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STATIONARY STEAM

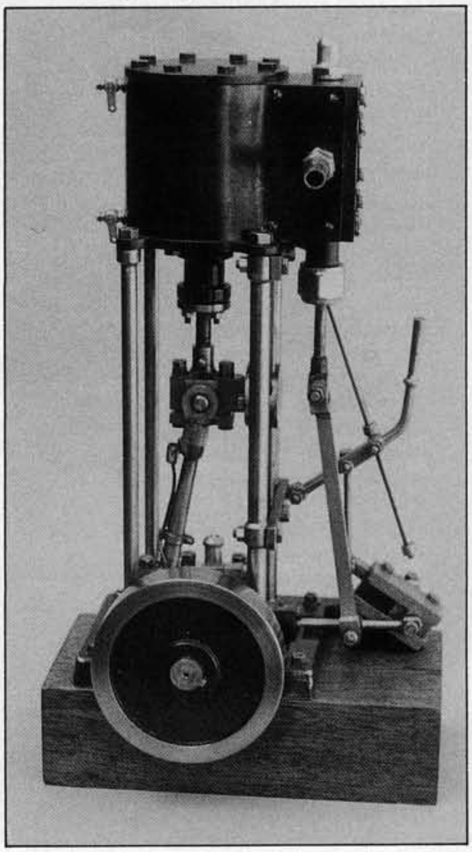
These models represent another major area of interest for the model engineer.

'Stationary steam engine' seems a somewhat odd term to use about an engine that is anything but stationary. The reason it is used is to differentiate between the engine that remains in one place to do a job of work and that which forms part of some form of transport such as the traction engine, locomotive, etc. I suppose we are just talking about plain steam engines. The invention and development of the steam engine really took man into the industrial revolution and changed the way we live forever. Perhaps we shall see a similar situation with a new technological revolution, but who knows . . .

Nobody knows who invented the steam engine but certainly many people experimented in an attempt to harness the power of steam and to get it to work for man. In the first century A.D. a man called Hero made what amounts to a small steam turbine. Whether or not the power it developed was harnessed we do not know but the design was practical if somewhat crude.

The first recorded use of steam power was for pumping, and possibly the first steam pump we have details of is one built by Thomas Savery. The engine depended on the simple principle that a cubic measurement of water makes some ten or twelve times that amount of steam. The system was to fill a container with steam and then to spray water on the container and so convert the steam back into water. A partial vacuum was so created. From the container a pipe went to a well and, if a tap was opened, the water then rose up to fill the space vacated by the steam.

This idea was to be the basis of steam engine operation for some years to come and various engineers worked on developing the system. One of these was Thomas Newcomen in whose works many engines were made for pumping water. All of these relied on a rocking beam and are known as 'beam engines'. Newcomen was later joined by James Watt. For some reason many people think of Watt as the inventor of the steam engine. The story goes that he sat at home watching the kettle and realised the lid was being lifted by steam and then went out and invented the steam engine!



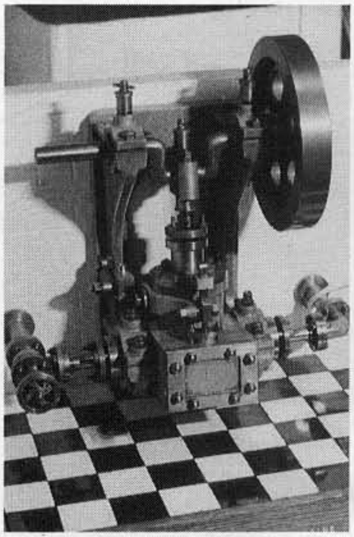
Watt did, however, carry out many improvements on the engines built by Newcomen and, as such, had a significant influence on steam engine development. At this stage steam engines were operated on a boiler pressure of two or three pounds per square inch and relied more on the difference in air pressure than they did on the steam pressure itself.

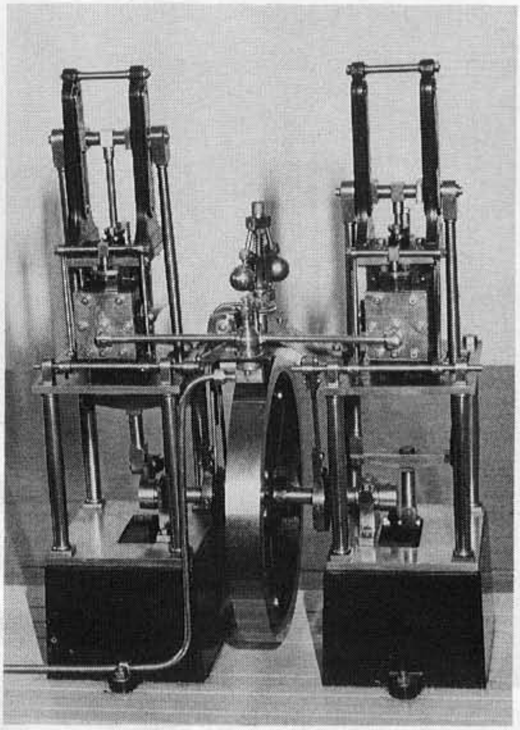
Later developments by engineers, including James Watt, made use of higher boiler pressures and generally increased the efficiency of the steam engine. We were still at this stage only seeing the engines used for pumping water and they were still heavy beam engines that literally had to be built into an engine house, the house itself often forming part of the engine construction.

Many of these engine houses still survive, particularly in Cornwall making the Duchy seem almost the home of the pumping engine. However, this is not the case. There were many fine Cornish engineers and later they were to work on and improve the engines. It was to be many years, though, before steam became commonplace in the county. The reason for this was that, although there were plenty of minerals, there was no coal available and it all had to be brought in by sea. That in itself made it expensive, but it was made even more so by the coal tax imposed by the government; not until this tax was repealed did steam became a viable proposition in Cornwall . . .

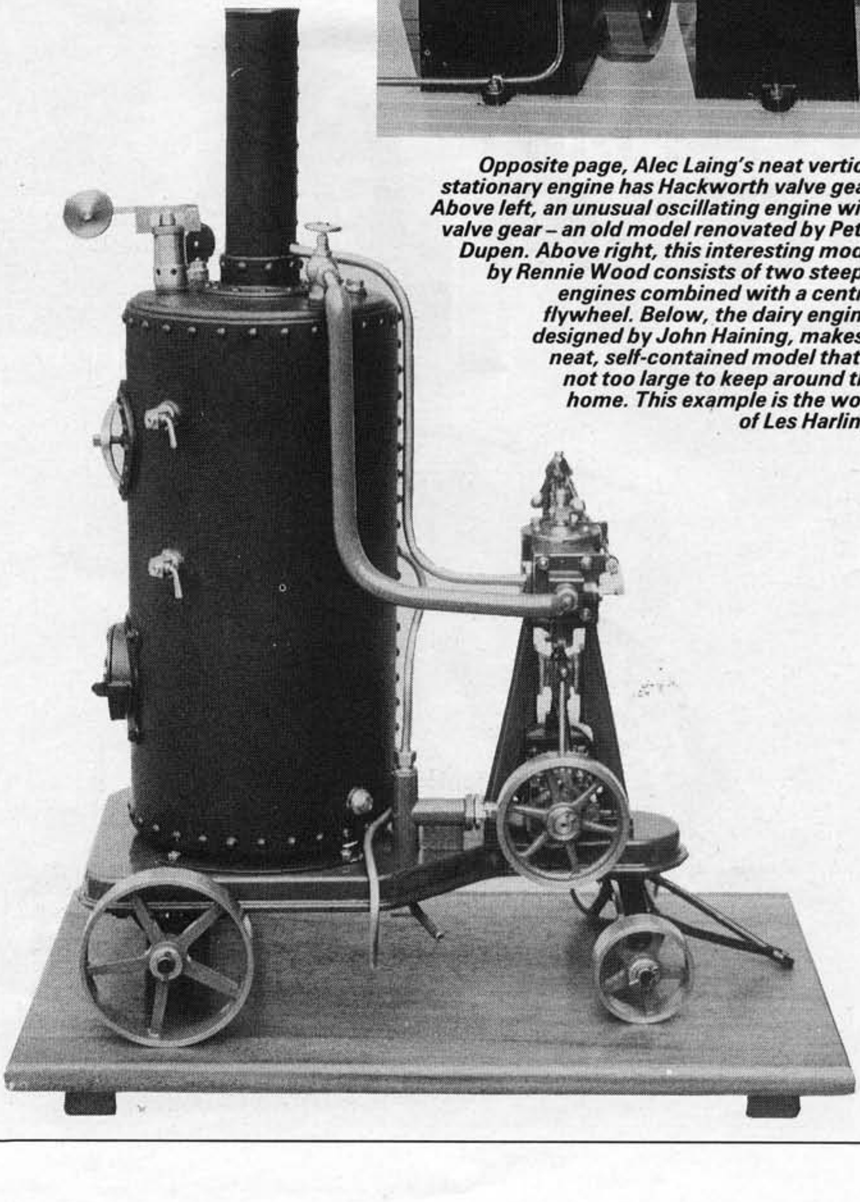
The next logical step for the steam engine was to make it rotate. So far it had only been reciprocating and the momentum had been maintained by the heavy beam moving up and down. The crank had not been thought of and when this was invented it was possible to convert the reciprocating motion to a rotary one. At first the engines were still of the beam variety and their motion was converted. Later the piston movement was to be made directly by means of the crank into a rotary movement. The engine could, once rotary movement had been obtained, be used for driving machinery and this was the dawn of the true industrial revolution. Engines were installed in factories all over the country, but particularly in the north, and used to drive machinery. Many of them lasted until comparatively recent times and I am pleased to say many have been preserved.

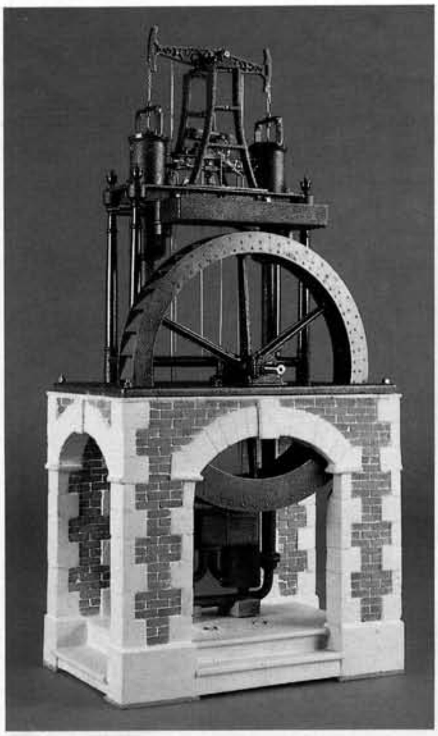
It was not to take long before the possibility of fitting such engines into vehicles was to be considered but that is another story. The stationary engine itself is worth a study on its own and well worth modelling. Apart from obvious differences such as beam and rotative types there were a whole host of developments and many different types evolved. They make most attractive models and it may well be worth while paying a visit to your local preserved engine in order to obtain details of a particular engine for yourself. In practice, most steam engines were slow-moving and quiet and if one can be seen in steam then the sight is well worth going for. The atmosphere is entirely different to that seen on a steam locomotive and it is impossible not to admire the craftsmanship that went into building these masterpieces. ■

