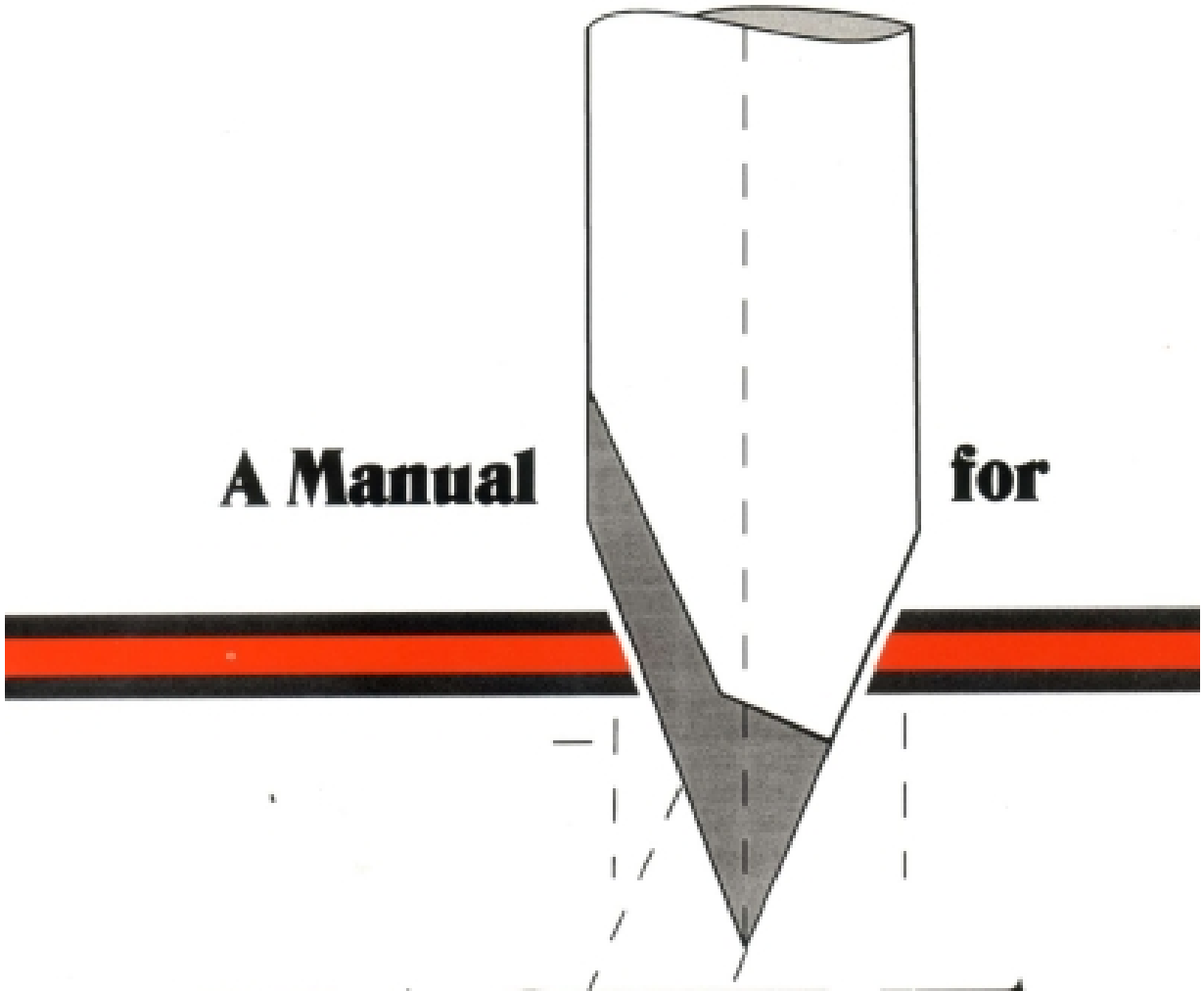
A Manual
for
Machine Engravers

A Manual for



MACHINE ENGRAVERS

BY

CHARLES HARWOOD-MATTHEWS

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BADGERS

EMSWORTH, 1993

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INTRODUCTION

COMPUTER Controlled and Pantograph engraving machines will live side by side for many years to come. Most engravers who have lived with the pantograph all their working lives now accept the fact that the computer is here to stay and will in fact engrave very quickly and to a high standard, despite their initial desire to see them fall through a hole in the ground.

Quite naturally when these machines first appeared on the UK market in about 1979 engravers were hesitant to accept them, it was hard to believe that a computer could do all that they themselves were able to do, after years of training and practical experience. Of course now, knowing more about computers as we do, through exposure to them. We realise that the computer knows nothing at all, until one of us tells it what to do in a given situation.

Realising that it is merely a useful tool makes it much more acceptable, as in that role it can only help you to work faster and more efficiently. In this manual I will talk about the pantograph machine, in the main, because with this knowledge, I believe, you will then understand what is required of the more technically advanced machines and will be able to handle them accordingly. It is very noticeable how quickly an already experienced engraver can learn to use a computer driven machine. He knows after all what he should be able to do with it, he also knows how to cope with the engraving materials available and which cutter to use for the various types.

