3 Making a start - tools and equipment

3.1 Introduction

It is amazing the amount of interest that is generated by a live steam loco running at a Gauge 0 meeting. The questions that come from all directions are varied and range from the innocent, "Did you make it yourself or buy it from Bassett-Lowke?", to the very complicated, "What is the cut-off in full gear?". Amongst the questioners there is clearly a significant proportion who would genuinely like to build a live-steamer.

When asked why they have not made a start, even though a number of them have constructed successful electrically powered machines, the answers tend to fall into three categories:

1 I haven't got the tools.

2 I haven't got the skill.

3 I haven't got the time.

With regard to 1, the right tools can be acquired progressively and it is remarkable how quickly one's collection grows. Where 2 is concerned, skill will come by using the acquired tools on a suitable project. If you get stuck, there is a list of books and articles in Appendix A and a myriad of books on workshop practice no further away than the nearest lending library; and don't forget that, 'practice makes perfect'. You may also find that a local school or college runs a Model Engineering Class where you can learn the basics. Classes usually commence in September.

With reference to 3, there, I am afraid, it is difficult to be of concrete help. Possibly the answer is held in the somewhat cryptic Naval saying that 'attitude is the art of gunnery'. To reduce this to 0 Gauge live-steam terms, it means that if you really want an engine you will find time to build it. A useful approach is to get up an hour or two earlier than usual. The world looks at its best early on and a small triumph in the workshop first thing will produce a state of mind that can lead to bigger successes during the working day. That is a personal view of course and maybe the converse is true, but we must all try to think positively.

So with that thought firmly in mind, it is my pleasant task to take you into the world of tools, materials and metal cutting in general.

3.2 A Place to Work

Before getting on with what to do and how to do it, possibly a few words on where to do it might be apposite.

There must be a few aspiring live-steam builders whose homes include a spare bedroom, study or downstairs extension perhaps with a bench or stout table already installed. These lucky people are one jump ahead in the game. Those not so fortunate are reduced to working either in a garden shed/workshop or on the kitchen table. In my own case, the relative smallness of the house and the demands for space made by a growing family forced my operations outside. The top few feet of the garage were partitioned off and, with a suitably insulated roof, have made a workshop which, although slightly cramped, has served well over the years.

The biggest problem is keeping the place warm in winter and this has largely been solved by a strategically positioned tubular electric heater. This is sufficient for all but the most severe weather and thoughts are being given to upgrading the system to compensate even for this. A word of warning. Don't, repeat don't, use a bottled gas heater in your workshop. These are fine for providing background heat in the house, but must not be used in confined areas for obvious safety reasons. In addition, they produce a lot of water vapour when in operation and this will rust any tools left out.

The kitchen table builder is not troubled in this way, the kitchen usually being one of the warmer rooms in the dwelling, but such a workplace brings its own little troubles. For a start, the 'workshop' must be portable and has to be set up and removed at the end of each session, thus reducing actual working time. Secondly, cleanliness of working methods is vital. The domestic authorities can be seriously alarmed, if not actually antagonised, by swarf and metal filings trodden into the carpet, so a dustsheet or a few old newspapers judiciously placed can prove a calming influence. A 'workshop tray' is a useful means of providing a clean working environment.

Then there is the noise factor. A certain amount of noise is inevitable when making a locomotive, whether it is electric or steam, (think of the boiler shop at Crewe). This can be intrusive, especially if your partner is watching television or a youngster is trying to solve his or her first quadratic equation in the next room. It is considerations like these that seriously trammel the activities of the would be live-steam constructor in the home environment, but with a little give and take on both sides there is no reason why a successful locomotive cannot be built in such circumstances. In fact, it has been done on many occasions. The golden rule is to try to make yourself as comfortable as possible when you work. That way distractions are minimised and you are free to give of your best.

Before going on to list tool requirements, one of your

first purchases should be a good quality pair of safety spectacles or goggles. Some processes, notably grinding, turning and the pickling of brazed items, can cause flying chips or droplets against which eye protection is of paramount importance.