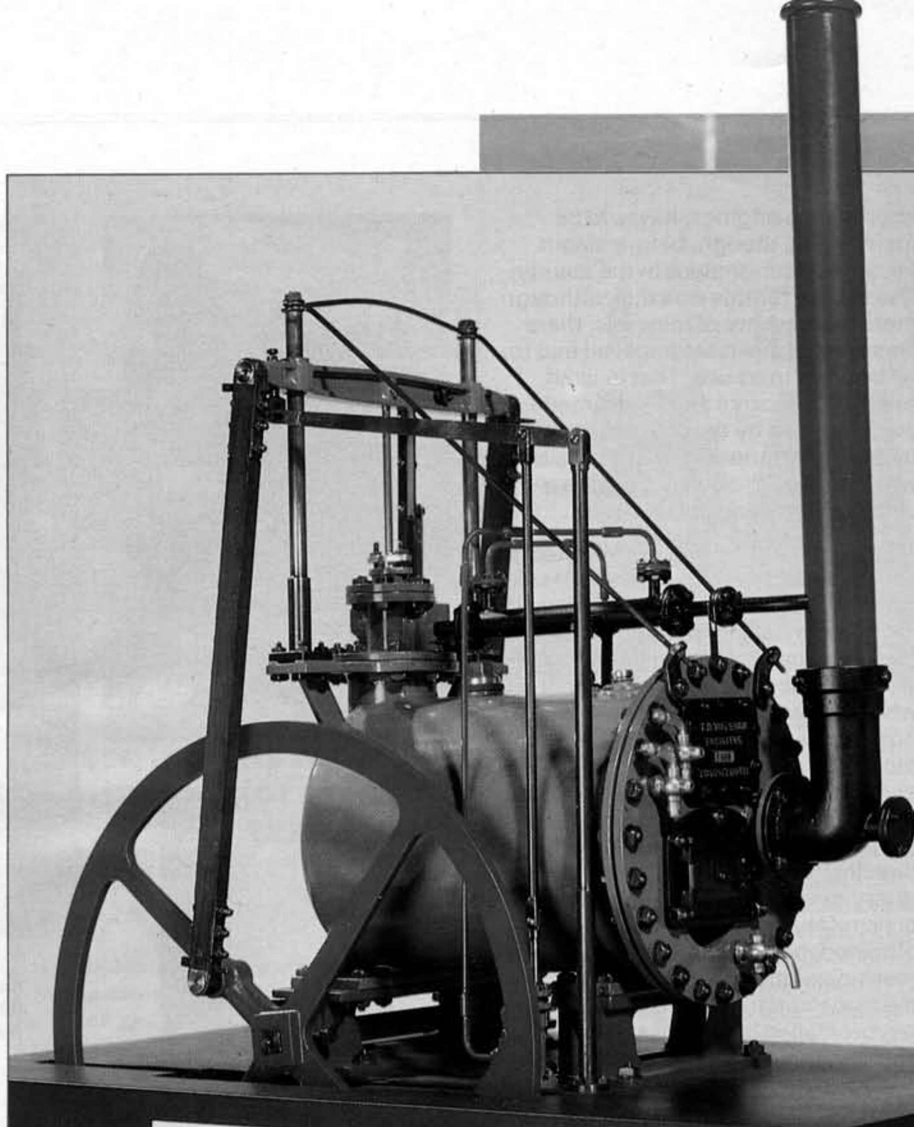




Opposite page, Alec Laing's neat vertical stationary engine has Hackworth valve gear. Above left, an unusual oscillating engine with valve gear – an old model renovated by Peter Dupen. Above right, this interesting model by Rennie Wood consists of two steeple engines combined with a central flywheel. Below, the dairy engine, designed by John Haining, makes a neat, self-contained model that is not too large to keep around the home. This example is the work of Les Harling.







STATIONARY STEAM

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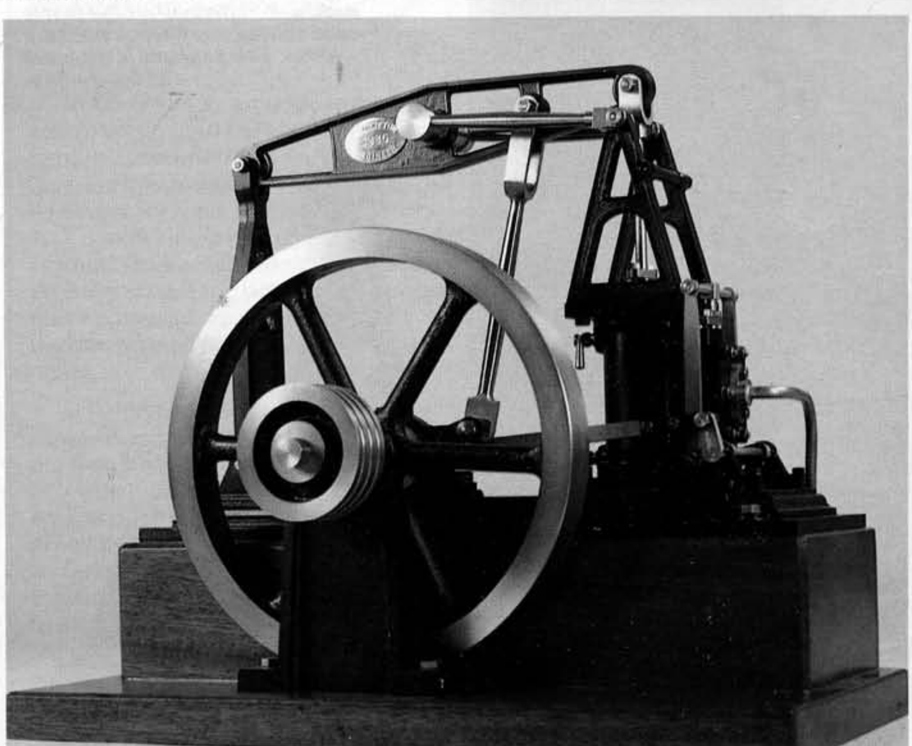
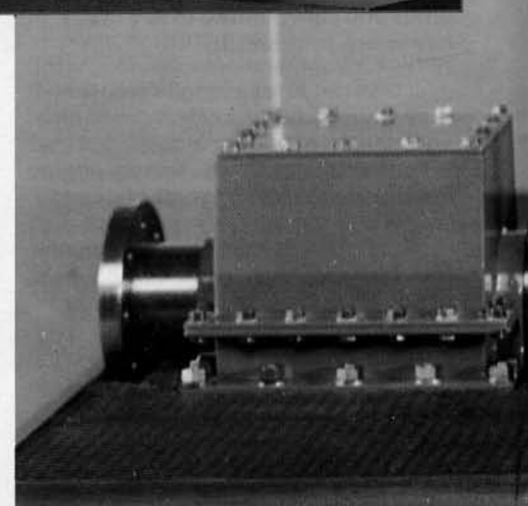
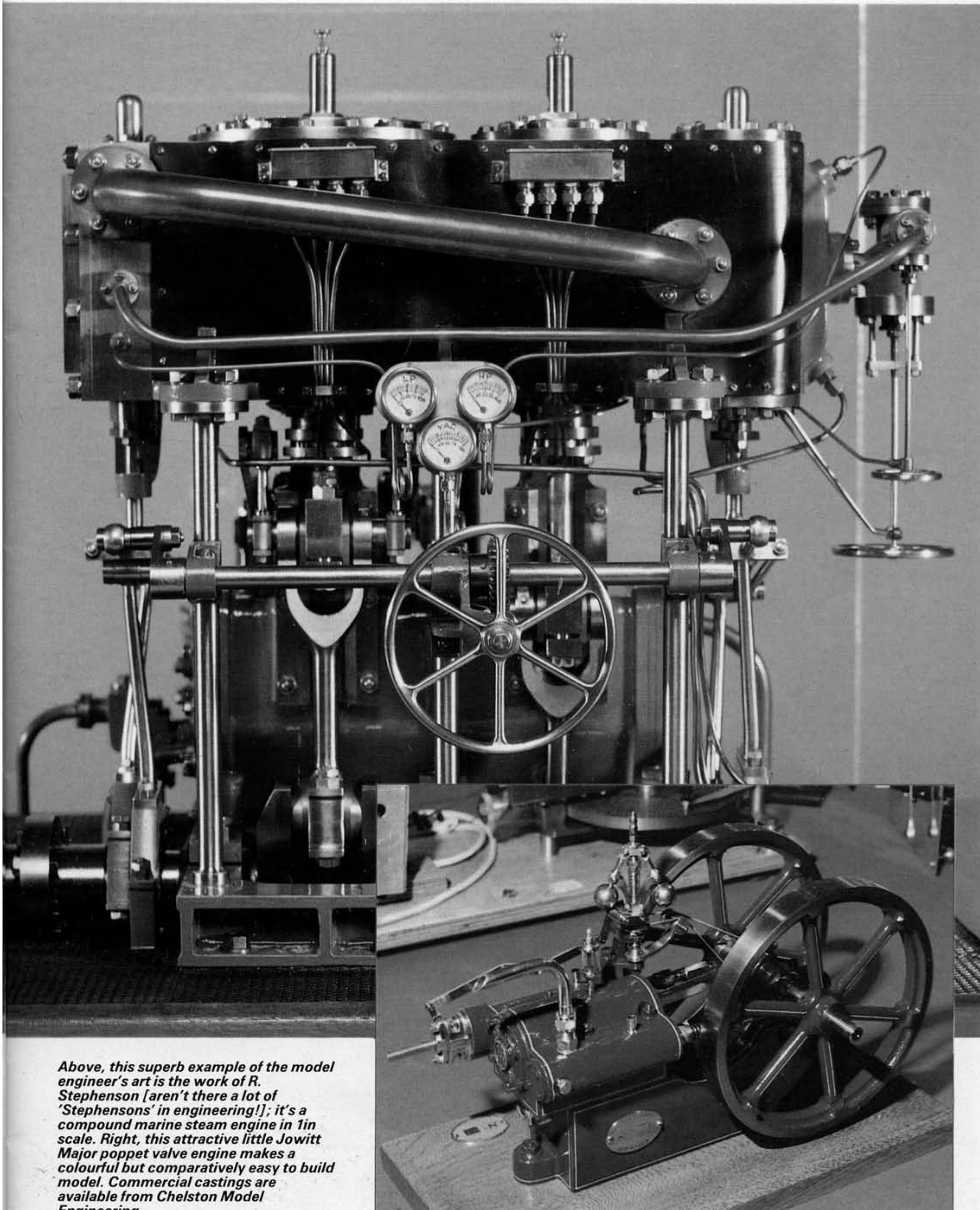




Above left, a superb model of Samuel Browne's gas vacuum engine built to 1/12 scale by R. Jarvis; model is a Model Engineer Exhibition Gold Medal-winner. Above right, Tom Walshaw's 1/16 scale model of Trevethick's Dredger Engine. Left, junior modeller Stephen Clifton built this model half-beam engine.



Above, this superb example of the model engineer's art is the work of R. Stephenson [aren't there a lot of 'Stephensons' in engineering!]; it's a compound marine steam engine in 1in scale. Right, this attractive little Jowitt Major poppet valve engine makes a colourful but comparatively easy to build model. Commercial castings are available from Chelston Model Engineering.

There is no doubt whatever that model steam locomotives are the most popular choice for construction by model engineers, although recent surveys show that there is a possible move to building other types of models under way at the moment. However, let us look at the steam locomotive and what is involved in its construction.

Whilst there are thousands of people who are interested in steam locomotives and who will go out of their way to see one and spend a great deal of time reading about them, it is doubtful if even ten percent of these enthusiasts really understand how a steam locomotive works. If we are to build a model locomotive then it can be done by simply following the drawings, and if these are correct the locomotive should turn out successfully. In my view, however, it's far better to discover something about how the real thing was constructed as this will enable us better to understand the drawings. It can also make viewing the real thing a great deal more interesting than merely gazing at the locomotive with admiring eyes, as we will have a much better understanding of what went into the construction of the original.

It's not difficult to see why working live steam model locomotives represent such a major section of the hobby.

Let's start with locomotive types. A typical British locomotive will usually present smooth lines and a comparatively plain exterior – which makes models of such types easier to build! However, if we take very early locomotives, then there are some complications for the builder due to the Victorians' eagerness for embellishment. Later British prototypes tended to be more complicated as the smooth line was somewhat lost in the search for efficiency, and there came a tendency by designers to put the plumbing on the outside as did the designers of many of the overseas countries.