I have heard the fear expressed that the new breed of computer controlled machine is eating away at the market. This is certainly not the case, because in our age of expensive labour, engraving the traditional way was becoming too expensive and other cheaper methods of marking were being exploited at the expense of the engravers. The new generation of engraver is beginning to claw back some of the work that had been lost to screen printers and hot stampers. The market is expanding in fact, because engraving is now becoming affordable again. You and I know it is the most effective form of marking, there being no other that requires no support from artwork or photography in one form or another.

I once knew a man who always boasted that he liked to learn by his own mistakes. As he worked for me at the time I found this rather worrying. Learning or preferring to learn by one's own mistakes surely means the experiences of people who have already tried and failed at a particular ploy are of no value. This man and others that would agree with him will never be wise men. To become wise it is necessary to take note of the experiences of others and build on them, thus moving forward with the maximum amount of knowledge available.

You would be entitled to ask why a manual on machine engraving when there are so many computer controlled engravers at work these days? The answer is simply that I believe that to do a job properly one needs to know "the hard way" first and as I have just said, there is a great deal of knowledge common to both types of engraving.

Computer control will be then seen in the proper light, as an excellent way of speeding up engraving. An operator that knows how to engrave with a pantograph machine will find its computer controlled successors much less daunting. In particular, a knowledge of cutters, speeds, materials, layout, letter styles, letter filling and much more, is common to all engraving. No matter what drives the machine, man or computer. It is also my belief that there will always be pantograph machines and engravers who will prefer to use them, despite the fact that in a purely commercial environment the computer driven variety is bound to dominate.

Perhaps you have a notion that you might start your own cottage industry, with a pantograph machine in your home workshop? If not why not? the pantograph has to be one of the most fascinating pieces of engineering equipment ever invented and I firmly believe that in some form or other it should be part of every engineering shop's equipment. Engraving lettering in two dimensions is just one of its functions, more sophisticated versions work in three dimensions and will copy complicated three dimensional designs and engineered components, enlarging or reducing them in size as required.

In this manual we are going to cover the use of the two dimensional pantograph as applied to the engraving of lettering. This is universally known as Machine Engraving and should not, just because it is done manually be referred to as Hand Engraving. There is a tendency now that we have computer controlled machines to refer to the pantograph operator as a hand engraver. The true hand engraver of course uses nothing more than a Graver and a collection of other small and, to the onlooker, rather insignificant tools to literally carve his designs out by hand.

I hope readers of this manual, which is built on long experience in the engraving industry and a knowledge born of many mistakes, will use it figuratively speaking, as a stepping stone. And then move on to greater things, becoming a better engraver than I ever was.

Engraving is part of our industrial history and quite unique, requiring as it does a strange mixture of artistic and engineering knowledge, the ability to place a mark accurately and neatly does not make an engraver, but it's a good beginning.

CHAPTER 1 - THE BASIC MACHINE

SELECTING YOUR ENGRAVING MACHINE

WHEN you set out to engrave for the first time, there are a great many things to be considered. Some of you will know exactly which type of work you are going to specialise in. You might have secured the promise of work from an electrical contractor, in which case you will know you are going to get for the most part, labels to engrave. You may be considering opening a trophy shop, in which case you will also know your likely requirements.

Usually the beginner just "knows" that there is a lot of engraving work out there and intends to catch as much of it as he or she can. This is where the problem arises. Which machine? As with motor cars, food processors and Hi-Fi systems there is no single solution. Engraving machines come in all shapes and sizes and each one has a different attribute. Let's see if we can shed some light on these.

I shall break down machines into three types: industrial floor standing engravers, floor standing trophy machines and lightweight bench top machines. The two ends of the spectrum are easy to recognise, heavy cast iron on the one hand in machines weighing perhaps as much as 500Kg and lightweight cast aluminium machines weighing as little as 10Kg on the other. No wonder then that choosing a machine can be so difficult.

Take no notice of old hands who scorn one particular make or type, each machine that has been built by one of the established manufacturers was designed for a purpose and most work well, within their own designers' parameters. In my experience, engravers like motorists tend to favour the machine they learned on.

The pantograph assembly is the single most important element of any engraving machine, as this dictates what it is capable of achieving. There are three distinct types. Let's deal first with the industrial engraver.

The industrial engraver

In order to withstand the stresses created by profile milling and engraving tough materials, the cutter spindle is mounted on a cast iron linkage attached to the main body of the machine. This linkage swings freely in a horizontal plane. The pantograph of such a machine dictates the movements of the cutter spindle only and is not troubled by the cutting stresses, which are absorbed by the heavier linkage, working alongside. The cutter on machines like this is fed downwards by a screw or lever, with coarse or fine movements. This movement up and down is known as the Z axis. If you refer to Sketch No. 1 this shows the other two axis that are referred to constantly when discussing cutter positions or directions of

movement. This terminology is common to all machine tools, not just engraving machines.