3.3 Tool Requirements

Those who have constructed electrically powered locomotives and who now wish to start on the real thing should not worry about having to put all their tools in mothballs. Whilst there are one or two new tricks to learn, many of the basic operations are similar, so what works for electric drive in many cases works for steam. Some additional equipment may be needed depending upon the range of tools already owned.

3.4 Basic Hand Tools

Before discussing suitable hand tools, a word or two on buying tools may not come amiss. Most hand tools, with the exception of drills and files are once in a lifetime purchases. It is therefore a good policy to buy the products of a good reputable firm, even though they may be more expensive than the 'bargain' items frequently advertised in the model press. It is a great comfort to have names like Moore & Wright, Eclipse and A.A.Jones & Shipman helping you in moments of crisis, although the reputable Far Eastern name of Mitutoyo is also well worth considering.

Your first real essential is a vice. Most households have one of these screwed to a bench in the garage or in a drawer waiting to be clamped to a table. Make sure that if you are buying one it is iron with steel jaws. The minimum size for successful 0 Gauge work is 2 1/2" (60mm) width. My own 3 1/2" (85mm) Record has lasted well over 20 years with no sign of wear; other makes may be equally good.

Most vices have jaws with a diagonal pattern cut into them. This will easily mark any workpiece, so your first task will be to acquire some soft jaw covers or 'clams'. These can easily be made by hammering suitable rectangles of thin copper sheet or tin-plate over the vice jaws themselves. It doesn't matter if you damage them with a saw or a file as they are easily replaced. Aluminium alloy angle is another useful material for clams. DIY shops stock this as it seems to enjoy a vogue for rubbing strips and guards on stairs and doors.

If you are feeling flush, you can invest in a set of fibre-faced jaws which can be bought in various sizes to suit the vice and which simply clip over the existing jaws. They are just the job for holding screws without causing damage to the threads. The only minor disadvantage is that if you are filing a workpiece it can heat up rather uncomfortably as the metal is insulated by the fibre. The first time this happens can come as a surprise.

Talking of filing leads us naturally to talk of files. Here it must be said that these notes are not intended to be a treatise on engineering and workshop practice, but the opportunity will be taken to pass on the odd hint that has been found useful.

The handiest files for our class of work are 8" and 10" flat and half round files. A couple of flat ones - one with a safe edge - and a single half round one should suffice to start. These should be 'second cut', which is a useful grade for general purpose metal removal. All files should be fitted with decent sized handles. When filing soft materials like brass, copper or white metal, it is a great help to rub a piece of chalk on the file. This will prevent the metal 'pinning' the teeth, i.e. clinging to the teeth, and spoiling its effectiveness as a cutting implement. A dodge used

Photo 3.1 A selection of hand tools including a 4oz hammer, tinsnips, coarse flat and fine half-round files, a selection of needle files, long nose pliers, side cutters, combination rule, 6in rule, piercing saw, spring bow dividers, 12in hacksaw, junior hacksaw, toolmaker's clamps, spring loaded centre punch and scriber. (Photo T. Hughes).

by old time fitters was to keep new files for brass or gunmetal and only relegating them for use on steel as they wore. The reason for this was that after using a new file on steel it was less effective when subsequently used on brass. A selection of needle files is also desirable; round, flat, fishback and wedge shaped being particularly useful. Files are well worth buying new; you cannot do good work with a file that Great Uncle Jim found in his hen run.

For marking out you will need a 6" (150mm) or 12" (300mm) steel rule. There are many good ones on the market. My own favourite is one that has both Imperial and Metric markings. Immediate comparisons are thus possible without fumbling about looking for different rules. A scale rule with 7mm/ft markings is also worth acquiring.

