch, drill and tap the thread M5, but don't break through into the cylinder and check that the tap commences square and true to the work. A cock-eyed spindle in the cylinder will not allow the port faces to remain in close contact when the engine is running. File away the centre area for approx. 8mm each side of the pivot spindle to a depth of ½mm. This should help to reduce friction. The steam port position is marked and drilled through 2mm dia. On setting up the engine we use this through hole for marking and drilling the positions of the inlet and exhaust ports, then block up the visible portion of the hole. The top end of the cylinder is closed by a turned or shaped piece of aluminium or brass, the same as the cylinder, and secured in place with Loctite or Araldite.

For the pivot spindle, a piece of mild steel, 35mm in length, 5mm dia. with an M5 thread cut on each end is prepared (Fig. 8). The short threaded end is screwed into the cylinder with a dab of Loctite.

Piston and Connecting rod

Any piston on an engine must be a good sliding fit in its cylinder and ours is no exception. Turn up a length of brass to go with an aluminium cylinder, or steel or aluminium piston for a brass cylinder, to be a tight fit in the cylinder. Using a sharp round nose tool in the lathe, turn the two grooves, now carefully skim to give a smooth sliding fit into the cylinder bore, use a sharp well-radiused toolbit to give a good finish. Face the end, centre drill, and drill and tap M4 for a depth of approx. 8mm. Remove from the chuck and hacksaw off overlength.

If you have no lathe then you will have to find a piece of brass or aluminium which is already a smooth sliding fit in the cylinder, cut off over length and gripping carefully in a vice, possibly using fibre protecting jaws, file the ends square. Mark out the centre of one end very carefully, hand drill and tap M4 whilst upright in the vice. Then when you make your connecting rod, a spare short end threaded M4 and fitted into the piston will let you grip this in a hand drill, whilst the hand drill is gripped horizontally in the bench vice. Turn the drill with the left hand and rest a 4 in. three square file, corner on to the piston which is on the right hand side of the bench vice. Your right hand controls the cutting tool which in this case is the file and produces the Vee's whilst your left hand is the motive power. Do make sure the work turns over the top towards you just like a lathe. A final smoothing over the surface with a dead smooth file should make that piston slide smoothly in its cylinder bore.

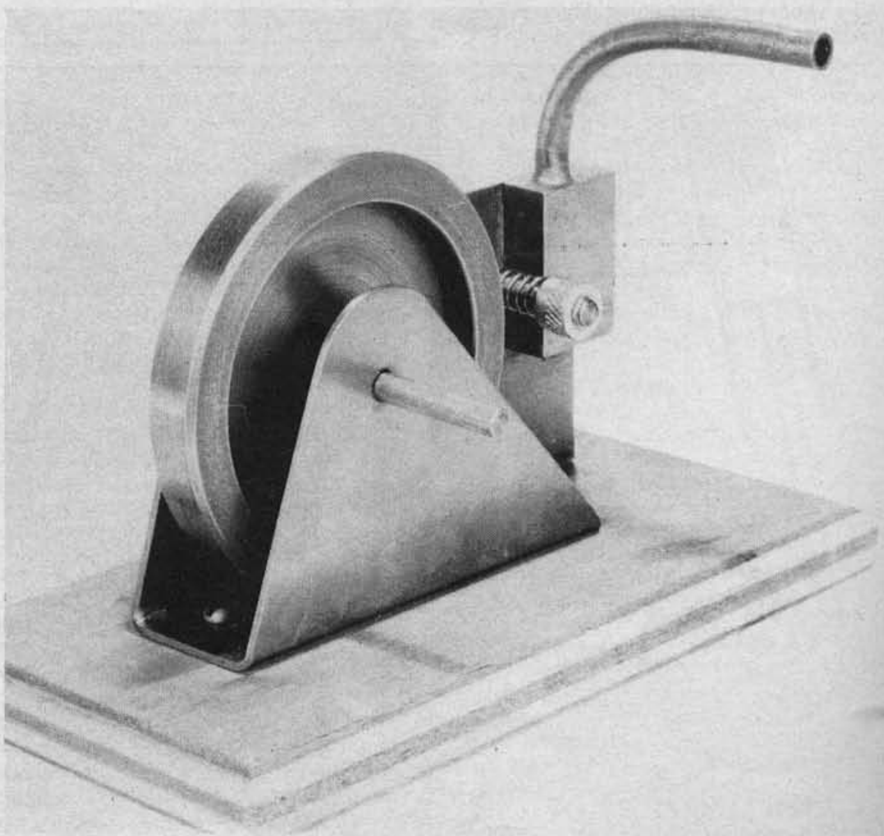
Whilst the piston is fitted to that short piece of brass rod, and can be gripped in the lathe 3-jaw chuck or the hand drill set up as a lathe, you can carefully clean up what will be the top face of the piston. We make the connecting rod from brass 4mm dia., length 45mm. Flatten one end, file to shape and drill 3mm dia. (Fig. 9). Begin to thread the other end M4, the final length is adjusted when the engine is assembled.

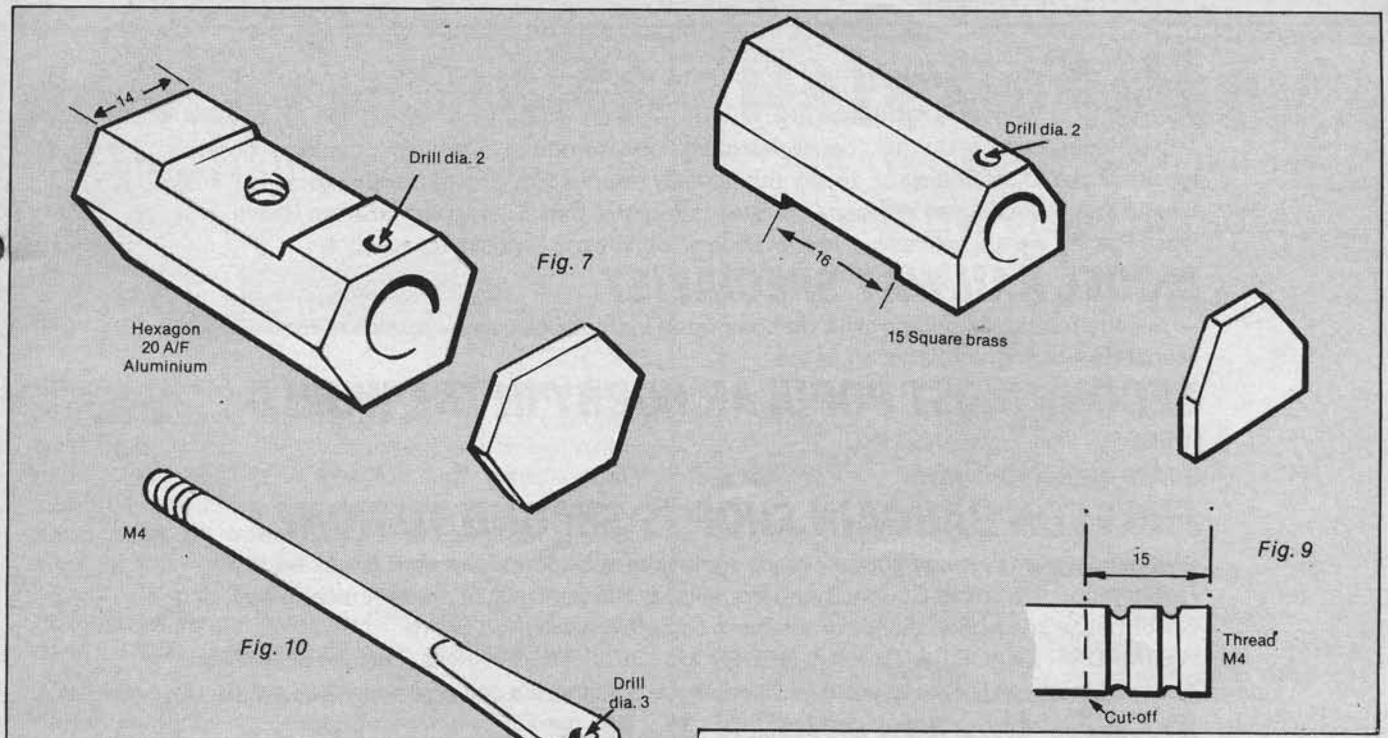
The port block is a piece of mild steel 30 x 30 x 10mm soft soldered or Loctited into the top corner of the engine main frame ready for the ports to be drilled into it.