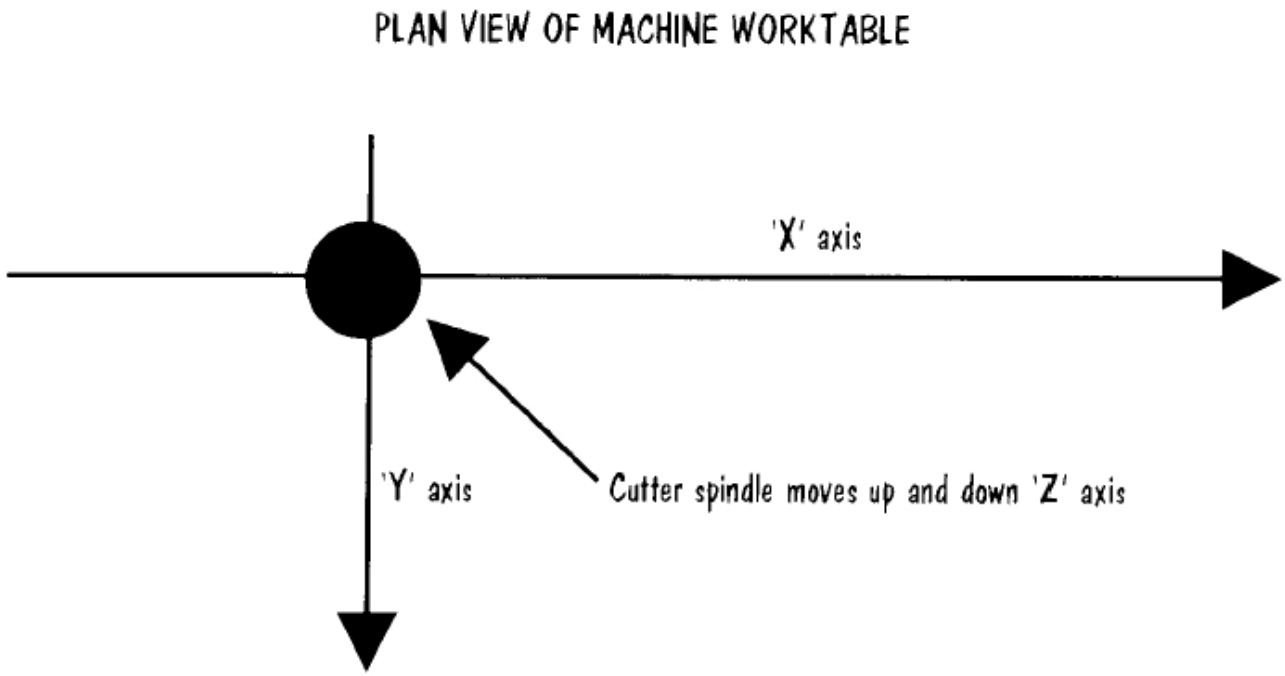


Figure 1 The XYZ movements

The whole framework of an industrial machine is rigid and built to machine tool tolerances enabling it to be used for accurate profile milling and the production of small engineering components as well as precision lettering. Industrial engravers usually rest on fabricated steel bases which stand on the floor, their inherent lack of vibration make them the best engravers in terms of accuracy and quality of cut, however their T slotted work tables make it necessary to employ a lot of jigs and fixtures if you want to engrave objects like trophies and cups.

The work tables on machines can be moved accurately, by handles that turn lead screws on the X and Y axis and in some cases these are calibrated in either metric or imperial divisions. The X axis is the movement across the table from left to right, the Y axis is the movement towards or away from you (see Sketch No. 1), the operator. Once again this is common to all machine tools. A Newing-Hall model K is the perfect British example of this type of machine.