A decent scriber and centre punch are also musts, as is a try square. For a scriber, try to get one with a tungsten carbide tip. This will last far longer than the standard type which requires regular sharpening to keep it in good shape. A 2" (50mm) try square will cover our requirements but don't drop it or you may spoil its accuracy. For scribing arcs and circles, a pair of spring dividers will be required; the smallest will do nicely. An automatic centre punch is a nice tool to have, but not essential, and the conventional centre punch is certainly cheaper, although you will then have to wield a 4 oz hammer to some purpose

Sooner or later you will need to invest in some metal sawing equipment. This can be quite elementary, a Junior Hacksaw being enough for 90% of all live steam jobs. For platework a piercing saw is almost mandatory and, if you intend to do some big-time sawing, a 12" pistol grip frame with a couple of 24 tpi (teeth per inch) high speed steel blades will enable you to laugh at most of the work likely to come your way.

For precision measuring you have the choice between a vernier gauge or a micrometer. It is, of course, pleasant to possess both items, but of the two I think that the 0 - 1" micrometer (or its metric equivalent) is the more useful. It is a source of real pleasure to be able to work to a 'thou' in a guaranteed manner and once the knack of reading it is obtained it will rarely be out of your hand. The vernier gauge is a very good back up tool and can be used on larger diameters with advantage. It also has a built in depth gauge and internal gap gauge which can save quite a lot of time in certain circumstances.

3.5 Drills and Drilling

Whatever type of model you contemplate, it is bound to be full of holes of one sort or another. Some have to be filled with screws, rivets, axles, etc. and some must be left open. In any case it is you, the builder, who will

Photo 3.2 Marking out tools. A centre square, 2in, 4in,and 6in try squares, callipers, clock gauge and a 'mystery object': an ingenious home-made device for setting out the shape of a tapered boiler on a flat sheet. The two discs are turned to the boiler diameters at each end of the taper and the distance piece is the length between them. By covering the edge of the discs with marking fluid and rolling them over the sheet the curved outline produced will give the correct taper when cut out and rolled up. (Photo T. Hughes).

have to select and use the necessary drills. But it is not vital to buy a full set of number, letter, metric and imperial drills. That would really break the bank.

A few of the sizes commonly used are 1/32", 1/16", 3/32", 1/8", 5/32" and 3/16". It is also advisable to buy tapping and clearing drills for 8, 10, 12 and 14 BA. These are nos 50/43, 54/50, 61/55 and 68/60 respectively. Get High Speed Steel ones if you can; they last much longer than the Carbon Steel variety although, naturally, they are more expensive.

With the change over to metric measurement in schools, many of the younger generation find Imperial measurement difficult. For those wishing to go the metric route the tapping and clearance drill sizes for 8. 10, 12 and 14 BA are 2.25/1.8mm, 1.75/1.4mm, 1.4/1.05mm and 1.1/0.8mm. Similarly, metric drills can be substituted for the others listed above. However, while 1/8" and 3/16" dia. axles continue to be used

together with 1/4" and 5/16" dia. bearing bushes etc., some Imperial drills will need to be obtained. In addition, most of the current writing and many of the designs found in model engineering magazines continue to use feet and inches; so add a good set of conversion tables to the list.

At this point it would be appropriate to look at drilling equipment. Much useful work can be carried out using the old fashioned wheelbrace, of which I am sure there are many languishing in sheds and garages. But, for the sort of accuracy you will need for successful live steam work, some sort of drill press is almost essential. These range in size from the simple type used to hold the ubiquitous hand held power drill to the excellent Astra and Fobco 'Star' machines. There are also a number of machines from the Far East on the market and they seem more than adequate for the work. The second hand market can produce the occasional bargain, so keep your eye on the local press - you may strike lucky. For the type of jobbing work involved in locomotive construction, a second hand 3/8" (9.5mm) or 1/2" (13mm) hand bench drill can be satisfactory. It is much kinder to drills than a power drill and very much cheaper.