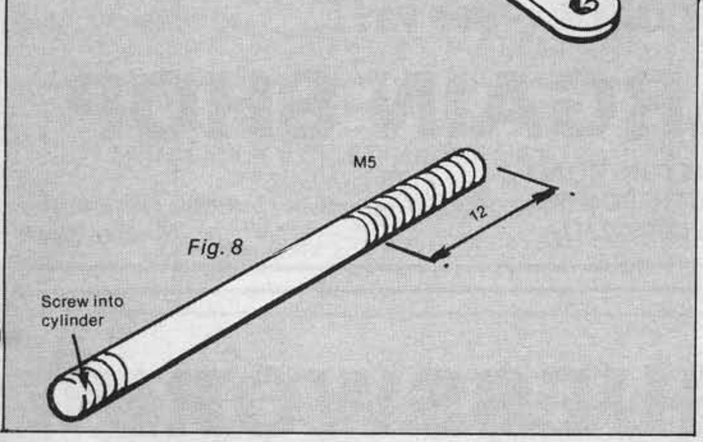
Flywheel

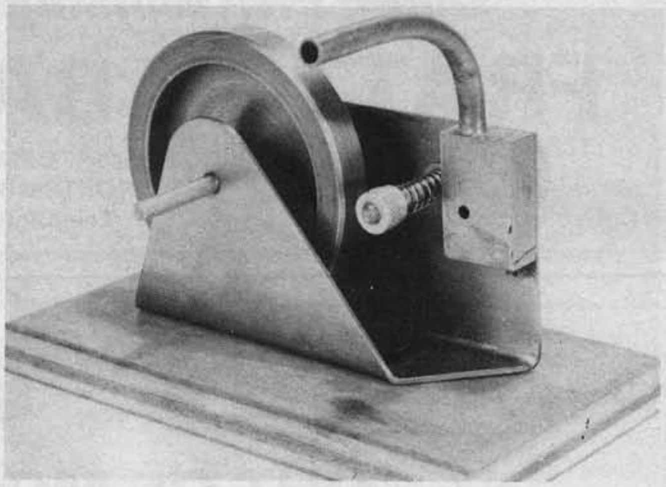
The flywheel really should be turned in a lathe to run true and smooth. You require a piece of mild steel 60 or 70mm in diameter and 20—25mm length. Grip in the 3-jaw chuck, face the end and turn down to give a shoulder 30mm dia. by 10mm length. Form a small chamfer using the left hand side of a Vee tool. Reverse in the chuck and grip by the 30mm diameter, face the end and turn the outer rim true to a suitable diameter, form a small chamfer on each corner as per drawing. Centre drill and drill through 5mm diameter to fit the crankshaft. By working this way, making the outer dia. and drilling the hole at the same setting we make certain the rim of the flywheel runs true when fitted to the crankshaft. A wobbly flywheel gives a poor impression of what could be a good engine. Furthermore a good flywheel has all its mass at the periphery, so if you are able, bore out the centre to a depth of

The oscillating engine is, perhaps, the most basic of all steam engines as there is no complicated valve gear. Future issues will feature more complex engines.









This view clearly shows the steam inlet pipe and the hole for the exhaust. Note also the knurled adjusting screw and spring.

10mm leaving a rim thickness of 10mm before removing from the chuck. Now set up in a machine vice and drill and tap M4 for the grub screw.

Assembly

You now have a choice, paint first, then assemble and try running or assemble, run, adjust, strip down, paint and then reassemble. I prefer the latter as small modifications can easily be made without the worry of damaging the paint finish. Fit a small washer behind the crankweb, slide the crankshaft in through one bearing, through the flywheel and into the other bearing hole. Now fit an M4 grubscrew to secure the flywheel onto the crankshaft, so that there is very little side movement. A slight dollop of oil makes the crankshaft and flywheel rotate smoothly.

Oil the piston, slide into its cylinder and fit the spindle into its bearing hole with more oil, find or make a compression spring 20mm long and fit with an M5 nut or turn a knurled adjusting nut, so holding the cylinder against the engine frame whilst fitting the connecting rod over the crankpin. Turn over using the flywheel and adjust the length of piston rod, screwing it further into the piston, even cutting a longer M4 thread so that the piston nearly touches the closed end of cylinder at T.D.C.

Setting out and drilling the ports

Turn the crankweb to a position where the piston rod crankpin and centre of crankshaft makes an angle of 90° (see Fig. 1 inlet power stroke), clamp in this position and using the 2mm dia. hole in the cylinder as a guide drill through into the port block, drill a hole suitable for the copper inlet pipe to meet this 2mm hole. Solder or Loctite the inlet pipe into place.

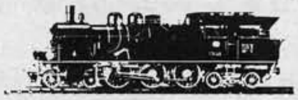
Position the cylinder, piston rod, crankpin and centre of the crankshaft to make the other angle of 90° (Fig. 1 exhaust stroke) clamp again and using the 2mm dia. hole in the cylinder as a guide, drill 2mm dia. hole right through the port block, giving the exhaust port. Fill the 2mm hole in the cylinder, which was used for setting up, not the hole at the port face, with a small tight fitting plug of aluminium wire aided by Loctite, or just fill with Araldite when you fit the cylinder top cover.