What then was the advantage of this smooth appearance of the British locomotive? The answer is none at all really and, in fact, by putting most of the plumbing and much other equipment on view maintenance was very much easier! The result was, of course, that the cost of keeping a British locomotive running was much higher than an overseas type as parts were so innaccessible that it was time-consuming to get at them.

I should point out that many of the locomotives running in what was the British Empire and also in some other countries also had the smooth British lines purely because we built

locomotives for countries all over the world and our private locomotive builders were well-known everywhere. Long after steam locomotives disappeared from British railways, companies in this country were still making them for export.

Locomotives are mostly constructed in two types; the tank locomotive and the tender locomotive. The tank carries its water in tanks which are part of its construction and its coal supply in a bunker; in the case of some small industrial engines the coal was just thrown onto the footplate, which is the name given to the floor of the driving compartment. The reason being that there was never going to be any need to carry any great amount as the locomotive was confined to running in a comparatively small area.

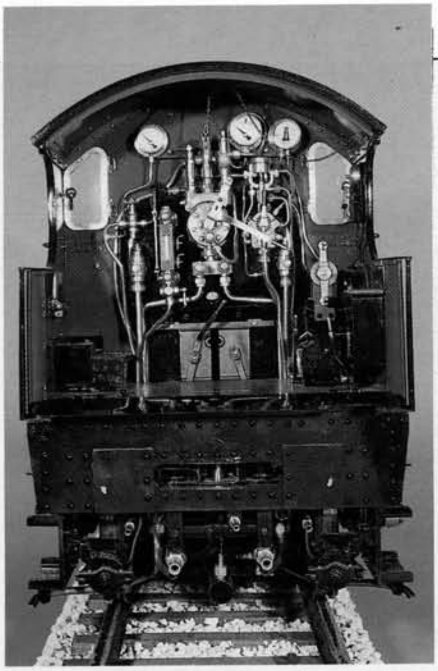
Tank locomotives used by the mainline companies were so constructed to make a turntable unneccessary. The locomotive could travel backwards as easily as it could forward; the front of the cab, which was for the protection of the driver and fireman, was called a 'spectacle plate', the reason being fairly obvious when one looks at the way it is constructed. On tank locomotives there was almost always a rear spectacle plate also to protect the driver and fireman from the elements. One thing to be borne in mind when making a model is that, if a tank engine is under construction, this rear spectacle plate will prevent the driver

STEAM LOCOS

or operator from getting at the fire and so it will be necessary to make it removable, or at least partly so, in order to get at the controls.

Although tender locomotives were sometimes run in reverse it was not a practice that was encouraged. There was a distinct danger of the tender leaving the rails and also there was the problem of the crew being open to the elements. With a high tender this was less of a problem, but, even so, it was still there . In cases where a tender locomotive had to be run backwards on a more or less permanent basis there was sometimes a rear spectacle plate fitted to protect the crew.

The tender was used to carry water and coal. The usual practice was to make the water tank at the rear and sides with a well in the middle which held the coal. The tender would have a hand brake of its own as well as being fitted to the train breaking system. It would also, possibly, have a pair of



Backhead detail of Bill Carter's magnificent 5in. gauge Dukedog "Earl of Berkeley". Below, this fine 5in. gauge "Lion" is the work of Keith Taylor-Nobbs.

tool boxes, one on either side. Although referred to as 'tool boxes' these were frequently used by the crew to hold spare clothing and any food that might be required. Tea or coffee was often made using the water from the boiler and the stories of frying eggs and bacon on a shovel are quite true!

The tender obviously had to be coupled to the locomotive with a strong coupling and connections were also necessary for the pipes carrying water to the locomotive. Tenders came in a wide variety of sizes. There were some small four wheeled versions but most were carried on six wheels. The Southern Railway, in particular, had tenders fitted with bogies and on north American and some South American railways where very long journeys were the order of the day tenders could be absolutely massive and as big as the locomotive itself.

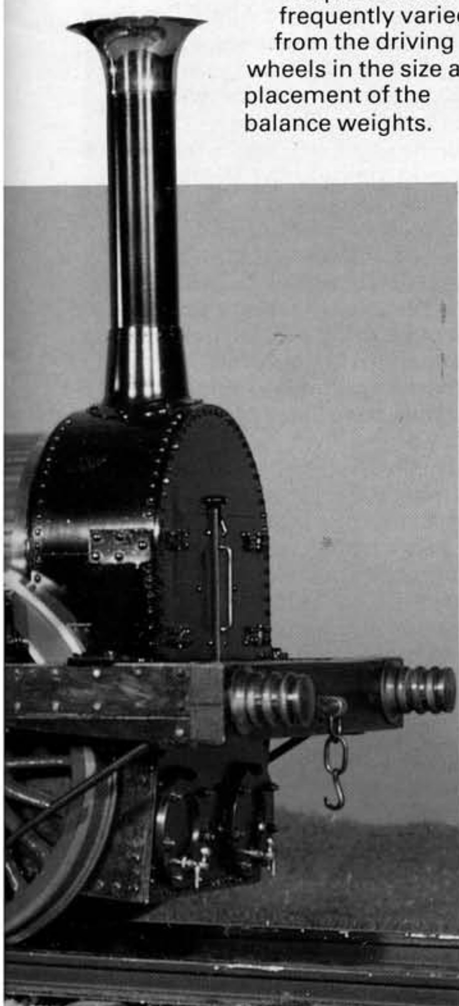
For the modeller, the construction of a tender should not present any great problems. It is a long job, though, and it is wise to build the tender before the locomotive as otherwise you'll be in for a long wait before the locomotive can be run. It is customary to fit a hand pump in the tender of model locomotives. This serves two purposes; it can be used to fill the boiler when it has been emptied but, more important, it can be used in an emergency.

The connection of piping from the tender to the locomotive can be a problem. If the water being carried is going to a mechanical pump on the locomotive or to an injector, then the water can be carried across by means of a push-fit tube in rubber or plastic. If it is to carry the water from the tender hand pump there must be a strong mechanical connection as the pump will have to overcome the pressure of the boiler. There are several ways of doing this and they have been well described in numerous books and magazines. In this modern day and age it is as well to think in terms of a pressure fitting in brass connected to a plastic tubing, the actual connection being made with a screw fitting.

Briefly, for those who have no knowledge of such things – although in my days as a boy it was common knowledge – I will describe wheel arrangements. The main pair of wheels on a locomotive are the driving wheels. These are connected via a crank and connecting rod to the cylinders and, as the name suggests, do the actual driving. Connected to these by connecting rods are the coupled wheels which are of the same

diameter as the drivers. The number of coupled wheels will vary depending on the locomotive. Some early locomotives did not have coupled wheels and were referred to as 'singles'.

Coupled wheels frequently varied from the driving wheels in the size and placement of the balance weights.

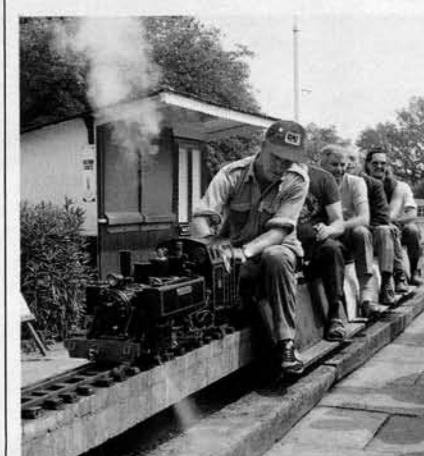


However, as the modeller is usually dependent on his supplier for wheel castings there may have to be some artistic licence here and the coupled wheels may have to be the same size as the drivers. On some foreign locomotives, in particular some designed for the French railways, the driving and coupled wheels differed completely. Obviously they had to be the same size but drivers might have spokes and coupled be solid or vice versa.

There are also likely to be some smaller wheels on the locomotive; these are placed in front of or behind the main wheels. They are mounted on either four-wheeled trucks or two-wheel ones, the four-wheeled varieties being referred to as 'bogies', the two-wheeled ones as 'ponies'. On some foreign locomotives there may be more than four wheels on the bogie. The wheels behind the driving and coupled wheels may be constructed as a separate unit but not able to move from side to side as would bogie or pony trucks.

It may be necessary, if the model locomotive is being constructed to run on sharp radius curves, to depart from the prototype and make these fixed carrying wheels in to bogies which will move. These leading and trailing wheels where fitted make a considerable difference to the smoothness of the running of a locomotive as at the front they act as a guide to get the locomotive smoothly into the curves and, in the rear, the fixed truck in particular acts as a support and prevents an oscillating motion being set up, rather like a car shock absorber does. Making a locomotive fitted with these wheels obviously entails extra work and a good well-designed bogie truck can be time-consuming. For the beginner there is something to be said for building a locomotive with driving and coupled wheels only.

The locomotive, and indeed the tender as well, are supported on frames. These, as far as British and



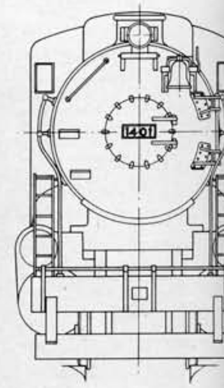
some overseas prototypes are concerned, are made of mild steel plate. They are separated and supported at the outer ends by the buffer beams or, as the rear one is called on a tender locomotive, the 'drag beam'.

Above top, T.G. Phelps' 3.1/2in. gauge G.W.R. locomotive "Saint George". Above, R. Sourbutts with his "Mountaineer" 3.1/2in. narrow gauge tank locomotive and happy passengers.

On all but the smallest models there will be one or more spacers between the frames at some position along its length. For the simpler models these need only be a piece of steel plate with some angle iron riveted to it and bolted to the frames. These spacers will sometimes also support the valve gear and often the feed pump as well. The feed pump is used to supply water to the boiler while the locomotive is travelling; it is something very rarely found on the full-sized machine but is useful on models, particularly in the smaller scales.

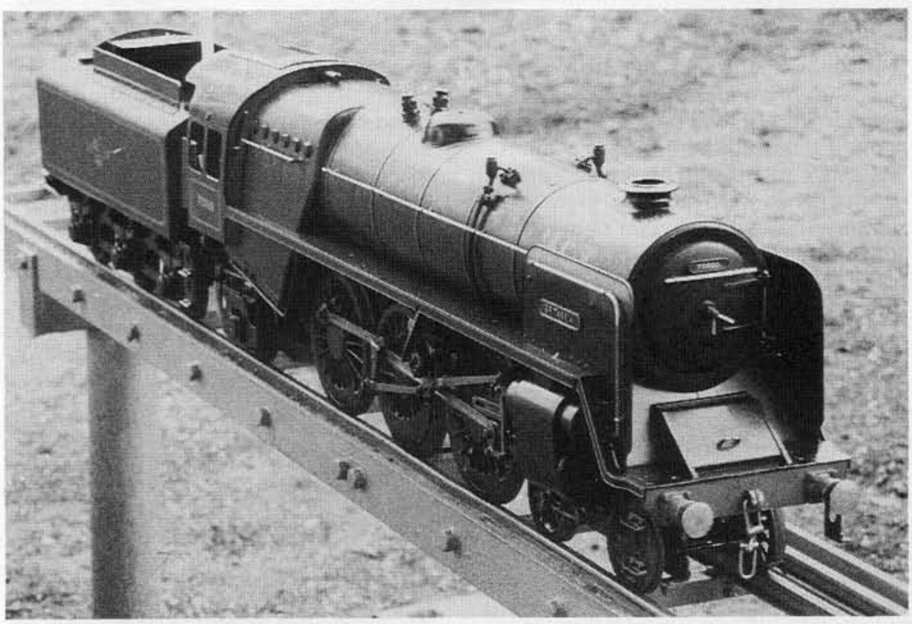
The plates for the frames are cut to shape and drilled as required. It is usual practice to mark out one and then secure it to the other whilst all the holes are drilled. In the past this has always been done by riveting the frames together and then drilling the rivets out when the work is completed. These days, I prefer to use a good quality cyanoacrylic adhesive for the purpose; there are many suitable types available but not all 'super-glues' will do. I use a product called Flex Zap; it takes a little time to dry and so allows for adjustment and I find it will withstand all the machining operations. There will be some slots on the frames which are for the axle boxes; these run in horn plates or blocks and these fit into the slots in the frames. They are drilled and riveted into position; once again I tend to stick them in position whilst I drill through.