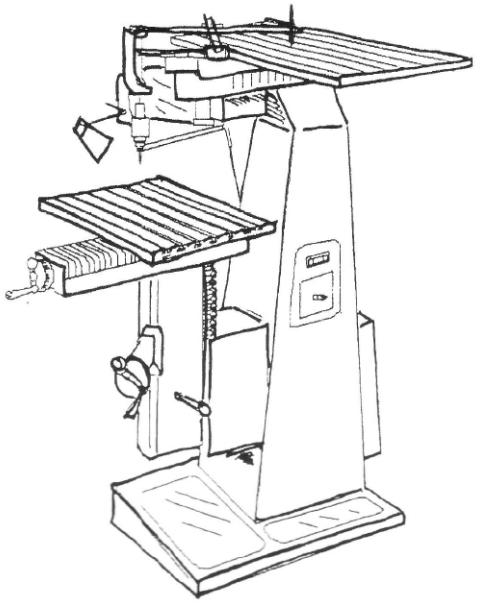


Figure 2 A typical industrial engraving machine

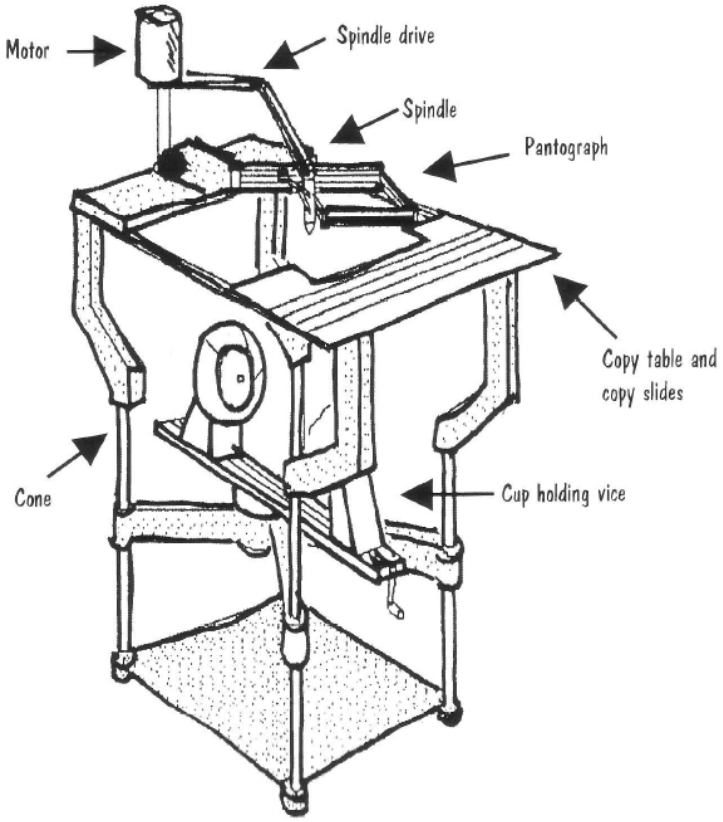


Figure 3 A typical floor standing trophy engraver

Heavy duty trophy machines

Floor standing trophy engraving machines fall into the middle weight category. On the Gravograph TX3 pantograph, which is typical, the cutter spindle is mounted directly onto an arm of the pantograph, which inevitably is much less able to resist the vibration and twisting movements created when the cutter is working. There being no separate linkage to carry it. It does mean though, that the machine is a lot lighter and less bulky, and being lighter means that when you are experienced you'll be able to move the pantograph faster. Cutter spindle feed is by lever and because the pantograph is in a fixed horizontal plane as with the industrial machines it means that the cutter feed is vertical, a good point and important if you are considering light profiling or hole cutting operations.

These middle range machines are usually designed with the trophy dealer in mind, and they are second to none in their ability to accommodate odd shapes and sizes of workpiece. Trophy cups, silver salvers and watches can follow in quick succession without causing any re-jigging problems. Work is held in a vice rather than on a flat table, and the vice is designed to take a wide selection of readymade jigs. Despite their "trophy" designation, they would be a welcome addition to any industrial engravers' workshop to handle the small awkward shaped objects.

Bench top machines

The third type of pantograph machine, the lightest of all, and usually bench mounted, has what I have christened the "floating" pantograph as this describes it well. The pantograph is pivoted at the back and the cutter is fed downwards by lowering the whole assembly until the depth regulating nose touches the surface to be engraved. Because of the pantograph', free movement you could be forgiven for thinking that this is a three-dimensional machine, but that would be too good to be true, in fact the geometry is Wrong. (Scripta, the French engraving machine manufacturer make a small benchtop 3D machine). Again the cutter spindle is mounted directly onto the pantograph. The principle drawback with this system is that the cutter comes down onto the job in an arc, this means that you cannot use the machine for making cut-outs or holes and cannot use it without a depth regulating nose. You don't feed the cutter on these machines, you lower the whole pantograph. The advantages are obvious though, it's extremely fast and light and an experienced operator can fly over his work at great speed. Incidentally, when using a machine with a floating pantograph it is essential to make sure that the cutter spindle will be working in a vertical plane, Sketch No. 11 illustrates this, manufacturers supply a device for setting the table and vice at the correct relative heights to each other. This can be achieved by raising or lowering the workholding vice. These small benchtop machines also use a vice to hold the workpiece rather than a flat table and the same wide range of jigs are available for holding awkward shaped workpieces.

DECIDING ON A MACHINE

Which of these machines is for your workshop? Should you envisage getting a lot of instrument and sign work and very few trophies then don't buy one of the machines in the two latter categories, as the spindle and pantograph tend to be rather lightweight for heavy cuts. Industrial engravers have the spindle capacity and generally much larger pantographs. The worktables are flat and the workpiece has to be clamped onto it with dogs. The flat; usually T slotted worktable gives good support to the job if you are making heavy cuts. Trophy work is not entirely lost with these machines as cup holding fixtures are available as an attachment. I have to say though that these fixtures are not nearly as good as the vices on machines designed specifically for this work.

Industrial engravers have an advantage that must not be overlooked, most of them have many more reductions to choose from and this includes, one-to-one, that is to say, the ability to produce a pattern without a reduction in size, almost essential when making your own templates, some trophy machine manufacturers offer one-to-one pantographs as an add-on feature but frankly I don't like these as in my experience none of these machines are built rigidly enough withstand the stresses of one-to-one machining. At this ratio the operator has no mechanical advantage over the cutter spindle and there is much more effort required to move around the template. Unfortunately while exerting this effort one is much more likely to lip, in addition to which any minor error will be shown at full size instead of being reduced as it would otherwise be!