Happily you can now connect up the inlet pipe to a low pressure compressed air supply, about 5—15 lb. per square inch will do, give the flywheel a flick and the engine will buzz away. Keep plenty of oil on all moving surfaces and adjust the spring pressure on the cylinder to give the fastest revolutions possible with no loss of air from between the oscillating port faces. The engine will run smoother when all surfaces have had time to bed in. When 'running in' is completed, strip down, clean off all oil and dirt and paint. Suggested colours are dark green engine frame, red crankweb, a black flywheel with a bright metal rim and red inside surfaces and natural polished surfaces to the cylinder and piston rod.

Later on when running using steam, ensure that the rubbing port faces and piston receive plenty of oil. Further increase in power and speed can be obtained by adjusting the inlet and exhaust port positions or shapes. However I'll leave that to you because I'm sure that once you have made this engine you will want to try putting two together in a Vee formation or opposing one another in an attempt to make it self starting, the parts are so simple very little time is wasted if an item is spoilt. Just make another!

HADLEY HOBBIES

The Railway People



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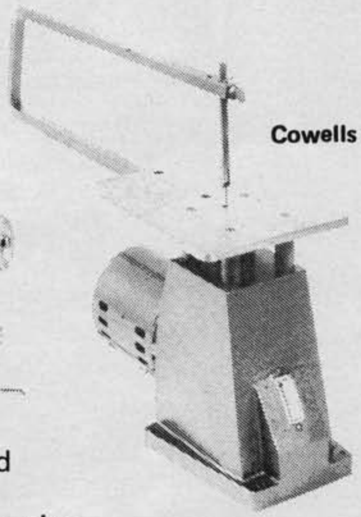

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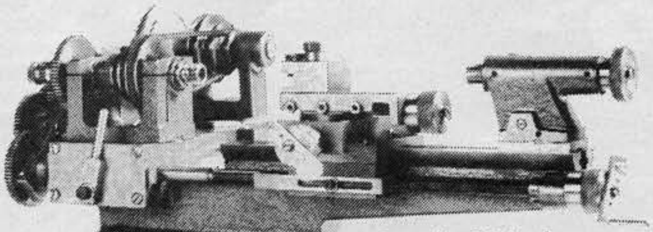

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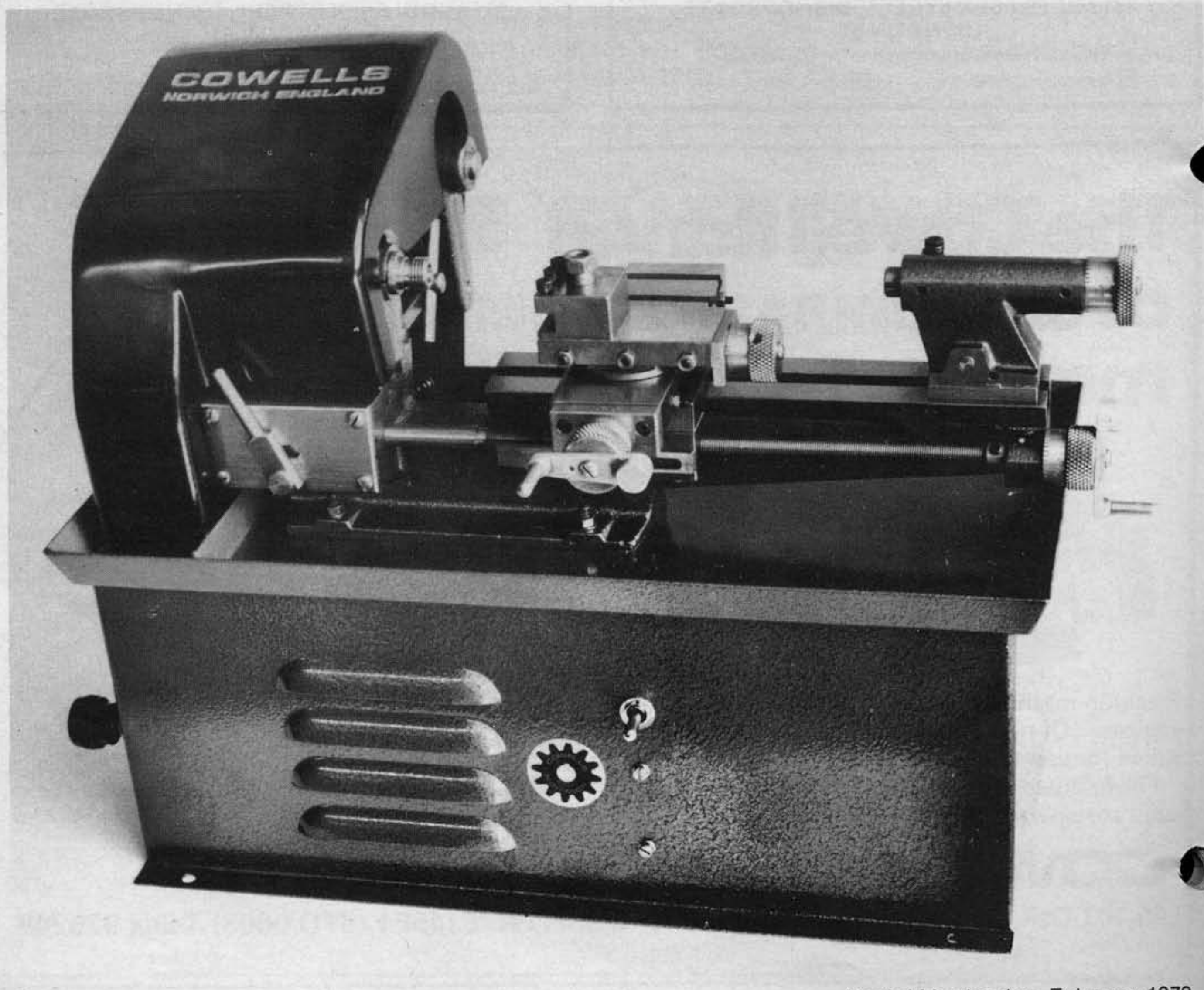
JIM KING LOOKS AT THE COWELL 90 LATHE

IN AN AGE when living accommodation is at a premium and many hopeful model engineers are living in apartment blocks where self-contained workshops are just another pipe dream, the advent of another small capacity lathe capable of being used and stored in a restricted space in a manner akin to that of the domestic sewing machine will be of interest to many. Another blow, perhaps, for sex equality for the male population? Not that the market has no other machines available to cater for this need, but the lathes generally on sale in this class and size are of continental origin and it is a market that in recent years has not had a British product to interest the potential customers.

The Cowell 90 is a lathe designed as a serious competitor in this market, one that has an ever-growing number of potential customers with the constant increase in general leisure time and activities, and one that will interest many who like to buy British if the product is as good as the overseas competitor. Original design of the machine was by Brian Perris who brought the lathe into production with several other small tools designed for this same market. Several years of hard work saw the Perris Company in a very sound position but all efforts came to an end when Brian Perris died on the way home from the 1976 Model Engineer Exhibition. Soon after the company folded and most people thought that this was the end of the line for these products, and indeed for a period the whole project was in a state of limbo until Sid Cowell of Norwich acquired the assets which included the remaining stock and the patterns. The machines were put back into production and made a welcome re-appearance at the 1977 Model Engineer Exhibition and to prove that business was meant, Cowells had a stand again in 1978 and will be regular exhibitors in the future displays.