This is the 4-8-4 American style locomotive "Columbia" designed in 3.1/2in. gauge by Martin Evans. It's typical of the many hundreds of construction plans sets available from a wide range of suppliers. This is just a part of one of the 11 separate sheets from the Model Engineer Plans service which to to make up this model. [Plans set LO 954, price £24.55 including postage and packing from ASP Ltd.]

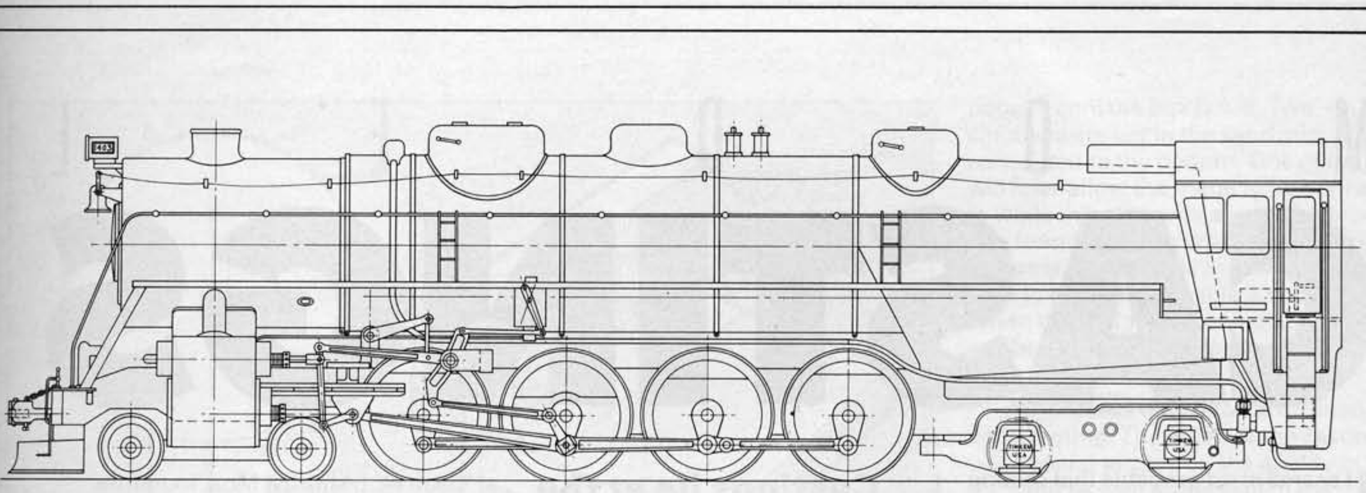


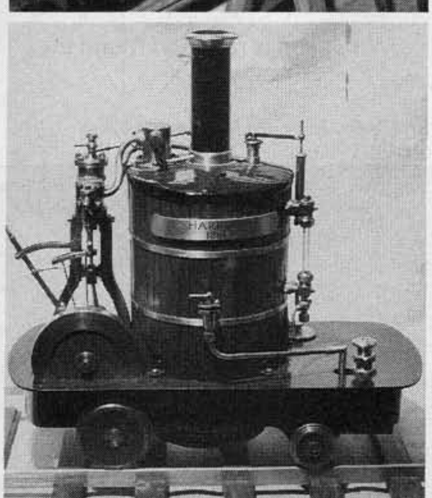
Many foreign locomotives, and a few British ones, had what are known as 'bar frames'. These were much heavier than the plate frame and often, in full-size practice, were cast. The modeller will, however, have to machine them and, whilst they can be made on a lathe with a vertical slide, the use of a milling machine would be an advantage. Because of the thickness of the frames, horn blocks are not used in the same way as they are on the plate frames. It's often just a case of allowing the axle boxes to run up and down in the frames themselves, although, strictly speaking, some form of liner should be fitted.

Usually the wheels of the locomotive will run outside the frames; in some cases, though, they are placed on the inside and the locomotive is described as 'outside framed'. This is particularly popular with narrow gauge prototypes as it leaves more room in which to position the valve gear.



Above left, a typically British locomotive of the late steam days; this is a 3.1/2in. gauge "Britannia" in a steaming bay at the track of the Hull Society of Model Engineers. Left, a narrow gauge model locomotive running on 7.1/4 gauge track; one of the advantages of this approach is the fact that, although the finished model is large enough to sit in, it can be built with comparatively small equipment. Right, top, "Simplex" is one of the most popular steam loco designs. Far, right, models come in all sizes; this is Paul Weiss with 2.1/2in. gauge 4-6-0 model. Right, a simple, basic model of a vertical boilered locomotive.





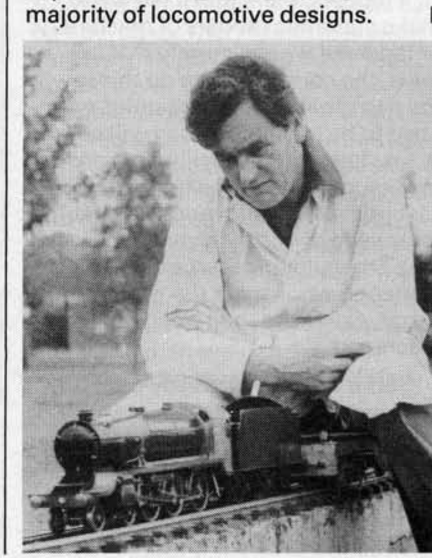
Axle boxes are usually made of either cast iron or gunmetal. All bearings should be made from cast material. They are bored for the axles and machined so that there is a lip between the wheels and the frame to hold them in position. Sometimes a lip is put on either side of them forming a slot to run in the horns. They have springs attached to allow the wheels to take up any irregularities in the track. These springs can be either coil or leaf springs depending on the type of locomotive under construction. Correctly speaking, the axle boxes should be split – that is to say, they are split across the centre and then bored, being held together with a cotter pin. The arrangement is not an easy one for the beginner but has advantages if a great deal of running is expected from the locomotive.

Cylinders can be either inside or outside the frames. The cylinder assembly consists of a cylinder block, and the valve port face and steam chest, the steam being admitted to the steam chest via the locomotive regulator and then allowed into the cylinder by the position of the valve. Sometimes the cylinder assembly is partly inside and partly outside the frames, i.e. the cylinder itself is outside the frame while the steam chest is inside, and a suitable hole has to be cut in the frames to allow for this.

Care must be taken to ensure that the centre of the piston rod on the cylinders lines up accurately with the centre of the driving wheels when the springs are in the running position. Usually with model locomotives the valves are either slide or piston valves. In the case of the slide valve, three slots are cut in the port face. In very small scales this can simply be three holes. The outer two are connected to the cylinder bore via holes drilled or slots cut at an angle so that the steam passage, as it will become, exits exactly at the ends of the bore. The centre one has a connection to exhaust.

The valve has a recess in it which covers two of the holes, leaving the remaining one uncovered. The result is that steam can travel from the steam chest through the uncovered hole into the cylinder, thus moving the piston. The other two holes being covered, any steam in that end of the cylinder is allowed out and into the recess in the valve; from here it can escape to exhaust. When the valve moves along, the cylinder end that has exhausted now receives steam whilst the end that had steam in it can now go to exhaust.

The piston valve works on a similar basis except that, as implied by the name, the valve itself acts as a piston. There can be some slight problems in getting piston valves steam-tight and they ideally need to be lapped in. However, when properly made, they are very efficient and for this reason in full-sized practice eventually superseded slide valves in the majority of locomotive designs. ■



MODEL CASTINGS

Castings lie at the heart of many model engineering projects. This is how they are made and used.

It seems most probable that casting of metal was used from the earliest times. As the industrial revolution gained momentum, so casting also developed with new techniques being discovered as well as new alloys which were to be used for casting purposes. The method of shaping and forming metal was used to construct bridges and buildings as well as being popular for ornamental purposes.

Most machinery has a percentage of castings included in its construction enabling unusual shapes to be formed very much more easily than would have been the case had they been fabricated. Take the modern motor car for example. The engine block is a casting and items such as the gear box and back axle castings will be made likewise. Let us not forget, however, the smaller pieces. Door handles are now often moulded from plastic but until very recently would have been cast. The carburettor is also a casting. In fact, if we took the car to pieces bit by bit we would find dozens of instances of cast metal.

It follows, then, that if we are to make authentic models of machinery, or indeed if we are merely making tools, the correct way to do this is with the use of castings. All castings will need to be machined and I will come to that later. For modelling purposes most suppliers stock a range of castings for various models which makes life comparatively easy. Decide on a particular prototype and find someone who stocks the pieces and simply purchase them ready to be machined.

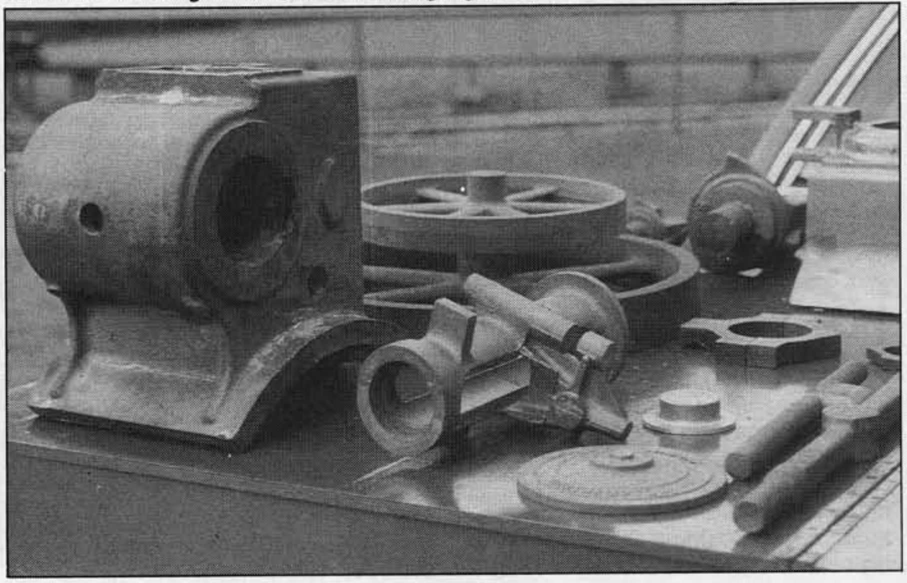
Some suppliers actually offer a machining service as well for those who have doubts about their own ability. For those who do not want to build a model for which drawings are available and for which there has possibly been a description of the construction in a magazine, then, by careful selection suitable castings can still be obtained; it is simply a case of using those available for other models. The range now available is so vast that this creates little problem other than the research involved in what will fit the model being constructed!