TYPICAL APPLICATIONS

Industrial engraving machine, floor standing

Cut out acrylic letters, labels and signs in brass, stainless steel, or plastic. Instrument panels including the routing of any holes, dials and scales. Engraved signs with solid sunk lettering. Stove enamelled panels for electrical switchgear, the occasional cup or tankard. House signs in wood or slate. Engineered components which because of their complex shape are best made on a machine the cutter spindle of which is guided by a pantograph. These engravers are suitable for all types of engraving.

Heavy duty trophy machine with rigid pantograph

Cups, tankards, rose bowls, trophy plinths, trays. Labels in plastic brass or aluminium. Small signs, door nameplates internal signage for public buildings. Lightweight industrial work, but not components that have to be made to machine tool tolerances.

Small bench top engraver with "floating" pantographs

Labels in brass, plastic or aluminium. Jewellery such as watch backs, bracelets. dog discs, pens, trophy plates, small internal signs, badges, computer key tops and small instruction plate.

Note well that the larger machines can do everything the smaller machines can do, but not vice-versa Therefore if you are going to attempt all types of engraving you should look for the largest machine that your budget will allow. Second-hand industrial engravers make an excellent buy, they last forever and when bought from one of the major companies selling reconditioned engraving equipment they usually carry a guarantee.

Computer controlled engravers

These machines do not use the pantograph system for guiding the engraving cutter. This is made obsolete by the electronics which enable the software programs to select almost any size letter or legend that the operator chooses. I nearly said reduction, but of course this word only applies if you have a pantograph and a "master" or "copy" on the machine to reduce.

The Newing-Hall Pantocut in fact has a pantograph which is driven by the computer operating system. The reason for this is that it was originally designed with existing manual machines in mind to be sold as a retro-fit kit. Which was good thinking on their part and widened their market considerably.

Like manual machines the computer machines vary considerably in their capabilities. Over the years the programs and the facilities they offer have become very alike, after all they are all aimed at the engraver. The physical attributes of these engravers vary widely, like the manual machines they are aimed at engravers from all sides of the industry.

I cannot set out here the fine detail of each of these machines after all each of their respective handbooks is at least as large as this manual. To a much greater extent than with the manual machines, the budget you have set yourself will help make the decision as to which you eventually buy. My advice is buy the next model up the scale if you can. If you don't you will live to regret it. Make sure that the worktable will accommodate the work you envisage doing.

Above all, make sure that the company who is offering it, has the capability to look after you and your machine. Most of you will have experienced the computer in some form, probably in the guise of a word processor or accounting machine in the office. You will know therefore that it is absolutely essential to have someone at the other end of a telephone line to advise you when you have a problem. It is unlikely to go wrong, but you are as surely as night follows day, going to get stuck at some point, especially in the early days of ownership.

This last aspect of computer driven engravers, the back up and servicing has caused the manufacturers and distributors of such machines severe problems, it has brought some to their knees in fact, although they themselves might not recognise this. In the past the engraving industry has been supplied by companies you would describe as machine tool manufacturers, people who traditionally are geared to selling a piece of equipment that will last a lifetime quite literally and require a small amount of "low-tech" maintenance occasionally, or to put it another way, a grease and oil when remembered.

These companies now find themselves in a new environment altogether, where the customer requires informed and intelligent help at frequent intervals, for several weeks perhaps after a machine is sold. Service contracts go some way towards financing this for them, but are not the whole answer. The advice I am giving you therefore is take a close look at the company you buy this type of equipment from and satisfy yourself that they will be able to look after you and your engraver in the months ahead.

In the same way you would look at a pantograph machine to see if it suited the work you envisage for it, you must take a close look at the worktable of the computer controlled engraver that you favour. There should be plenty of room around the table this applies whether or not you plan to do large work or handle awkward workpieces there is nothing more time consuming than having to man-handle things in and out of awkward spaces.

Is the machine robust enough for you or will the framework distort when you try too take heavy cuts? Is it well engineered? Are the slideways covered and properly protected from swarf (engraving chips)? Does the spindle look robust enough? Top loading spindles are by far the most convenient but a collet spindle will be better if you want precision and vibration-free service when working under stress.

The software on the vast majority of machines is good now, positively magical some would say. There are some packages which are too closely related to publishing software and which have been modified to theoretically suit the engraver; watch out for these, they are unnecessarily complicated more often than not. Programs which have been designed first and foremost for signmakers are in danger of being too remote for engravers also, unless of course you happen to be needing it for signmaking. You have to remember there are hundreds of fonts suitable for profiling and which look good in letters one foot tall but which would not translate happily to one inch lettering on an internal sign or a door plate, so don't be fooled by the promise of massive font libraries, engraving imposes strict limitations.