So once again there is a British small lathe back on the market and it is already selling to the capacity of the manufacturer, for like so many other engineering companies, capacity is only restricted at the present time by a scarcity of skilled workers, and so there is a short waiting time in delivery. Hopefully this time will diminish until over the counter sales will be possible and already Cowells are setting up a network of agents so that prompt delivery of orders can be made.

What then is the specification of the Cowell 90? There can be no better way initially than to repeat that given in the Cowell Catalogue. The lathe is built in the traditional way of many larger machines with a cast iron cantilever bed. In fact all major castings are of high grade cast iron and in the machine now in use by the writer, are well-finished and have been well "seasoned" in store while awaiting



final machining. Machine tolerances are close and gib strips are fitted on the moving slides to give adjustment in use. But why talk about details when we were going to lay out the Specification for you? So here it is:—

Speed range using 1450 motor with 25mm (1") dia. pulley

Ungeared	880	500	280
Geared	188	107	60

Speed range with high speed bearings, free running speeds

High ratio	7500	4260	2430
Low ratio	830	470	270

Spindle Nose Thread	14mm x 1.5mm Pitch
Spindle Bore	6.4mm (¼")
Spindle and Tailstock Taper	'0' Morse
Cross Slide Travel	89mm (3½")
Compound Slide Travel	38mm (1½")
Tailstock Barrel Travel	32mm (1¼")
Centre Height	44mm (1¾")
Distance Between Centres	200mm (8")
Swing Over Bed	88mm (3½")
Swing In Gap	120mm (4¾")
Swing Over Cross Slide	47mm (1⅞")

Speed range using 1725 RPM motor with 25mm (1") dia. pulley

Ungeared	1042	592	332
Geared	222	126	71

As can be seen, a number of options are available for the basic lathe, it can be bought with or without a motor, motors are available for most voltages and there is a version with bearings suitable for the high speed needed for clock-making and the like. Some may find it a disadvantage that the machine is very much with it in having metric threads but this is not so as ISO threads will serve most purposes in the model, light engineering and instrument making worlds.

Accessories

To complement the lathe there is a full range of accessories, vertical slides, steadies, tailstock chucks and very good three- and four-jaw chucks made exclusively for Cowells by Pratt-Burnerd. Of course, like all machines, when it first appeared the Cowell 90 was not perfect, there are always improvements and extras to be made to any basic design and this was no exception. Already minor changes have been made, the original Perris-designed handles have been discarded and all current models are fitted with a better type of hand wheel. For the customer with the original handles a replacement will be supplied at a nominal charge. The motor case and covers are also being modified in the light of users' experience and it is the hope of Cowell's that users will let them have a continuing flow of information as to how they find the lathe in use.

The manufacturers say that the lathe can be mounted on a board and stood on any convenient surface to use. Being used to having machine tools no matter how small, firmly bolted down I was sceptical at first but after bringing the lathe from Norwich and fitting a 13 amp. plug, the lathe was placed on the dining room table and a piece of mild steel about 3 in. long and ¾ in. diameter was reduced down to ¼ in. without any problem. It would be advisable, though, to place a piece of hardboard under the machine and also to clamp any mounting board down as some movement will take place due to vibration. A good idea also is to have the vacuum cleaner handy in case you get chips or swarf on the floor for you know how funny the womenfolk can get.

Proof of the robustness of the Cowell 90 was provided within a few days of its acquisition when it was loaned to the St. Albans Society for use during their exhibition and it was just left for anyone to use. Screwed down, of course, to prevent any bright ideas of the light fingered brigade, it was worked all three days without any problem.

So much for a first appraisal of the Cowell 90 and it can be assumed that in the coming months there will be a lot of work found for it, so that any improvements can be suggested to the manufacturer and also some of those smaller turning jobs that have been awaiting my retirement can be completed. First jobs will be a couple of Stuart No. 10s for marine use and these have been selected firstly because I have an immediate use for them and, secondly, they would appear to be the largest traditional type of engine that the Cowell 90 can handle with comfort and it will prove of interest to see how the machine performs while doing the job. Perhaps when some progress has been made the Editor will find space for a resumé of the work.

Iris Phelps using the Cowell 90 lathe.

Prices:		
	Model 10-200	**£154.15**
	Model 10-200A	**£173.43**
	Model 10-200B	**£246.85**

These prices are excluding motor, faceplate and chucks. Other accessories will be required.

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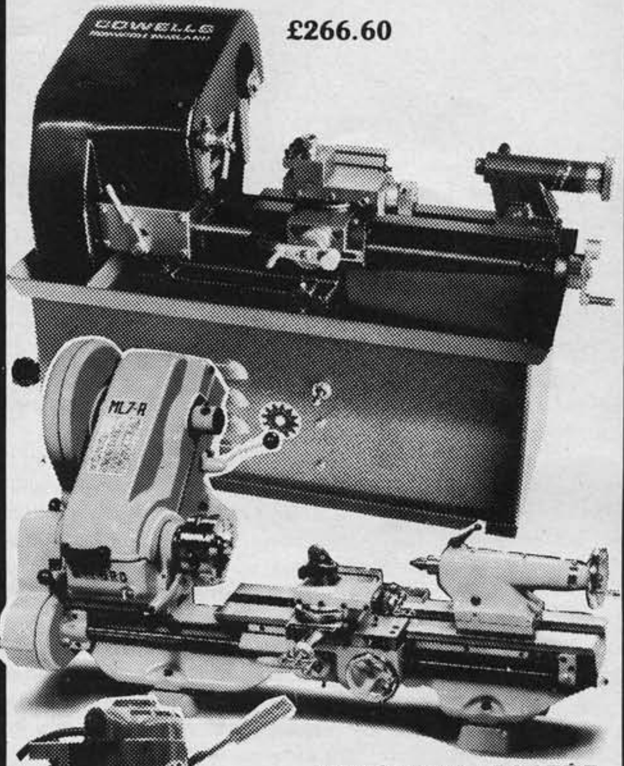