3.6 Taps, Dies and Reamers

Having mentioned tapping and clearance drills earlier, the types of useful taps and dies must be considered. BA and ME 40 tpi (threads per inch) taps and dies seem to be the norm for live steam construction. The most useful sizes are 8, 10, 12, and 14 BA with 7, 6, 5 and 4BA coming closely behind. In the ME 40 tpi sizes, 5/32", 3/16", 7/32", 1/4" and 5/16" are the ones that should be progressively obtained when cash and opportunity permit. For those wishing to use the metric ranges there is no direct equivalent of the ME 40 tpi sizes, however, a good approximation would be to obtain ISO Metric Coarse taps and dies in the 4, 5, 6, 7 and 8mm sizes.

Tap wrenches used on small taps are a menace and you will be a sadder, wiser and poorer person if you experiment in that direction. There are few thing more sapping to the morale than the ominous 'ping' of a 12 BA tap snapping off flush in a cylinder block. To avert, as far as possible, nightmares like that occurring, the answer is readily to hand in the form of a Meccano small pulley wheel and tyre. These are readily obtainable and are bored to fit a 5/32" axle. They can be used as a nice sensitive tap wrench for anything from 10 BA down to 4 BA. Some of the smaller taps, 12 BA and above, have very small shafts. These taps are best used by holding them in a pin chuck, an item that should be in the possession of every aspiring builder. This will give ample sensitivity for normal use.

Brass, cast bronze and cast iron are best tackled with the tap used dry. Phosphor bronze is a useful metal but a shocker to tap. If you have to tap or machine it, use plenty of straight cutting oil or, at a pinch, 20/50 motor oil plus firmly crossed fingers and lots of care. For steel, use either straight cutting oil or a sulphur based paste. The latter is sold in the UK under the name 'Trefolex'. Such a product certainly eases the work and produces a good clean thread. It also has the advantage of being relatively cheap. I bought a 2 lb. tin about 15 years ago and, at the current rate of usage, it will help to tap all the holes that I will ever want to drill.

Photo 3.3 Taps and Dies. A die stock, pin vice with 10BA tap, a range of taps and reamers, tailstock die holder, range of dies, Meccano wheel tap holder with 12BA tap, tap wrench, 0-1in micrometer, 0-6in combination vernier. (Photo T. Hughes).

A drilled hole may appear round but, rest assured, it is not. Holes can be shaped like hexagons, ridged, grooved, gouged and scored while looking just fine to the naked eye. Put a drilled hole under a watchmakers glass and all will be revealed. The accepted way to true a drilled hole is to drill it slightly undersize and use a reamer to take out the last few thou, leaving a true and clean surface.

In the smaller sizes up to 1/8" (3mm) dia there is

usually no problem, the necessary few thou under finished size left by the appropriate number drill being easily removed by the reamer. In the larger sizes the problem is different. Larger reamers will, if given the slightest chance, chatter or produce a tapered or rifled bore.

To be truthful, I never have much luck with reamers on cylinder bores and similarly sized holes and have resigned myself to boring them to size in the lathe using a fine feed and finishing with a lap. (A lap is a piece of wood or copper machined to be close sliding fit in the bore. It is coated with a mixture of fine carborundum dust and oil and passed back and forth through the bore to remove any roughness due to the turning tool. In the later stages of polishing the grit coating is cleaned off and replaced with metal polish). This can produce a very good surface but requires patience; a moment's lack of concentration can undo an hour's earlier efforts. All this sounds like a homily of disaster and despair but don't be put off by the above paragraphs. With care, slow speed and adequate lubrication, (motor oil seems to give the best results) reamers can give excellent results. If the hole left by the reamer is true, it will reflect the light in a similar manner to a gun barrel. I have achieved this happy state many times, but not on a sufficiently regular basis to be entirely confident.

3.7 Tool Sharpening

Having obtained a reasonable selection of hand tools it will be necessary for you to keep them sharp and generally in good rust-free condition. A decent box with a lid makes a good repository and, as extra insurance, you can put in a piece of vapour phase inhibitor paper or, alternatively, lightly oil the tools to keep rust at bay. Also, try to keep hand tools well clear when soldering as some fluxes are very corrosive.