Beware of programs that were designed for graphics designers and just happen to be able to be used on your plotter (engraver). A program linking one of these packages to your engraver is not an engraving program. You will find that as an engraver you have very specific requirements, on the whole quite simple ones

which require the quick laying out of a standard typeface within set margins. Sometimes the lettering has to be very precisely placed on a panel and you need to be able to see exactly where it is going. You need to be able to see where the centre of a word is and be able to locate it accurately above a hole or on a dial.

Most of the graphic packages work on the assumption that the user of the software is the designer of the end product. Most engravers have to work from the other direction and need to translate exactly what is on an architect's or engineer's drawing (or cigarette packet), doing exactly as they are told to within fine tolerances.

To sum up this warning, if you are looking for an engraving package, as opposed to a graphics design package, don't accept a demonstration that concentrates on how easy it is to modify the shape of a letter. Make sure you are convinced you can lay out six lines of standard Gill Sans or Helvetica or single line block, or any other common typeface, quickly and easily and that the software brings all the functions you require together. I suffered a demonstration of an "engraving" program recently where the operator had to use several programs to achieve a simple label, dodging between a graphics package and a word processing package to achieve an acceptable result. A pantograph would have been quicker

Perhaps the best advice is, take a handful of your current jobs to the demonstration and ask the salesman to show you how he would tackle these.

The same parameters apply when buying the hardware for your CC system as apply if you were going out to buy a pantograph machine.

I know I have just issued this warning, but it is of paramount importance that the company that sells the machine to you is able to look after you, this means that they should always have someone in an office who is qualified to put you right when you make a wrong move as you will. They should also have the ability to put right actual faults with the software or the hardware, either by sending out an engineer or taking in the faulty component and repairing it in their own works. Pay a visit to their works and see this for yourself, if possible speak to the service engineer himself. Take a look at their workshop. Remember you may have bought this machine on the premise that it will do the work of four men, if this is true and it stops, you have four men idle until it can be repaired.

My preference would be for a machine that operated off any IBM compatible PC and one which would accept software from other sources than the supplier of the engraving machine. There is a lot of very exciting software available for the workshop, ranging from design to accounting. Don't think though that because you have a PC that will take an accounting package that is a bonus. If you genuinely need to buy a CC engraver the PC will be taken up all day serving that, and unless you are going to do the accounts in the evening there is no point.

These then, are the principal types of engraver, there are other permutations some machines combining several of these features, but this will, at least, help you classify any machine that you consider purchasing

CHAPTER 2 - CUTTERS AND CUTTER GRINDING

CUTTERS, THE FIRST ESSENTIAL

Your cutter is the most vital single item on your engraving machine and must always have the best possible cutting edge. Relate it to a cook's knife, a carpenter's chisel, a hand graver. It must be sharp at all times, there is no substitute. Any engraving instruction should begin with the cutter, the most basic and essential piece of your equipment. I shall be emphasising this over and over again.

Inexperienced engravers, for some reason have a terror of using a cutter grinding machine, imagining that they have to be an engineer before they can attempt to use such a device. Not so, in fact it's quite

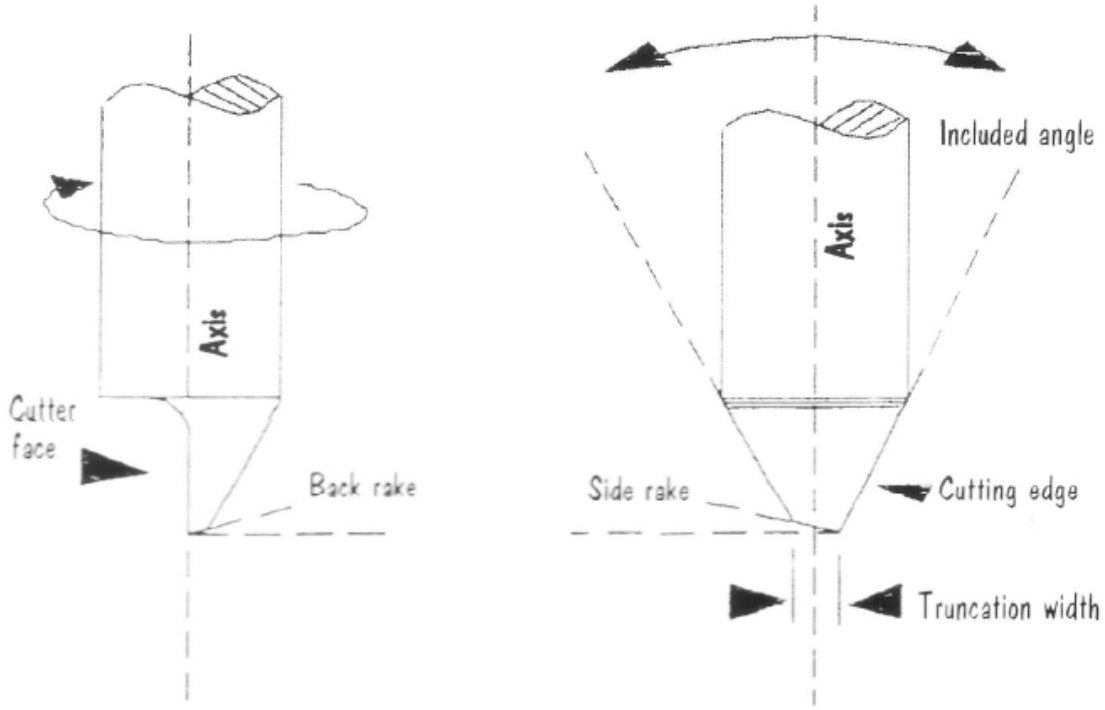


Figure 4 A typical engraving cutter

the reverse, the whole purpose of a cutter grinding machine is to take the freehand element and the doubt out of the process, therefore guaranteeing a good cutter is ground each time.