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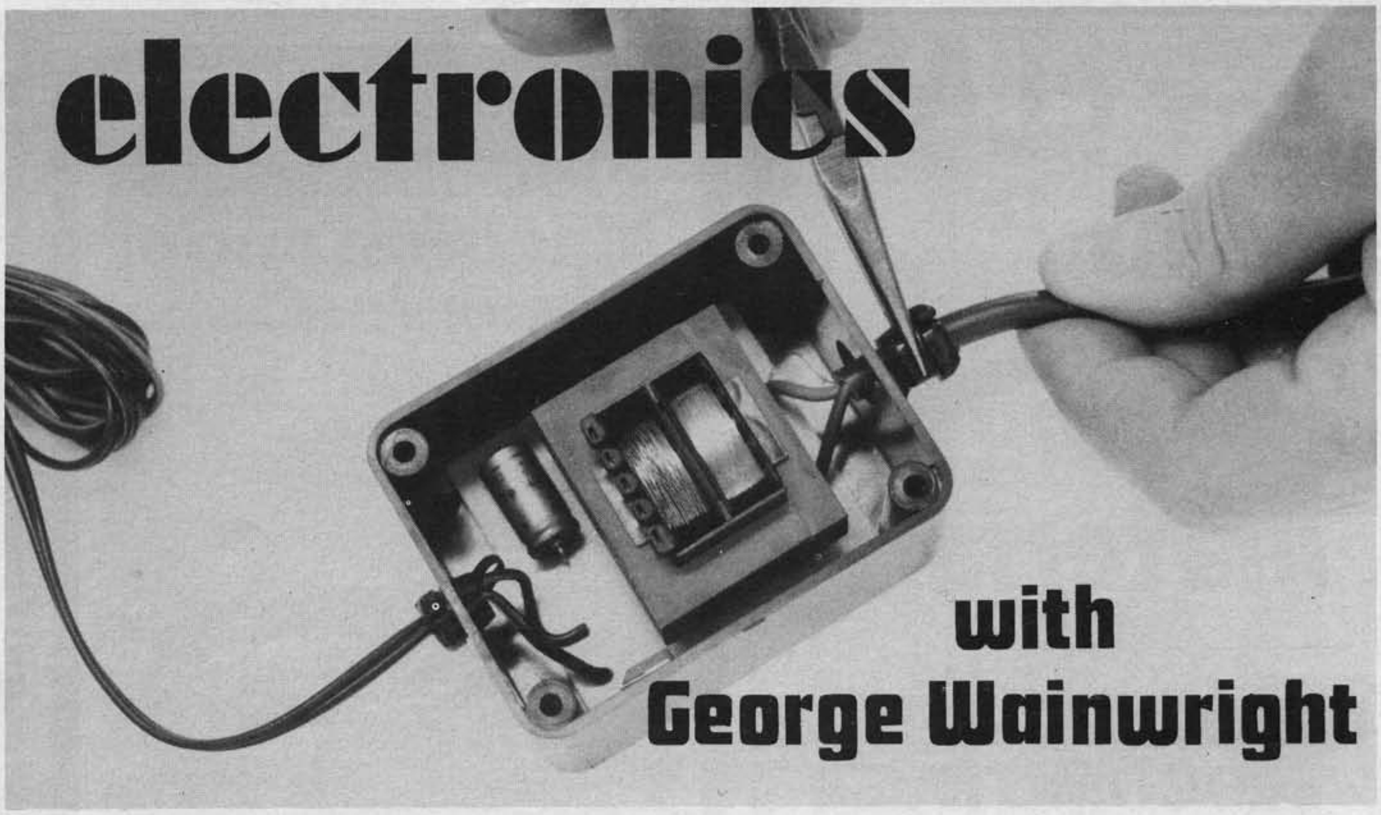


I REMEMBER BACK in the later years of World War II my interest in Electronics was first aroused, in those days it was called Wireless or maybe radio. My parents and others of the older generation had little help to offer as they had other interests, so those initial years were ones of experiment and failure, and occasionally success. However, the success was usually more good luck than a result of knowing what I was actually doing.

Some sort of line must be drawn between the aspects of Electronics as a hobby and therefore something to enjoy and a need to do some research into the subject to gain a basic knowledge of what it's all about. A hobby of this sort is essentially of a practical nature so we must find out what is really needed in order to get started. Something to build is a very good starting point as this will focus the interest in a positive manner with an end point to set our sights on. There are very many designs around for various 'Electronic' gadgets which will be gone into in greater detail later.

A theoretical circuit diagram may be fine for an engineer with experience but it is almost useless for a real beginner — so where do we start?

Tools

On the practical side we need the tools for a workbench. I have found a very more specialised equipment which will come later on; but screwdrivers and a soldering iron. Try to obtain some room for a workbench and I have found a very good one can be made out of an old door on a 'speed frame' stand fastened to a wall. Try to avoid a garage unless some form of heating can be employed as electronic components and damp don't mix.

You will see from the photograph some of the tools that will be needed from the beginning. Let's look at these tools in more detail. We will have mechanical work to do, sometimes much more mechanical than electronic, so these tools first. A set of screwdrivers with plastic handles of both the conventional and Philips or Pozidriv type and try to use the right Pozidriv size for the screw in question. It's quite easy to chew up a Pozidriv 'slot' with the wrong screwdriver size. Spanners are better than pliers to hold nuts and whilst more and more metric sizes are being used there are still a lot of BA sizes around so a set from 0BA — 8BA and similar metric sizes would be a good idea.

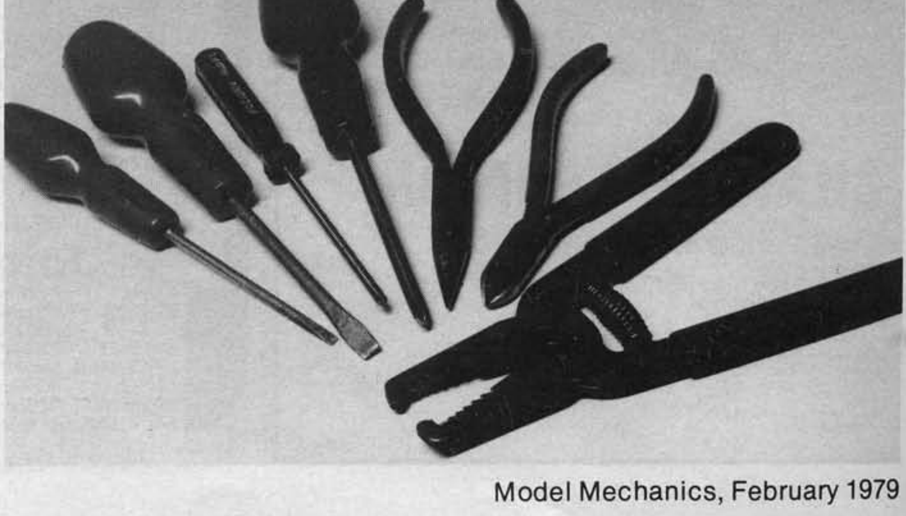
The pliers I mentioned should be of the 4 in. pointed nose type which will find uses in forming wire ends, placing nuts on screws and generally getting into places where fingers won't go.

Soldering

Soldering, now that is almost a subject in itself. Buy a good iron with a fairly fine 'bit'. I suggest a 15 or 25 watt iron such as the Adcola, Antex or Weller. All make a reasonably priced iron equipped with an iron coated copper bit which is pretinned. This type of bit, as opposed to pure copper, does not need to be filed to preserve its shape as new, just a wipe on a moistened cloth or sponge.