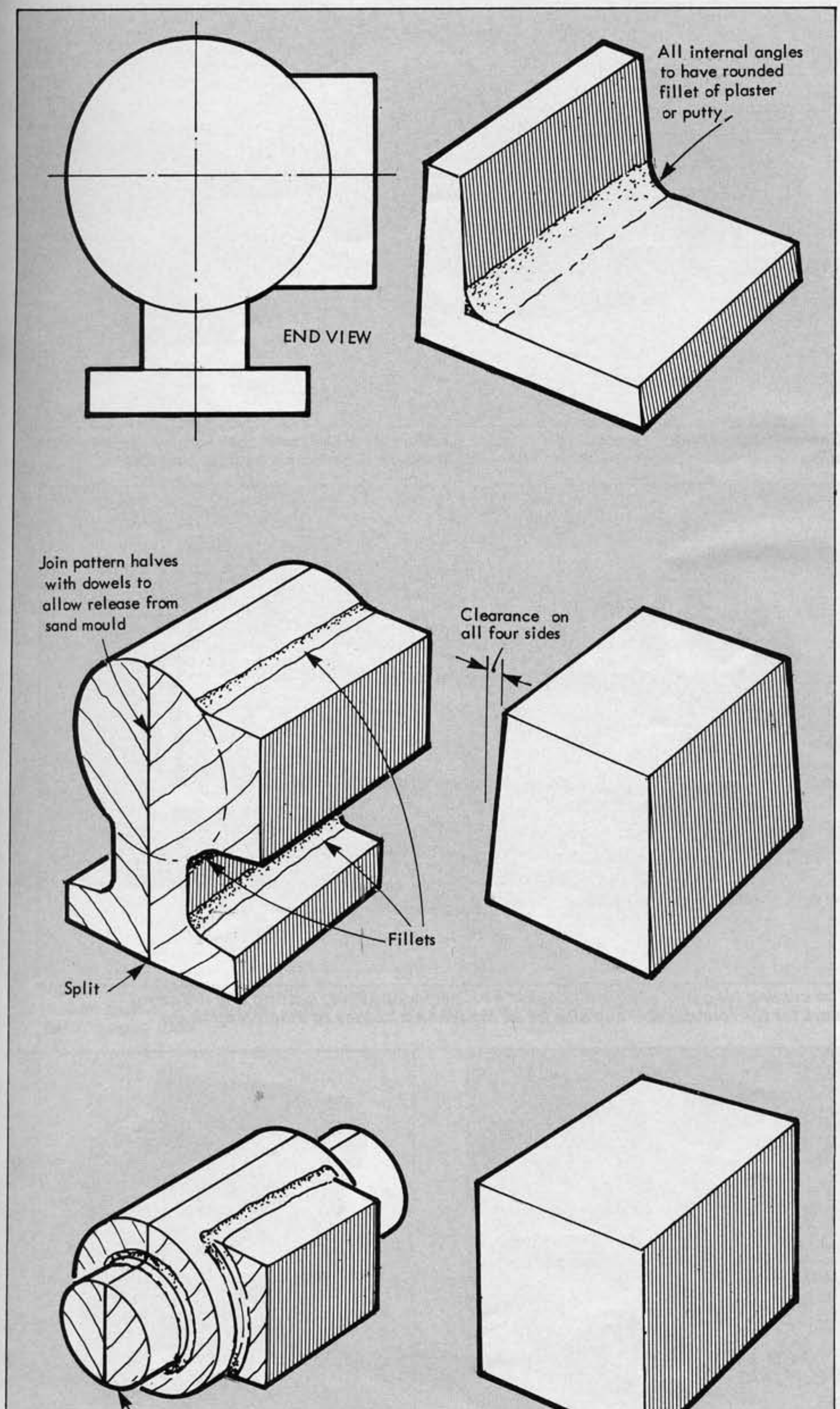
If, in spite of this large range, it is still not possible to obtain what one wants then there are plenty of foundries who will produce the castings to order. For this one needs a pattern the making of which will be dealt with shortly. Most foundries have their own pattern maker who will make suitable patterns by reference to the drawings, but this can be somewhat expensive.

So what is a casting? I suppose a definition would be a piece of metal that has been formed to shape in a mould after it has been made molten thus allowing it to flow through the mould. What then of the moulds? Mostly, as far as the model engineer is concerned, these will be formed of sand. Specially prepared sand is used for the purpose, it being mixed with an agent which enables it to form the shape required. This is done in a two-part box. The pattern is placed in one half and sand rammed round it so that it will take up the shape of the pattern. The other half of the box is then put on and held in place with clips.

More sand is rammed round the

A selection of castings by Paul Wainwright of Sheffield; they are for Marshall and Allchin traction engines in 6, 4.1/2 and 3in gauges.





pattern until the box is full. Two channels are left in the sand and connected to the pattern. One of these will later allow the metal to be poured in while the other will allow the air out. The founder knows when the pattern recess is full of metal as the metal will start to flow through this air hole. When the metal has cooled, the box can be parted and the complete casting removed.

The process described is ordinary sand casting. The finish of the casting will depend largely on the quality of the sand as well as the skill of the founder. A slightly better finish can be obtained by a process known as 'shell moulding'. In this the sand is mixed with a special agent, usually a synthetic resin, and the pattern is first moulded in this then removed. There remains a shell which can be hardened and can then be used for making further castings. This method is particularly useful for small castings as well as those with fine detail. It is also ideal for production work but the castings can be expensive because of the extra work involved.

For a really fine finish the 'lost wax' process gives easily the best results. In this case the pattern is made in wax and the sand pressed into place round it. When the molten metal is poured in the wax melts and runs out leaving the cast metal in place. Not only is the process suitable for particularly fine work, but it also means that more intricate shapes can be cast.

When we deal with patterns it will be seen that they have to be carefully shaped to allow them to be extracted from the mould so that the metal can be poured in. This means that often surplus metal is used to make this possible and also that it is not always possible to obtain the exact shape required as, in doing so, it would be impossible to extract the pattern. When wax is used the sand can be put into any position as the pattern is melted out and does not have to be pulled from the sand. A similar result can be obtained by using polystyrene for the patterns. Here again the molten metal will melt the pattern away leaving the finished casting in place.

The usual way to make the wax pattern is in a mould which will allow any number of the items to be cast. The wax is melted into the prepared mould which is parted leaving the pattern intact. In the case of some

CASTINGS

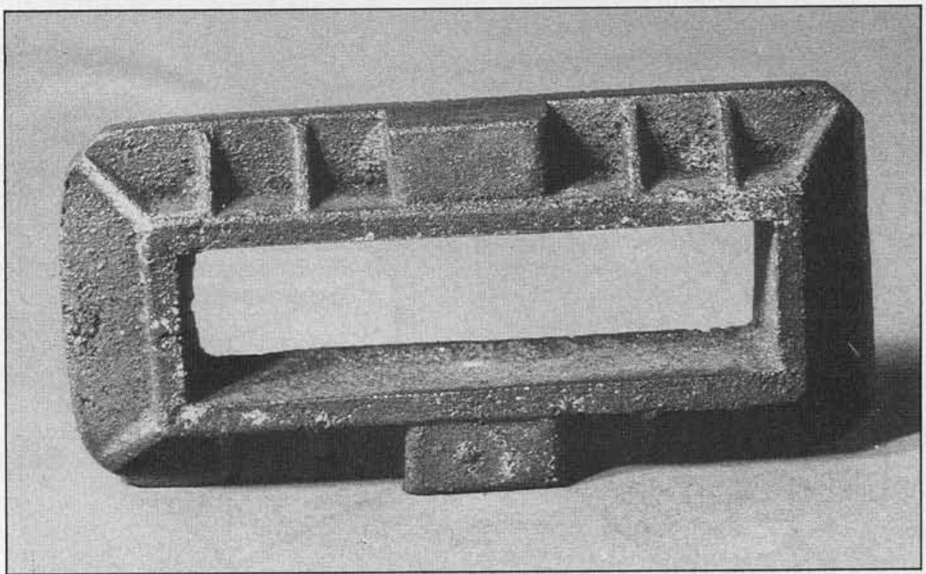
intricate shapes the waxes may be in several parts to enable them to be withdrawn; they can be joined into one piece by means of applying gentle heat.

Other moulding processes include 'die casting' which is a method of casting into metal moulds whilst putting the metal under pressure. A modern idea is to use silicone rubber. This will only take limited heat though and so only very low melting point metal can be cast with it. It can be a useful medium, however, for making wax patterns for lost wax casting, the original die being made of silicone rubber and the waxes being formed in it. Since the rubber is flexible, it is possible to remove the waxes even when they are of a shape which would not allow them to be removed in one piece from a metal mould.

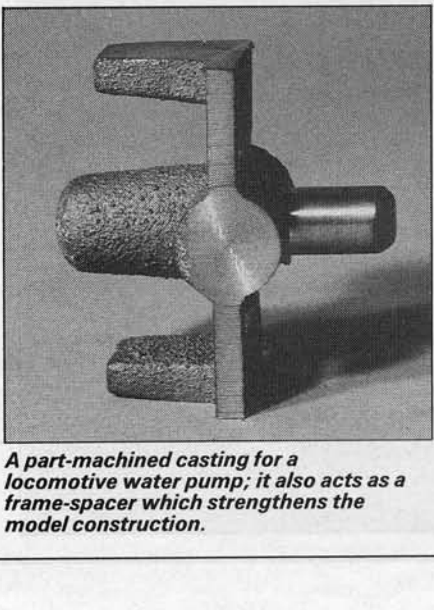
Patterns for castings can be made from wood; the drawings and photographs will probably tell the reader more about what is required than any description. There should be no sharp corners on the patterns, these being filled with either a plaster type filler or with putty. Where the pattern will be required to have a draught in two directions then it should be split and joined with dowels. When the founder gets the pattern he will lay it on a board and put the open box round it. He will then ram sand hard round it. If it is a single piece pattern the box will be turned over. A special powder is put over the sand and the second part of the box is put in place. This, too, is filled with hard rammed sand. The two parts are separated and the pattern removed. Now the box is ready to be filled with molten metal.

Where the pattern is in two parts the second section will be located to the first which has been rammed into the half box. This will be correctly positioned by the dowels. The second half of the box can then be filled up, the box opened and both parts of the pattern removed. Sometimes an odd third or even fourth section might be needed to obtain a particular shape. This would involve making a 'core'. The core is made by the founder in special sand and is prepared in a core box. This box is made so that it

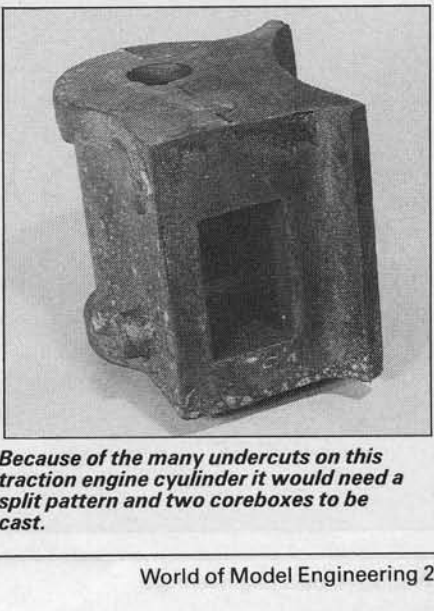
Castings are sometimes produced in 'sticks' which saves waste at the foundry. Here a slide valve, steam chest cover and eccentric strap have been cast as a single piece.