A grinding machine is an excellent acquisition and a good excuse for keeping all your tools sharp and ready for action. There are a number of first rate double ended grinders on the market at very reasonable prices.

Photo 3.4 A live steam Mogul by the late Fred Eggleton. Except for finished wheels all Fred's locomotives were built entirely by hand using the minimum of equipment. His only 'machine tool' was a hand drill. Nevertheless they turned in some excellent performances. (Photo C. Edwards collection).

Follow the makers instructions and never, repeat never, remove the eye shields. (This is one process where the use of goggles or safety spectacles is of vital importance as sparks and grit can be discharged from the wheel at high velocity). You should then have a long and trouble free tool grinding career. With a green grit wheel, tungsten-carbide tipped tools will hold no terrors for you, but beware; when word gets around you will finish up sharpening all the neighbours' masonry drills if you are not careful.

We say tools should be kept sharp, but just how sharp is sharp? As a rough rule of thumb, scribers, centre

punches and dividers are just about OK if, when allowed to rest under their own weight on the back of a fingernail and the finger is gently agitated, the pointed end of the tool does not slip off. I forget where I read about this dodge but it works quite well. A slipstone or Arkansas stone is also handy to have to put a keen edge on small tools but they won't remove large amounts of metal.

This really wraps up the section on hand tools. I realise that it is far from exhaustive but, as explained earlier, it was never the intention to be so. However, it is hoped that a reasonable outline has been given, so we will move on to consider the slightly more complex items of home workshop equipment, namely machine tools.

3.8 Machine Tools

Many successful live steam locomotives have been built by skilled and determined people without the aid of a lathe, but it must be said that the possession of such a machine will simplify the process immensely. With a lathe the potential builder need never say that he is stuck for any part. There appears to have been quite a mushrooming in the availability of small lathes over the past few years. A quick browse through the pages of *Model Engineer* or comparable publications will reveal an almost bewildering choice of machine, all of them suitable for our purposes.

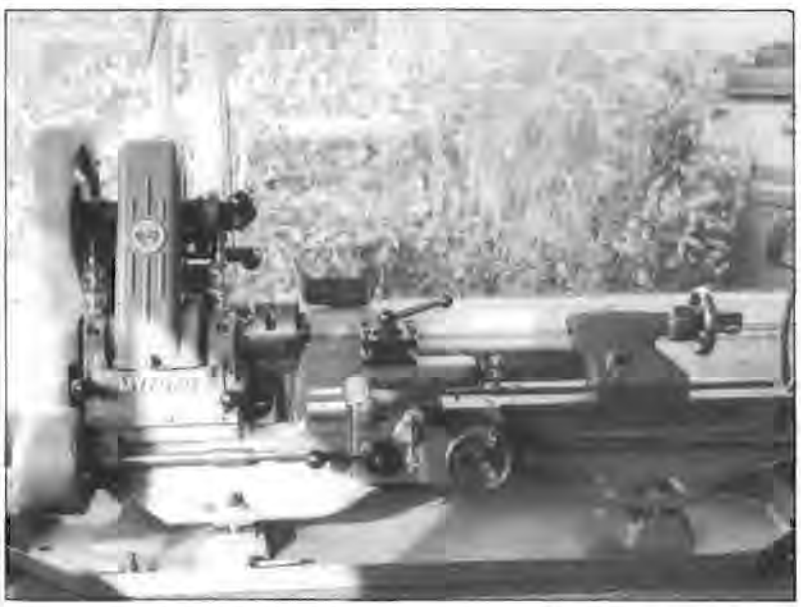

Photo 3.5 A Myford ML7 lathe - no longer produced but occasionally available second-hand. Now superseded by the ML10 and the Super 7. Lathes about this size are ideal for live steam work. (Photo T. Hughes).