An ordinary copper bit tends to slowly dissolve under the continued action of solder and flux necessitating frequent filing in order to maintain a clean tip essential for good soldered joints. Talking of good soldered joints — use only a resin cored solder such as Multicore Ersin of medium gauge — say 20 swg. The flux

Screwdrivers, pliers, side cutters and wire strippers.



needed for good soldered joints is contained in the solder rather like the name through a piece of seaside rock. Any other additional flux is not necessary and may indeed by very harmful to electronic components and must be avoided.

Let's now look at soldering itself. Try twisting pieces of copper wire together first and, as you will see from the illustrations, obtain a good joint.

What we are trying to do is heat up both parts to be joined at the same time and also cause the solder to flow from the iron to each part. The iron must not remain on too long or delicate parts will be overheated and damaged. Also the iron must not be removed before time or a 'dry' joint will be the result.

To assist in avoiding a 'dry' joint, which really means one where the solder has failed to flow properly giving a crystalline effect, we rely on the flux within the solder. Imagine trying to thoroughly wet your hands without soap — it just doesn't work properly.

So placing the soldering iron against both parts (our twisted copper wires) and at the same time applying a little solder to bridge the contact between iron and wires will also release some flux as the solder melts, this will immediately cause the solder to flow around the 'job'. Whilst observing that this has taken place, try to remove both solder and iron at the same time. If the iron is left on the joint for a while after the solder is removed we use up the active flux and the joint then tends to be less than perfect. Keep trying until you feel you have the hang of it.

I now suggest that a move to a slightly more practical form of joint is made, still in a practice mode however.

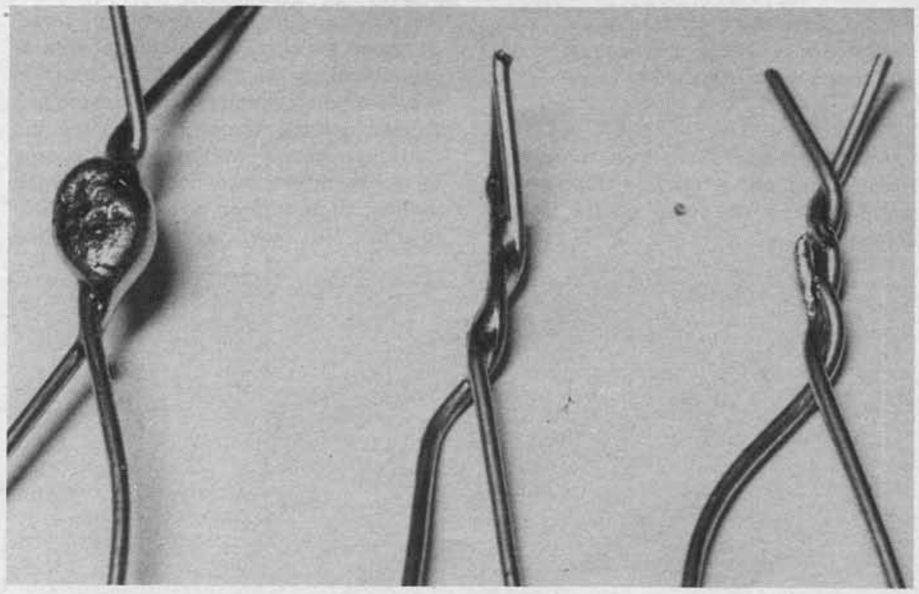
Circuit Boards

Obtain a piece of 'Veroboard'. This is a piece of printed 'circuit board' designed for the experimenter and, whilst we will talk about circuit boards later, soldering of wires and parts to these is essential at this stage as it forms such a basic part of soldering itself.

'Veroboard' consists of strips of copper bonded to a synthetic fibre base about $\frac{1}{16}$" thick. Each strip is pierced with holes about 1mm dia. Make small wire hoops like 'U's and place, say, half-a-dozen of these through any holes so that the ends stick out on the copper side. Bend the legs over at about 45° and try soldering in the same way as already described for the wires. Place the iron so that it touches both the copper strip and the copper wire and bring the solder to them both at the same time. Allow, as before, just enough time (2-4 seconds) for the solder to flow then remove both iron and solder.

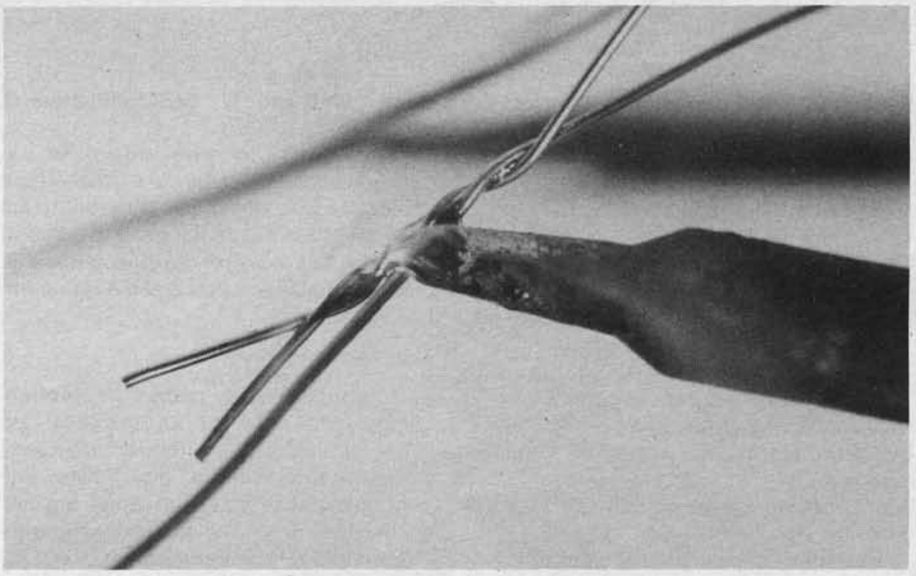
Back to the other tools. Obtain a good small pair of side cutters. Use these for cutting off the surplus wire from the joints soldering to the circuit board; but make sure that you don't cut too close otherwise you may disturb the joints.