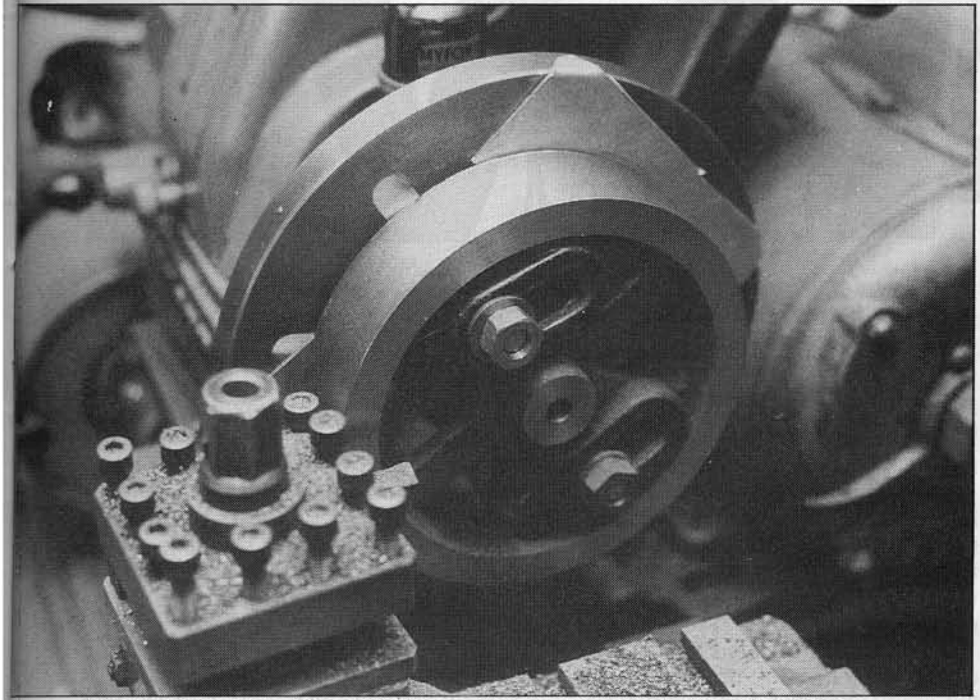
The casting for a pair of hornblocks for a model locomotive; casting in pairs saves work for the founder and can also be an aid when it comes to machining them.



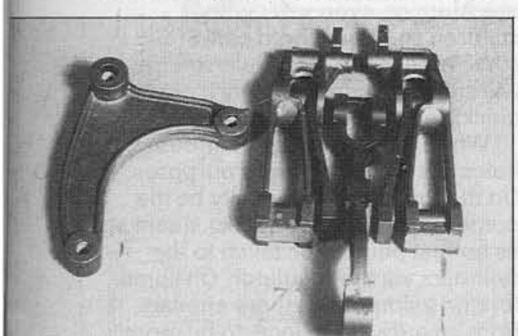
A part-machined casting for a locomotive water pump; it also acts as a frame-spacer which strengthens the model construction.

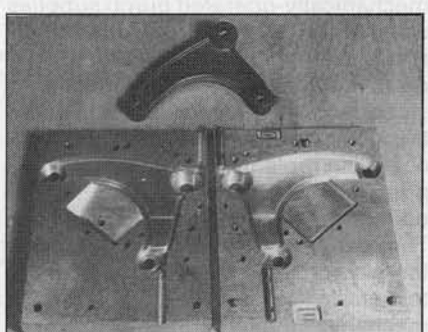


Because of the many undercuts on this traction engine cyulinder it would need a split pattern and two coreboxes to be cast.

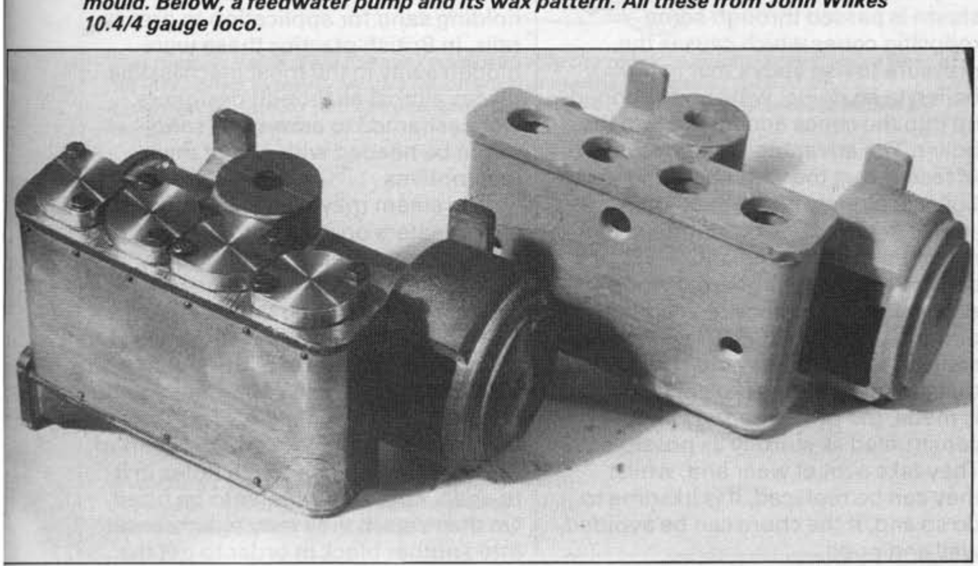


When machining the rims of flywheels or locomotive wheels, they should be supported to prevent movement; this one is supported by the faceplate of the lathe.





Above, a complete motion bracket cast in steel by the lost wax process and its mould. Below, a feedwater pump and its wax pattern. All these from John Wilkes' 10.4/4 gauge loco.



will open along its length and allow the prepared sand core to be removed.

Making one's own castings is quite possible and many model engineers do just that. A home foundry can be made from special bricks designed to reflect heat and the heat can be applied by means of propane gas or by coke. Considerable heat will be required and so such a foundry should be carefully placed where no harm can be done.

Machining castings can be a problem, particularly to the novice. They are invariably, by their very nature, of odd shapes without parallel sides for gripping in a vice or chuck. More often than not they are best dealt with by using the lathe face plate or bolting them direct to a milling table. The aim must always be to produce one smooth face as a reference from which all the others can be obtained.

Materials generally cast are aluminium, a soft metal which, when machined, is inclined to build up on cutting tools. It has advantages though; because of its low melting point it is easy to cast and the finish left by the moulding process needs little cleaning up. Next is brass; this, when cast, is more likely to be used for ornamental work. It has a comparatively low melting point but its wearing properties are not good which is the reason for its limited use. Then there's gunmetal; this is a form of bronze and has good wearing properties whilst being comparatively easy to machine. It is useful for small cylinders and for bearing surfaces. Cast iron is a hard material with a high melting point. It will invariably possess a shell when cast and, when being machined, if possible, it is well to machine this coating off the outside in one operation. Cast iron is a hard-wearing material which is self-lubricating to a large extent. It machines well once the outer coating has been removed. It is useful for any object that will be subject to a lot of wear.

Other materials such as mild steel can also be cast; the operation is much more difficult, however, and so not normally used in model engineering. Making such castings is often an expensive process and it is doubtful if mild steel has any advantages over cast iron in the majority of cases. ■

VALVE GEAR

The chapter on stationary steam engines describes an eccentric and explains how it is used to operate a valve. The same principle applies to the locomotive and to traction engines, etc. The set of the eccentric decides the point at which the valve opens to let steam into the cylinder at the right moment and it follows that, once the eccentric is set, this is the only way that the engine can operate. We cannot therefore reverse the model.

In order to do that we must be able to change the position of the eccentric so that steam can be admitted at a different point. The simplest way to do this is to make the eccentric loose and to drive it with a pin on a fixed collar. When the position of the pin is reversed in relation to the eccentric, the engine will go backwards. This type of valve gear is called 'slip eccentric' and is quite efficient. True, one cannot notch up and so cut the steam off earlier thus getting better value from its properties of expansion, but if we assume that we are unlikely with our locomotive to win IMLEC (the annual International Model Locomotive Efficiency Competition), then the valve gear can work quite well. It is very suitable for the smaller garden gauge locomotives, in particular.

Slip eccentric is far simpler than any other type of valve gear and is very suitable for beginners. There are many other types of valve gear that have been applied to locomotives and there is certainly no hope of giving descriptions of them all here. However, there are four main types that we are likely to come across in model locomotive construction and these are: Stevensons, which is usually applied to models with inside valve gear; Walschaert's, which is popular on the larger express and the more modern steam locomotives; Baker valve gear, which is almost invariably fitted to American locomotives and is similar to

Various forms exist and most models need it.

Walschaert's; and Hackworth valve gear which will, from time to time, be found on narrow gauge models. It is a fairly simple type of valve gear to construct but needs a fair amount of room and so the type of locomotive to which it can be fitted may be somewhat limited.

Feed pumps fall into various categories. The hand-operated pump has many uses and is of particular value in emergencies. The mechanically-operated pump supplies water when the machine is operating and is useful but has the obvious disadvantage that, when a model is stationary with only the boiler in use, the water is being consumed and is not being replenished. Steam-operated pumps are not, in my opinion, as popular as they should be. They can be used at any time when there is sufficient steam in the boiler to operate them and do not rely on mechanical movement. The injector is a means of supplying a boiler by using the pressure of the boiler itself. The steam is passed through some reducing cones which causes the pressure to rise above that in the boiler. In so doing, water is syphoned up into the cones and forced into the boiler. The advantage of this method of feed is that the water entering the boiler is already partly heated.

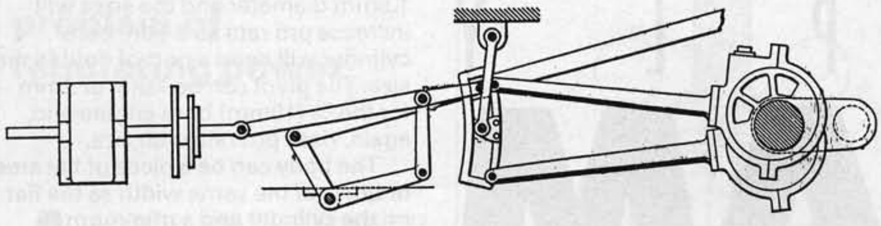
Room precludes descriptions of methods of designing and constructing valves gears; I would suggest that reference be made to one or more of the excellent books on the subject. However, I would suggest that, no matter what type of valve gear is made, the pivot bearings should be constructed as sturdily as possible. They take a lot of wear and, whilst they can be replaced, it is irksome to do so and, if the chore can be avoided, well and good.

Boilers

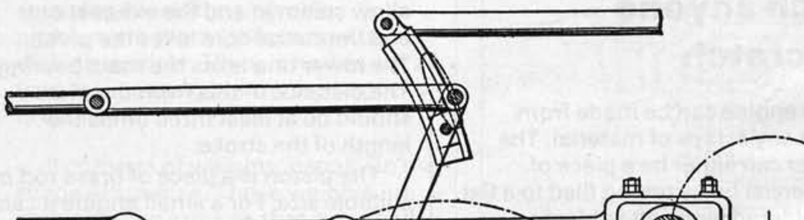
Locomotive boilers are mainly built to a standard pattern, although in the smaller gauges there is a considerable variation as the standard locomotive type boiler is not always practical. Whatever the boiler type it should be of adequate strength and of an approved design. Boiler-making is not too difficult and at least smaller boilers can easily be tackled at home. I would suggest anyone doing so should invest in a decent propane torch and make up a good brazing hearth. To clean the copper after each operation, acid will be required. In fact, instead of acid it is possible to use Alum or, even safer where children and household pets are concerned, a gallon of neat vinegar will clean the copper nicely if not as quickly as the stronger form of acid.

When making boilers, various holes are left for different purposes. On the top there will usually be the dome. This is used to collect steam at its hottest point to be taken to the cylinders via the regulator. On some foreign locomotives there appears, from an outward glance, to be more than one dome. This is not really so, the others are, in fact, sand boxes holding sand for application to greasy rails. In British practice these were hidden away in the most inaccessible places almost as though designers were ashamed to admit that sand might be needed with one of their locomotives . . .