There is a rule of thumb in cutter grinding, which is, decrease the clearance angle for hard materials and increase the clearance for soft materials. The clearance angle is the space that the chip has to escape from. The softer materials having

generally larger chips than the hard materials, require a larger space to escape from. If the space created by the clearance angle is not large enough heat is generated by the chip as it is forced out between cutter and engraving material and in the case of plastics melting occurs. In metals this lack of space manifests itself as a burr pushed up by the chip.

I get a steady flow of enquiries from engravers who say that they are unable to cut a particular engraving material, in ninety percent of the cases it transpires that they are trying to engrave with a cutter that has not been sharpened for days or even weeks.

If you use a motorised and rotating cutter to engrave more than about half an hour a day, then you should consider buying yourself a proper cutter grinding machine.

These relatively inexpensive pieces of equipment (compared with the cost of an engraving machine that is!) will save you money in the long run, and simplify your life as an engraver considerably. The alternative you are faced with is to have at least double the number of cutters to hand, allowing for some to be always in the post to a company that will regrind them for you.

If you rely on this system you will be caught out from time to time. Your cutter perhaps breaks its point halfway through a job, can you find another that will give you the same results? No, you have to send it away for a regrind and when it comes back it's not quite the same as the original. If you still have a customer by this time, you are just plain lucky. Add to this the cost of the regrind, the cost of the postage, the cost in annoyance to you and more importantly your customer, then one has to ask whether this is the right way to approach the problem.

As the owner of a cutter grinder, you will be able to restore the point of your cutter in a matter of minutes. Great economies can be achieved by keeping cutters ground in the same form. Don't, in other words, change a pointed cutter to a parallel cutter, and back again, because this will necessitate grinding away large amounts of valuable material.

I am often asked how regularly a cutter should be sharpened. This is an impossible question to answer as there are so many variables. When it doesn't cut properly is not the right answer, because when lack of quality becomes noticeable it's too late, unless you are going to throw away that particular workpiece. Certainly a cutter should be sharpened at the start of every job.

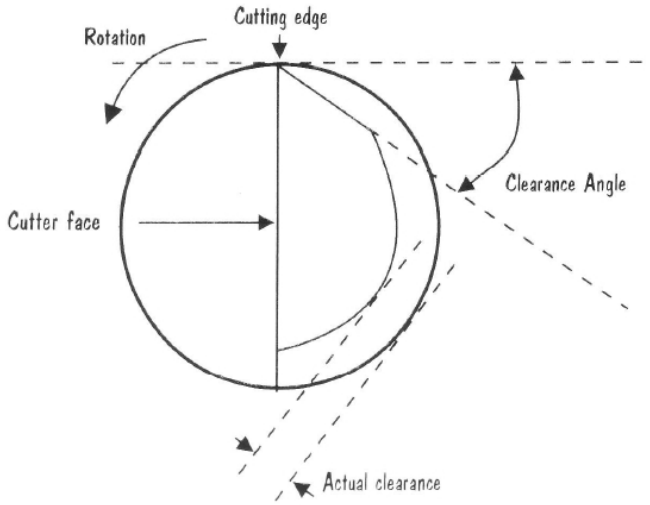


Figure 5 End view of cutter showing clearance angle

WIDTH OF CUT

I know that the depth of involvement in the technical side of engraving varies a great deal. In this manual, I am attempting to cover the activity of all types of engraver. If I can encourage a man who has never dome anything but drag mark trophy plates to venture a little deeper into the intricacies of machine engraving then I shall have succeeded in making his job more interesting, worthwhile and, let's not beat about the bush, commercial.

Width of cut to size of letter

This is a table of useful settings in English and metric sizes. Please note this is not to be taken as a conversion table.