So we have screwdrivers, spanners, soldering iron, solder and cutters. There

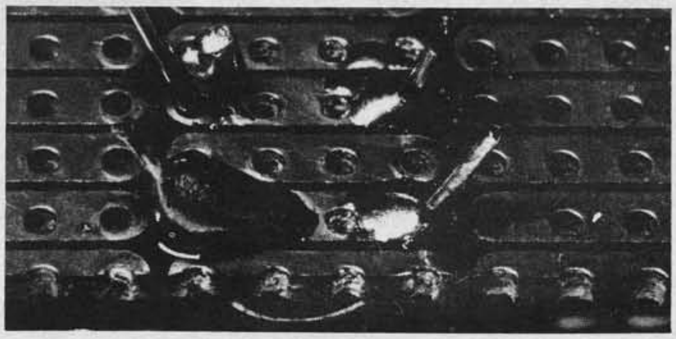


Top — **Only the centre joint is correct.**

Below — **A joint in progress.**



Above — **Soldering iron and stand.**

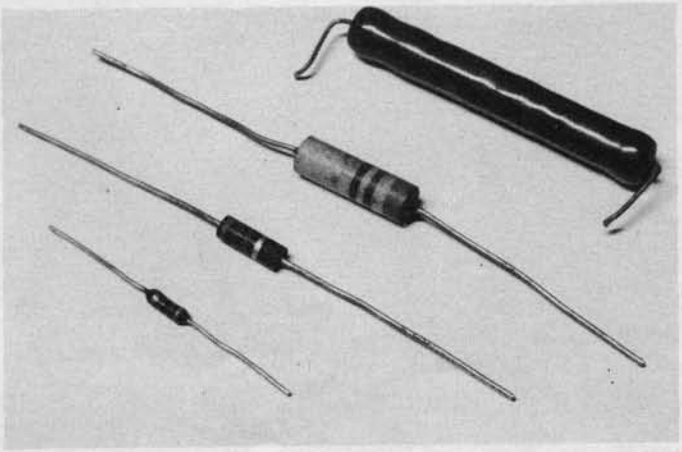


Right — **Veroboard joints, those on the left are incorrect.**

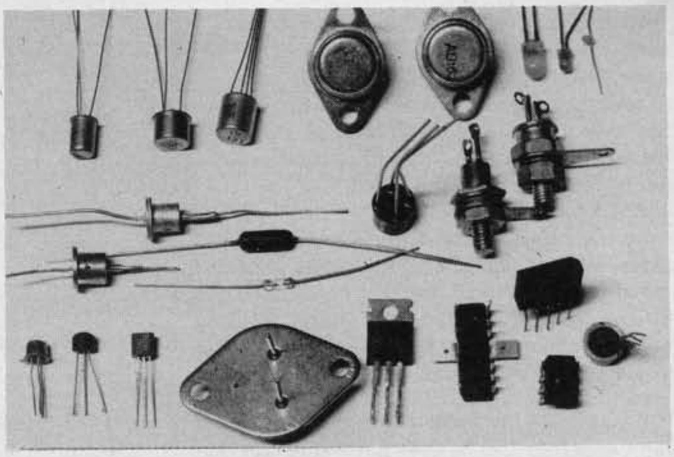
are of course many other tools which are desirable but not essential to make a start. The others will be detailed as we progress.

Components

Well up to now all we have made is a circuit board with a few wire loops so we ought to look at some of the actual components.



Resistors: ⅛ Watt, see photo for correct value Watt, 1 Watt and 5 Watt.

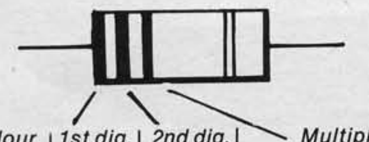


Semiconductors: Germanium, Diode, Silicon.

We can divide our components into 'passive' and 'active' types. Firstly 'passive' components are resistors, capacitors and inductors, whilst an 'active' component can be loosely described as one which provides amplification to a circuit such as a valve, transistor or integrated circuit. We usually require a combination of both types to achieve the desired operation of a circuit, be it a power supply, amplifier, burglar alarm or whatever. Each component has some form of identification so that we may tell what in fact it is.

Resistors for example are used to limit the current flow and have values measured in ohms either marked in figures or by colour code. This code, shown in the table, should be memorised. A capacitor value may also be shown colour coded; but it is more usual to mark the value and its working voltage somewhere on the body of the components. A capacitor can store electrical energy in the form of a charge. The amount will depend on the value. The greater the value, the greater the amount of energy stored. A capacitor will not allow (after the initial charge current) direct current (DC) to flow, but will pass on alternating current (AC) in the form of a charge/discharge/charge, also the effect of a coil of wire will appear different to an alternating current as opposed to a direct current. The basic unit of measurement is the Farad for a capacitor and the Henry for an inductance.

RESISTOR COLOUR CODE



Colour	1st dig.	2nd dig.	Multiplier
Black	0	0	1
Brown	1	1	10
Red	2	2	100
Orange	3	3	1,000
Yellow	4	4	10,000
Green	5	5	100,000
Blue	6	6	1,000,000
Violet	7	7	10,000,000
Grey	8	8	100,000,000
White	9	9	1,000,000,000
Gold	–	–	·1
Silver	–	–	·01

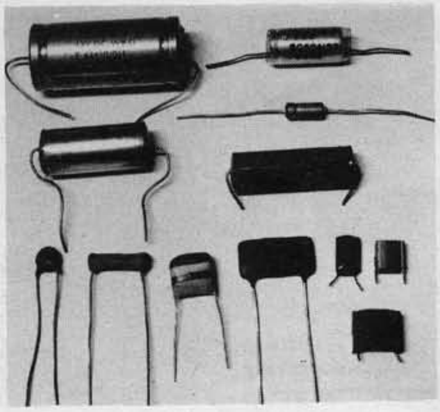
The tolerance band, right, is: Gold, 5%; Silver, 10%; None, 20%.

Transistors

I suppose the really interesting components used in an electrical or electronic circuit are the active ones, valves and transistors, etc. Valves are only used these days for rather special applications so we will not be dealing with them in this series of articles.

A transistor is a three terminal device, collector, emitter and base, made from a slice of silicon or germanium which has been 'doped' in one of many ways with a small impurity which will impart a characteristic flow of current between two of the terminals, emitter and collector, the third terminal, base, can by suitable connection, be made to influence that current flow. The main current flow can be made much greater than that which is controlling it and so we will have a useful measure of current amplification.

Various types of capacitor.



Dependent on the type of impurity used in the manufacture of each transistor will be determined by the 'polarity' of the device. Transistors can thus be made to operate in a circuit with a positive supply or with a negative supply, also by the basic design of the transistor they will have different parameters which will determine the code numbers allocated to the device, these are listed in the very many books published for reference. A very useful book for your workshop is 'Towers International Transistor Selector' by T. D. Towers which lists over 10,000 types including available substitutes. Familiarise yourself with the typical outlines of these devices and for simple circuits many types will be found to be interchangeable provided the basic parameters are adhered to, such as polarity, NPN or PNP (negative or positive), the working voltage as specified, etc.

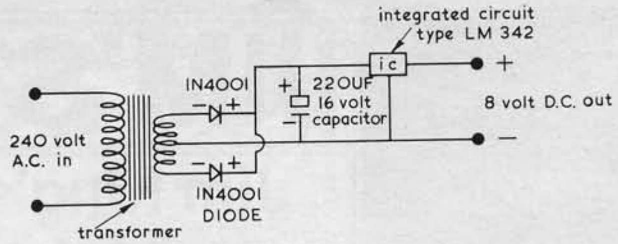
If a circuit calls for a 24v collector to emitter device, obviously one which the table lists as only having a 10v specification will be unsuitable yet a 50v device will be OK. Power handling is also specified by type number as is the ability to work at high frequencies such as the early stages in radio sets, so any alternative must have similar characteristics.