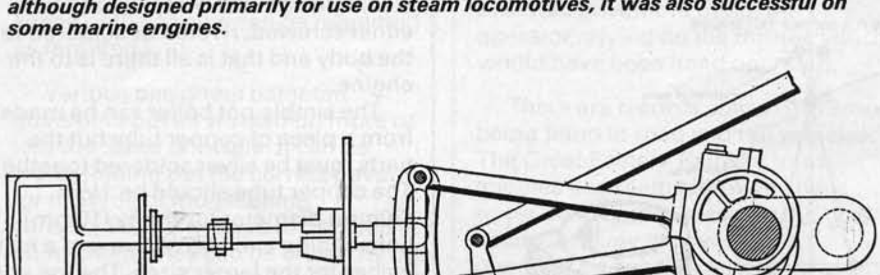
The steam may well pass through superheaters on its way to the cylinders and there is nothing very complicated about these. They are simply tubes carrying the steam back into or near the firebox in order to raise the temperature of the steam before it is used. The superheaters are attached to a 'wet header'. This is a name for a metal block which is part of the boiler which has screw holes in it to enable the superheater to be fitted. On their return they may again come into another block in order to get the



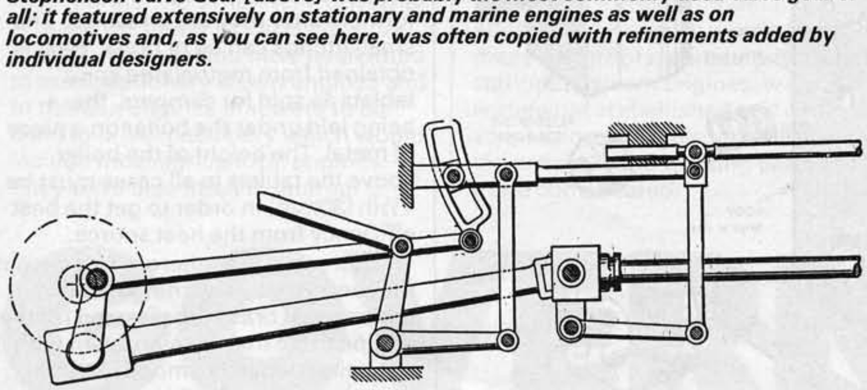
The Gooch Link Motion was developed from the Stephenson Valve Gear and is a good example of the variation achieved by the numerous locomotive designers who wished to produce their own types of valve gear.



Joy's Valve Gear was yet another development of the Stephenson Valve Gear; although designed primarily for use on steam locomotives, it was also successful on some marine engines.



Stephenson Valve Gear [above] was probably the most commonly-used valve gear of all; it featured extensively on stationary and marine engines as well as on locomotives and, as you can see here, was often copied with refinements added by individual designers.



Walschaert Valve Gear was something of a late-developer; nevertheless, it soon became highly popular with locomotive designers.

various superheaters into one main steam pipe for transferring the steam to the cylinders. This is known as the 'dry header'.

Regulators come in various types and can be anything from a simple screw-down valve, which operates the same as the domestic tap, to much more sophisticated designs. The only important thing about them is that they must be able to shut off steam completely and they must, when opened, be able to regulate the amount of steam which they pass.

Safety valves are self-explanatory; if at all possible two at least should be fitted in case there should be a failure. Most operate by means of a spring-loaded valve, the spring being adjusted with a screw so that the valve will lift and allow steam to escape when pressure gets too high.

Water and pressure gauges are necessary in order that we can get some idea of what is going on in the boiler. The pressure gauge is, more often than not, purchased ready-made but a water gauge is easy enough to make. It consists of a top and bottom fitting and between these a glass tube. The glass can either be sealed with rubber washers or with 'O' rings. A 'blow-down' valve should be fitted at least to the bottom fitting and possibly to the top one as well.

Blow-down valves are used to empty the boiler; the name is really only a fancy one for a tap! When the tap is opened the water runs out. 'Clack' or non-return valves allow water in against the boiler pressure but are constructed so that the pressure in the boiler will keep them closed and so prevent any escape of steam or water from the boiler itself. They are usually simple ball type valves which are easy to construct.

Lubricators supply oil to the cylinders, a necessity to prevent things seizing up, and come in various types, the simplest being one where a jet of steam across the top acts as a syphon and draws up oil. Mechanical types operate either on a ratchet or non-return clutch.

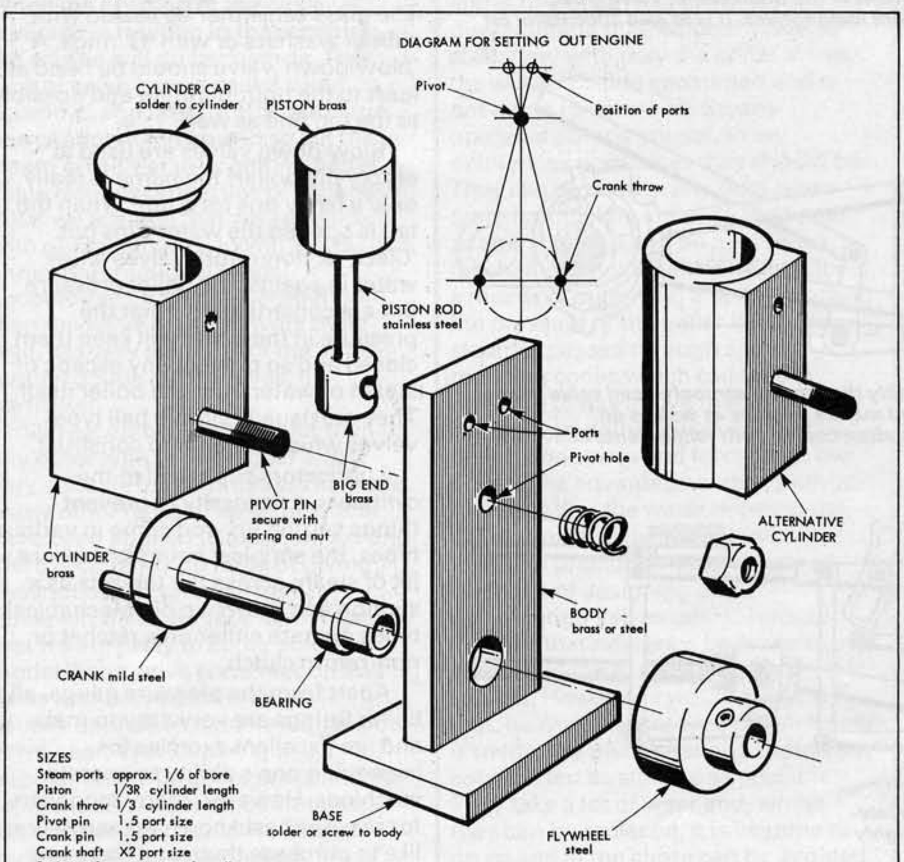
Apart from the pressure gauge, all boiler fittings are very easy to make and are excellent exercise for improving one's ability to operate machines. However, many modellers, for reasons best known to themselves, like to purchase them and there are many suppliers of such items. ■

SIMPLY STEAM

A basic engine which anyone can build from scratch

The simplest form of steam engine is the oscillator. They have been built in their thousands and are manufactured commercially. Many a model engineer has had his interest first aroused by such an engine which is so very simple to make and costs so little. I will give details of how to go about constructing one; believe me they make highly suitable presents for the children, grandchildren, nephews, etc.

The engine can be made from almost any scraps of material. The cylinder can either be a piece of commercial brass tubing filed to a flat and soldered with soft solder to a brass strip or it can be made from square brass bar. The cap can be soldered to the top. Two holes will be needed, one for the pivot and one as a steam port, their size depending on the cylinder bore. For a bore of ⅜in. or 10mm, the port must be $\frac{1}{16}$in. or 1.5mm diameter and the sizes will increase pro rata so a ¾in. bore cylinder will need a port of double the size. The pivot can be $\frac{3}{32}$in. or 2mm for the ⅜ (10mm) bore engine and, again, rises pro rata with size.



The body can be a piece of flat steel or brass of the same width as the flat on the cylinder and a minimum ⅛ (3mm) thickness; again, for a larger size, the thickness should be increased. There are four holes in the body – the two small ones side by side allow steam in and the exhaust out and the cental hole takes the pivot. The lower one takes the main bearing. The distance of this from the pivot should be at least three times the length of the stroke.

The piston is a piece of brass rod of suitable size. For a small engine it can also act as the big end and no piston rod is needed; however, for a larger engine it is as well to put on a piston rod and make a separate bearing.

The crank-shaft and crank can be made of mild steel and the throw can be decided by referring to the drawing which also shows how to lay out the steam ports in the body. A base is either screwed, riveted or soldered to the body and that is all there is to the engine.

The simple pot boiler can be made from a piece of copper tube but the parts must be silver soldered together. The copper tube should be 1½in (30mm) diameter for the ⅜ (10mm) bore engine and two or two and a half inches for the larger sizes. The top and bottom plates must be of copper of equal thickness to the boiler shell and this should be at least 2mm. The end plates can be formed over wooden formers after they are annealed. The small fittings can be of brass. Heat is obtained from methelated spirit tablets as sold for campers, these being laid under the boiler on a piece of metal. The height of the boiler above the tablets in all cases must be 1½in (30mm) in order to get the best efficiency from the heat source.

That really is all there is to it except maybe a word of warning that if commercial brass tube is used for the engine there may be a problem with it not being perfectly smooth. In this case the piston should be ground in by working it up and down inside the tube after first coating it with metal polish. ■

GOVERNING
P O W E R

The answer to the problem of regulating power.

A governor was fitted to engines, whether steam or internal combustion, in order that speed may be regulated as required. The construction of this simple device seems to cause considerable problems to many people new to making models. There is no need at all for panic as the governor is simplicity in itself!

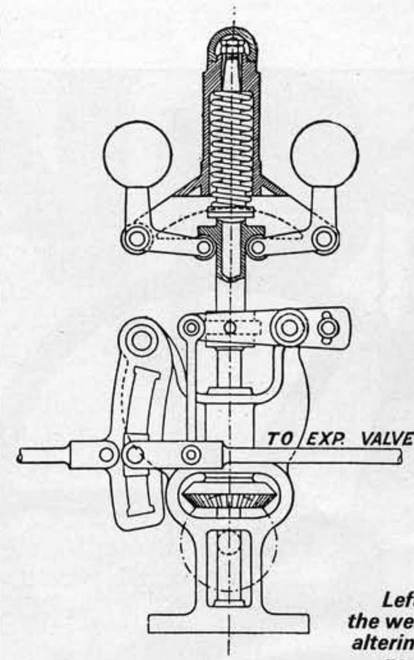
It consists of weights, usually in the shape of spheres. These weights are supported on arms so that, as speed increases, they pivot outwards by centrifugal force from their normal path of travel. Connected to the weights is a linkage which, in turn, is connected to a regulator which will cut off steam or fuel when the weights have reached a certain position. The linkage can be adjusted so that the speed of the engine can be regulated as required.

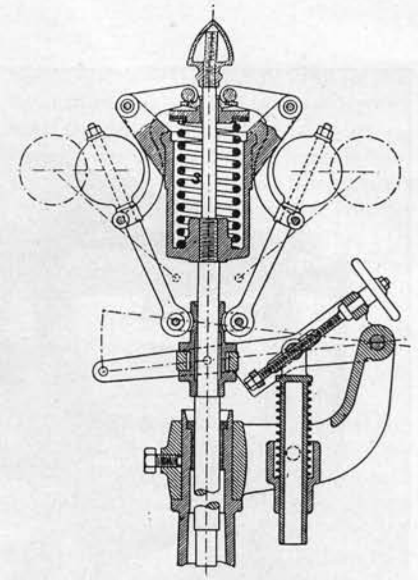
Various designers patented governors but all worked on more or less the same principle. It can be worth finding out the correct governor for the type of model being constructed. They have to be fitted at a point where they can be driven by the engine and this is usually via a belt. It may be that gears will be required to change the direction of the motion in order to make the governor work. Like most things, the simpler the governor is made the better it is likely to work.

A governor would have been fitted to most stationary steam engines and to traction engines that were to be used to drive machinery which would include most agricultural engines. They were also fitted to internal combustion engines that were used for driving heavy machinery and pumps. Many small internal combustion engines were used in the agricultural industry; these rarely if ever had governors fitted, the operator relying on the throttle which would have been hand operated.