In terms of size, a 2" (50mm) centre height lathe will do everything that will be required for 0 gauge live steam. Naturally, a larger machine will widen the scope of your operations but, even quite a small lathe represents a fairly hefty item of expenditure if bought new. If you do decide to push the boat out and buy new, the manufacturer will provide the usual guarantee and, in some circumstances, a test certificate for the particular machine certifying its accuracy.

In addition to the manufacturer's standard equipment, you will need a 3-jaw self-centering chuck, a 4-jaw independent chuck and a tailstock drill chuck. These items are pretty well indispensable to turn the basic lathe into a really productive machine. The bad news is that the additional items are not particularly cheap.

However, if you do buy a new lathe, you will have three major advantages. Firstly, you will have the undoubted pleasure of owning a machine tool which will have an accuracy and tautness that will make turning a pleasure. Secondly, you will have a manufacturer's guarantee and thus a period where any problems that develop can be referred straight back to the maker. Thirdly, you will not inherit problems which may be the result of an earlier owner's abuse of the machine.

This brings us to the rather knotty problem of buying a second-hand lathe. Buying anything second-hand is a chancy business. (I still have bad dreams about a friend's second hand Mark 1 Hillman Imp car I helped to purchase). A visit to, or an enquiry to, a reputable firm of machine tool dealers is, without doubt, a good idea. Some offer rebuilt machines which are as good as new but considerably cheaper. One must, however, consider that these people are there to make a living and in a dealer's store real bargains are few and far between. To set against this is the fact that the better dealers have a reputation to maintain and will normally give a guarantee with any item purchased, whereas in the private market you are very much on your own.

With the private second-hand market it is difficult to give any specific advice. Lathes offered for sale can range from the sublime to the ridiculous. Perhaps the best advice that can be given is, when you see a machine

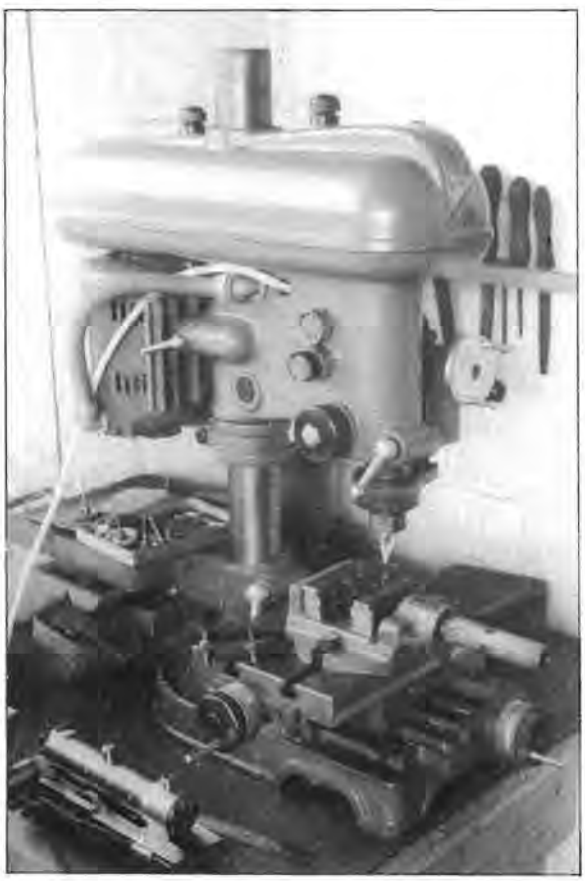

Photo 3.6 A Fobco Universal Mill/Drill set up for vertical milling. In the lower corner of the photograph is the Midland Compound under construction that will feature in a future Guild Publication. (Photo T. Hughes).