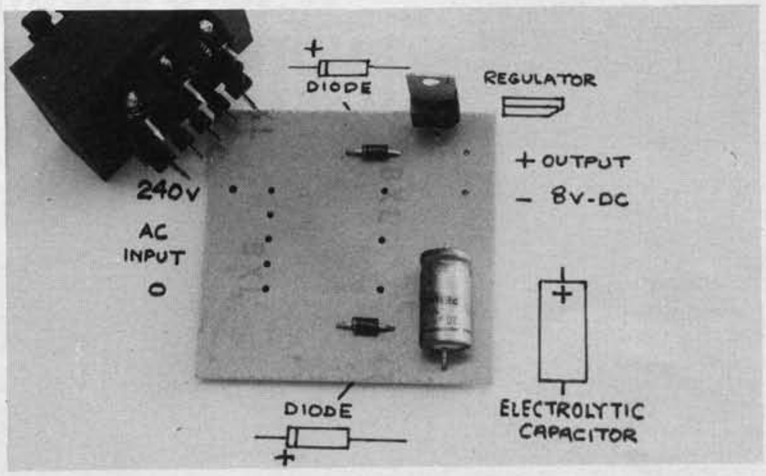
I have just mentioned that the transistor may be chosen to work from a positive or negative supply. Where do we obtain this supply you may ask. Well one obvious answer is a small battery but a nice starting project would perhaps be a mains operated power supply.

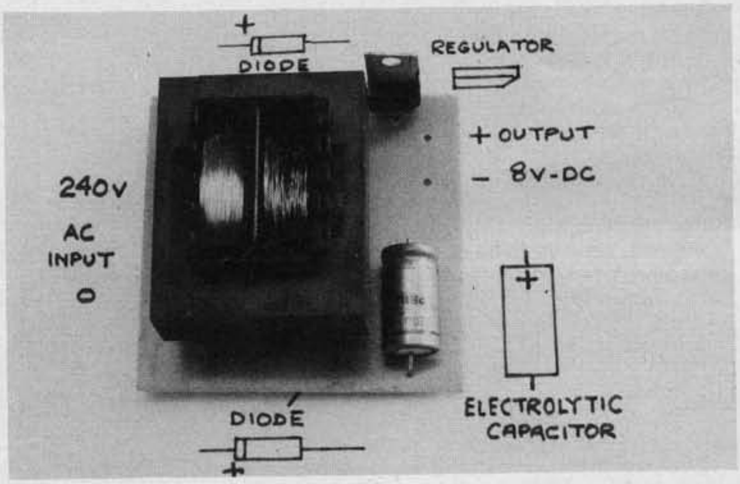
A Power Converter

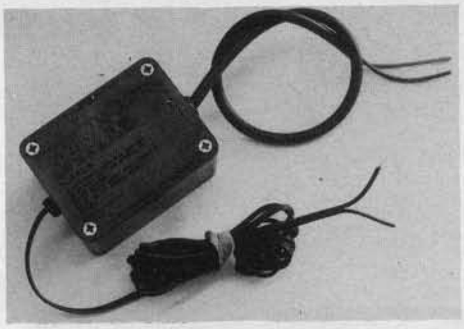
This could be made to give say 8 volts DC output at a fairly low current say 0.2 amperes. Such a power unit can be used to power many new projects and also be used to work a small cassette recorder or radio set normally running off 7.5 or 9 volts.

We have then 240v AC from the mains and we require to apply the information gained so far plus some more specifically applicable to this power supply and to finish up with 8 volts DC at the end of the exercise.









Various stages in manufacture —
Top: **Circuit.**
Second: **Printed circuit board with components positioned.**
Third: **Complete but for mains input lead and low voltage output lead.**
Left: **Complete in case.**

Firstly we must reduce the 240 volts to a much lower and safer voltage. We will use a transformer with an iron core. On this iron core will be two coil windings. One winding, consisting of a large number of turns, will be connected to the 240v supply and will produce a magnetic field in the iron core. The other winding which will have a lower number of turns will provide the lower voltage we require from the magnetic field produced by the first winding.

The voltage ratio will be the same as the turns ratio $\frac{V1}{V2} = \frac{N1}{N2}$. A small factor (efficiency) will in fact have to be introduced as no device is perfect.

However, we are not going to make the transformer, only use one purchased for the job.

Right, we now have a low AC voltage which we need to turn into direct current. The AC voltage as its name implies alternates from 0 to a positive value, then back to zero, from zero to a negative value and again back to zero.

We now use two diodes — devices which will only pass current in one direction, to change this alternating voltage into a pulsating direct voltage. This pulsating direct voltage rises from zero to a positive value, back to zero and back to the positive value, etc. If we used a pulsating voltage to power our equipment then a hum would result. We must have a steady supply like the battery we might be replacing. We achieve this steadier supply by fitting a capacitor across the DC output. This will accept a charge, as mentioned earlier, the first time the voltage rises from zero to a positive value. This charge will remain in the capacitor as the voltage returns to zero so filling in the ripples in the DC and steadying the supply.

In the design shown I have added a small integrated circuit. Although I have mentioned integrated circuits briefly I have given you no idea what they are. Due to the very concept of the IC there is no limit to the type of function that these units can be designed to perform, tens of thousands of types are available at present; but each one is built in micro miniature form by the manufacturer using the basic silicon slice that formed our transistor. On each slice of silicon many, many transistors are formed and interconnected to do the job required.

I have chosen a simple (from outside) IC, it only has three terminals and looks just like a small power transistor, but with characteristics very suitable for our power supply. If we had a small meter to check our power supply (more about meters in a later issue) we would find that the output would probably read 14 volts when not connected to a 'load', that is 'open circuit'. If we connected, say a cassette recorder we would find this voltage would fall to perhaps 9 or 10 volts. In other words we have built an unstabilised power supply. One which has a constant output from zero to full load is called stabilized and we use the integrated circuit to achieve this end. Built into the design by the manufacturers is an 8 volt reference so that whatever voltage the input rises to (within the limits specified for the IC) the output will remain at 8 volts. An added bonus is provided in this IC design. The output will fall sharply to zero if the current taken exceeds 200mA (0.2 ampere on design figure) and therefore our power unit is protected against accidental short circuits.

When building this simple power unit remember the rules for soldering, ensure the diodes, integrated circuit and capacitor are all fitted the right way round.

Remember that the input is 240v AC mains so treat it with respect, always treat mains electricity with respect.

Finally make sure that any circuit or equipment connected to the power supply has any batteries removed and is connected the right way: positive to positive, negative to negative.

To be continued.

NOTE: **The power unit kit of parts is available from AGW Electronics Ltd. See advertisement.**