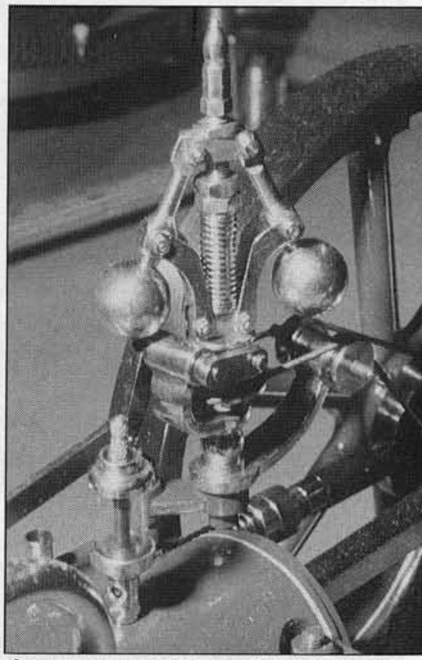
There are records also of governors being fitted to road and rail vehicles. The Great Eastern Railway tram engines had them although I have never been able to discover the type used. Certainly they were not operated by spheres but rather by weights and they were encased. Early lorries were sometimes fitted with a similar arrangement.

As in all forms of modelling, attention to the prototype is useful as many governors, particularly those on stationary steam engines, were somewhat embellished and could be very handsome. This embellishment did not make the working parts any more complicated. ■





Left, the Hartnell governor; as speed increases, the weights swing out raising the central shaft and altering the throttle opening. Above, on this Proell governor, a handwheel attached to an auxiliary spring allows adjustment.



A governor not only regulates the speed of a model engine, it also enhances the appearance.

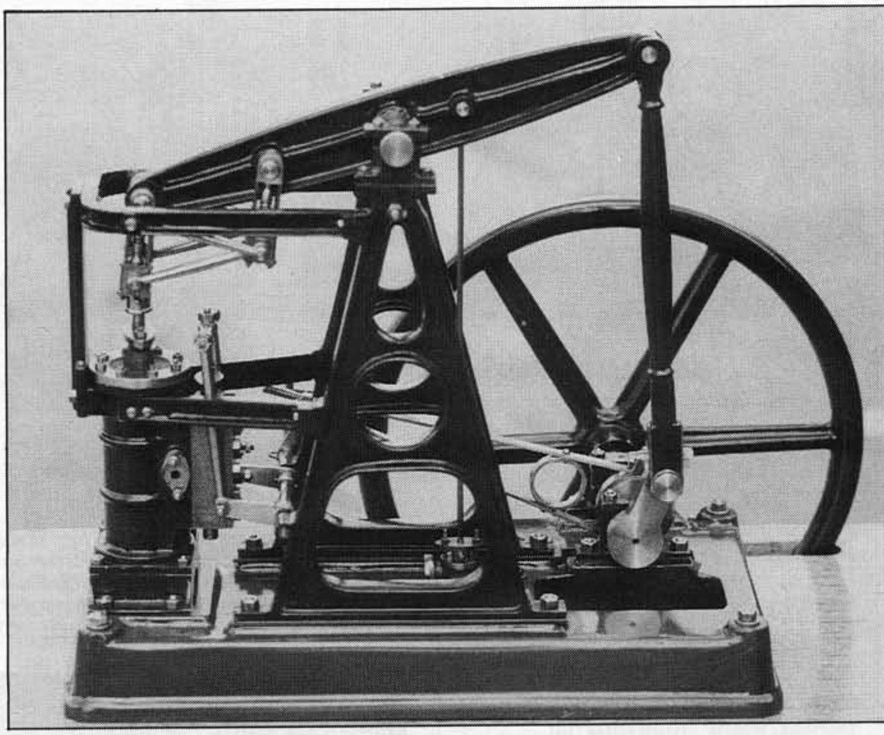
PUM

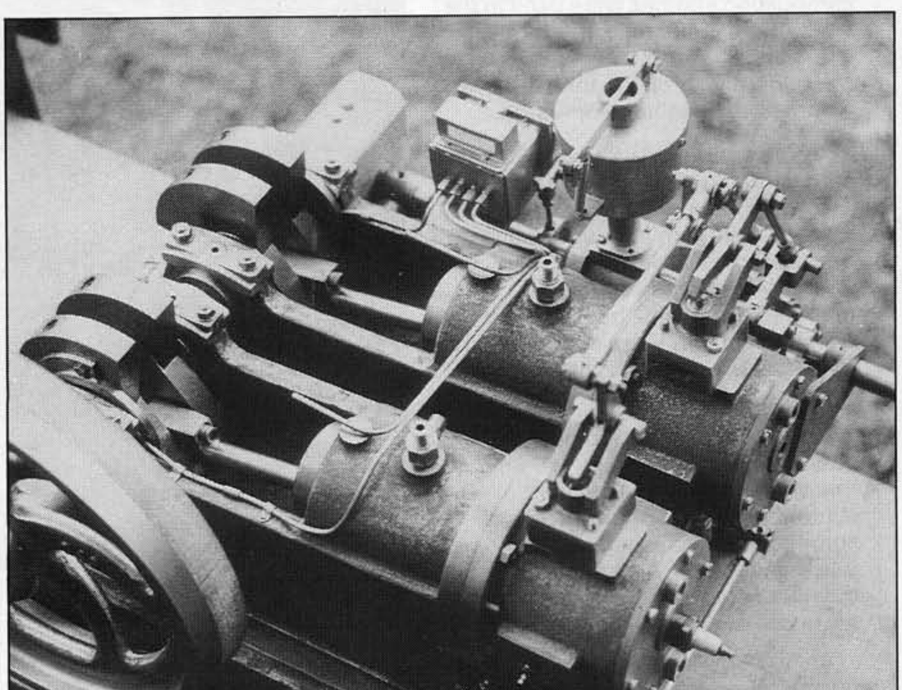
M A C

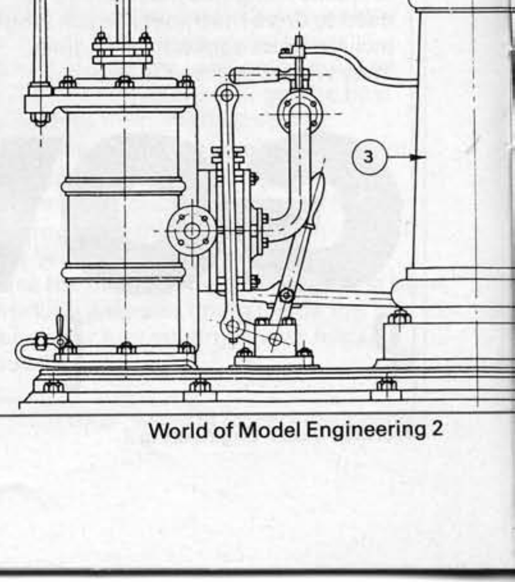
Possibly the first machinery required by man was for pumping water. Water is essential to life, particularly where agriculture is the prime means of gaining a living. The tendency was to live as near a ready source of water as possible; look at any of the world's major towns whose origins go back more than a century or so and invariably they will be found centred on a river.

Primitive people gathered their water from the rivers and lakes collecting and carrying it to their homes. For those who, for one reason or another (the usual reason being availability of land), had to live away from a water supply, there was difficulty in carrying it and the first forms of pump, which would allow water to be moved some distance away from the source were developed.

The early pumps were primitive indeed but they worked and,







Above top, a model 'A' frame type beam engine, typical of the kind used for pumping. Above, cylinders on a model gas engine used for pumping; gas followed steam as a power source in this field of industry. Drawings right depict part of the ASP plans for the popular 'ME Beam Engine'; set comprises four sheets for a 1/12 scale steam pumping engine, price £7.85 including postage and packing from Model Engineer Plans Service, 9 Hall Road, Hemel Hempstead, Herts.

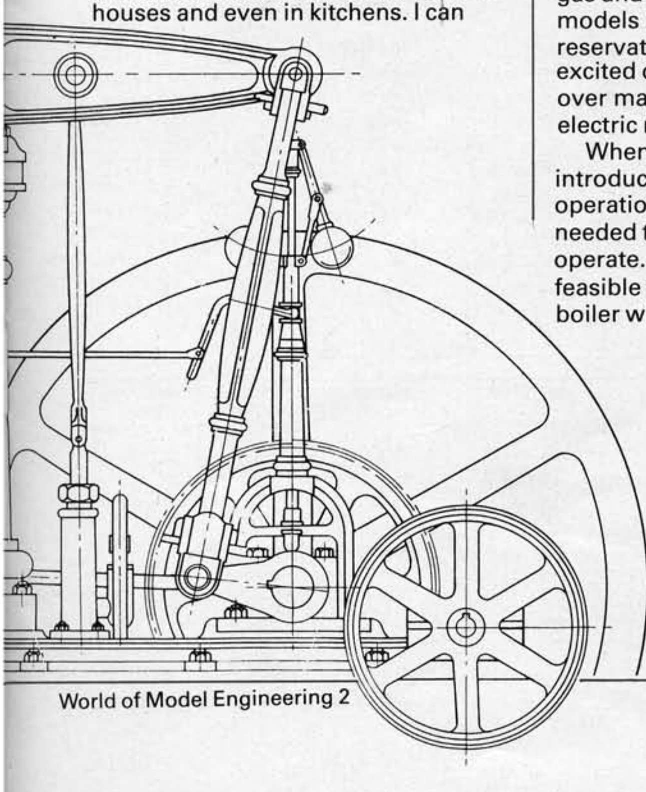
MPING

H I N E R Y

incidentally, would make interesting models. Invariably they were operated by hand or by ox or horse. Water was also found deep in the ground and the early method of obtaining this was a bucket or primitive container on a rope thrown in and then hauled out.

A principal early use of steam power with lots of modelling possibilities.

This was followed by the well which became popularised in children's books far more than it was possibly ever used. We come next to hand-operated pumps which would be situated in the centre of a village or perhaps one at each end. Later pumps were installed in the back gardens of houses and even in kitchens. I can recall visiting a relative living in the country where water had to be pumped up and, of course, caravanners will well know the principle. The method of constructing hand pumping equipment has changed very little and the same principles are in use today.



When mechanical pumps were introduced it became possible to pump water over greater distances. Not that the actual pumping principle had changed – it was just that mechanical operation made continuous pumping possible. From here it was a short step to connecting up pipes and allowing the pressure introduced by the pumps to force the water to our homes and to industry through taps.

At first this mechanical operation was by steam. Later it became gas or petrol-driven and now it is nearly always electrically operated. Steam, gas and petrol engines make fine models but I have my reservations about how excited one could get over making a model electric motor!

When steam was introduced for pumping operations, water was needed to make the boiler operate. It was hardly feasible to fill a boiler with water and boil it all away then let the boiler fire out whilst it was refilled to start the whole process again. So pumps were called for to keep the boilers full as well. Again they worked on the same basic principles. The water enters the boiler via a non-return or clack valve – a term which will become well known to model engineers as the making of clack valves will be part of the hobby.

Not only were pumps used to get water to people, they were also needed to get it away from them! As metal became harder to find it became necessary to sink mines deeper and deeper into the ground in order to recover it and this meant that the bottom of the mine, being below the water table, had to be pumped out. It is possible that this was really the application that brought the steam engine into its own and pumping engines became commonplace.

Another area where pumps were used extensively was in low-lying areas where water tended to cause problems to agriculture. Take the fens round Lincolnshire and Cambridgeshire as an example; these were drained to some extent by the digging of drainage channels and water kept in check with banks or dykes. It was still necessary to pump away surplus water, though, and mechanically-operated pumps were needed. Initially these were operated by windmills, later by steam and then via gas and petrol to electricity. The windmills are now being preserved so that future generations can see what they were like. These, too, make very fine models and look particularly well in a garden. ■