Photo 3.7 A Fobco Star bench drill with 0-1/2in chuck and speed range from 425 rpm. Drills of this type are a useful addition to the workshop. (Photo T. Hughes).

advertised that seems a likely choice, never go to see it alone. Always take someone with you, preferably someone with some engineering knowledge and experience, (and sufficient physical strength to carry you bodily away from any unsuitable bargain). A useful source of second hand tools and materials is the Sales and Wants Section of the Guild's quarterly *Newsheet.*

As a general rule, look for any obvious signs of wear, slackness in the slides and play in the headstock bearings. Put in centres and check the alignment between the headstock and tailstock by sliding the tailstock up to meet the headstock; the two centres should line up accurately. If the bed is sound and the spindle and tailstock are satisfactory, you should be OK. Any other wear can usually be taken up.

Finally, equip yourself with a good book on lathework, several are included in the further reading in Appendix A.

It has been said that the lathe is the 'king of tools'. If that is the case, one might say that the milling machine is the 'crown prince'. A milling machine in the home workshop is a bit of a luxury, but a most useful one. If you have a miller you won't be able to throw away your files, but you will use them a lot less. The machine can produce non-standard angles and channels, slot ports, produce flat and parallel surfaces and is instantly available. To reproduce these facilities on a lathe requires a vertical slide to be fitted and set up. Where time is no object this may be merely inconvenient, but when you have done it half a dozen times in an evening the fun begins to pall and the possession of a mill begins to seem a most attractive alternative.

The rules for purchasing new and second hand lathes

also apply to the purchase of milling machines. The only point to watch, especially when buying second-hand, is that quite a number of the smaller units on offer may have seen hard service on factory production work. Whilst this is not necessarily a bad thing if the machine has been well maintained, considerable wear may have taken place in one area only with consequent ill-effects on the accuracy, so check for wear and backlash throughout the range of travel. The wear can be taken out but the necessary work of scraping bedways and the subsequent adjustment and replacement of bearings can be time-consuming and is not usually tackled by newcomers to workshop practice.

3.9 Soft and Hard Soldering Equipment

The major difference between electrically powered model locomotives and steam powered models is the desireability of hard-soldering components, notably the boiler and associated pipework. Most of the soft soldering work can be tackled using the same sized irons as would be used for general model work, that is a 50 watt iron for the lighter jobs and a 100 watt iron for heavy jobs, particularly those involving brass where the heat can be dissipated very quickly. Electrically heated irons with some form of thermostatic protection to avoid 'burning' the tip are very reasonably priced but much good work has been done in the past using gas heated 1/2, 1, and 2 lb copper bits. As an aside, LBSC used to claim that in his early impoverished days he used his mother's brass poker heated in the domestic grate to successfully carry out simple soldering jobs.

For hard (silver) soldering or brazing a much hotter source is required and the ideal tool for this job is a propane torch with a medium sized burner. I acquired mine well over twenty years ago and it has never given a moment's trouble despite fairly constant use. Actually this useful gadget is not particularly expensive if bought one piece at a time starting with a regulator, small and medium sized burners and a handpiece. A 15 kg cylinder of propane costs about £10 (1990 price) and will last several years. Alternatively, you may get away with using a butane cartridge blowlamp which is cheaper to buy but may need coke packing to help distribute the heat. Details of home made brazing hearths of various types can be found in a number of workshop practice books; Tubal

Photo 3.8 A Sievert propane self-blowing gas blow-torch. Various burner nozzles are available to suit a wide range of work. (Photo T.Hughes)

Cain's *Soldering and Brazing* has several illustrations. (see Appendix A).

Another method would be to use the 'old time' approach and use a 1 pint paraffin blowlamp which would be more than adequate to carry out the job. A lot of my early brazing work was carried out with paraffin blowlamps and very good they were. Of course, they had their own troubles like clogged jets and running out of fuel at a critical moment; and on one occasion a vapouriser burst at full pressure which was quite exciting. Luckily, I was outside at the time. Incidentally, not long ago, I saw several blowlamps in a curio shop. They were being sold as 'antiques' at colossal prices. I passed on down the street with a vague feeling of impending middle age!

The list of items described above is far from exhaustive but should give a broad idea of the tools that go to make life easier when producing live steam model locomotives.