Metric		English	
Letter Size	Tip Width	Letter Size	Tip Width
1mm	.12mm	1 /32"	.004"
1.5mm	.18mm	1/16"	.007
2mm	.25mm	3/32"	.011"
2.5mm	.31mm	1/8"	.015"
3mm	.37mm	5/32"	.019"
3.5mm	.43mm	3/16"	.023"
4mm	.5mm	7/32"	.027"
4.5mm	.56mm	1/4"	.031"
5mm	.62mm	9/32"	.035"
5.5mm	.68mm	5/16"	.039"
6mm	.75mm	11/32"	.042"
6.5mm	.81mm	3/8"	.046"
7mm	.87mm	13/32"	.050"
8mm	1.00mm	7/16"	.054"
9mm	1.12mm	15/32"	.058"

10mm	1.25mm	1/2"	.062"
11mm	1.37mm	17/32"	.066"
12mm	1.5mm	9/16"	.070"
13mm	1.62mm	19/32"	.074"
14mm	1.75mm	5/8"	.078"
15mm	1.87mm	21/32"	.082"
16mm	2.00mm	11 / 16"	.085"
17mm	2.12mm	3/4" "	.093
18mm	2.25mm	25/32"	.097"
19mm	2.37mm	13/16"	.101"
20mm	2.5mm	27/32"	.105"
21mm	2.62mm	7/8"	.109"
22mm	2.75mm	29/32"	.113"
23mm	2.87mm	15/16"	.117"
24mm	3.00mm	1"	.125"

Sketch No. 6 shows how the clearance angle that is "built in" when grinding the cutter, causes the width of cut to be greater than the actual width of the truncation. The truncation being the amount taken off the tip. Sketch No. 4 illustrates the angles that will be referred to often in this manual and instructions generally.

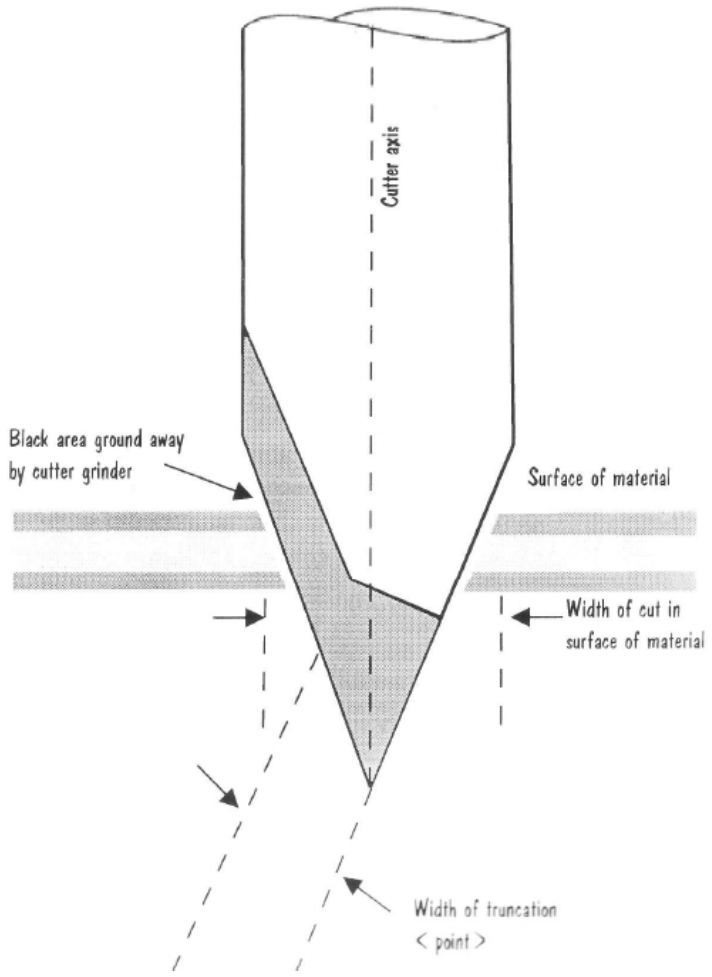


Figure 6 Cutter width compared to width of truncation

There are those among us, who when asked to check the width of an engraving cutter will hold it up to the light and say with great gravity, "hummmm ... yes it's about 1/16" across the tip". That may be so, but it's not the distance across the tip of the cutter that matters in fact. Should you be comparing one cutter with another then that will be a reasonable way to check them, and a hand held magnifier with a graticule will make this comparison easier.

In most cases however, what you really want to know is the exact width of cut that you are going to achieve (and this is not the same as the width across the tip). The manufacturers of industrial engraving machines such as Newing-Hall (Taylor Hobson), Deckel and Alexander (Precision Grinding do not produce the Alexander machine anymore although there are plenty of secondhand ones available), all produce cutter microscopes for the precise measurement of cutter angles. I am are not going to say, as I do with cutter grinders that a cutter microscope is something you can't manage without. This will only apply if you are an industrial engraver who spends his time working to precise depths and widths of cut and having to repeat them faultlessly.

A question I have been asked literally hundreds of times is "Which cutter should I use for this job, diamond or rotary, with or without the motor?" There is no straight answer because, in some cases it's a matter of personal preference and not a case of right or wrong. However, the material you are about to engrave and the size of letter required will often dictate the answer. If we go through a few of the factors involved it should make the decision more obvious to you.

DIAMOND OR MOTOR DRIVEN CUTTER ?

The most limiting features of a diamond cone cutter is that it only cuts one width of line. In fact it does not really cut at all, it scratches the surface. A deeper impression can be made by going over the job several times but this is sometimes hazardous because of the danger of you or the workpiece slipping. The proper term for engraving with a diamond is "drag-marking" this sounds more professional than scratching, doesn't it?

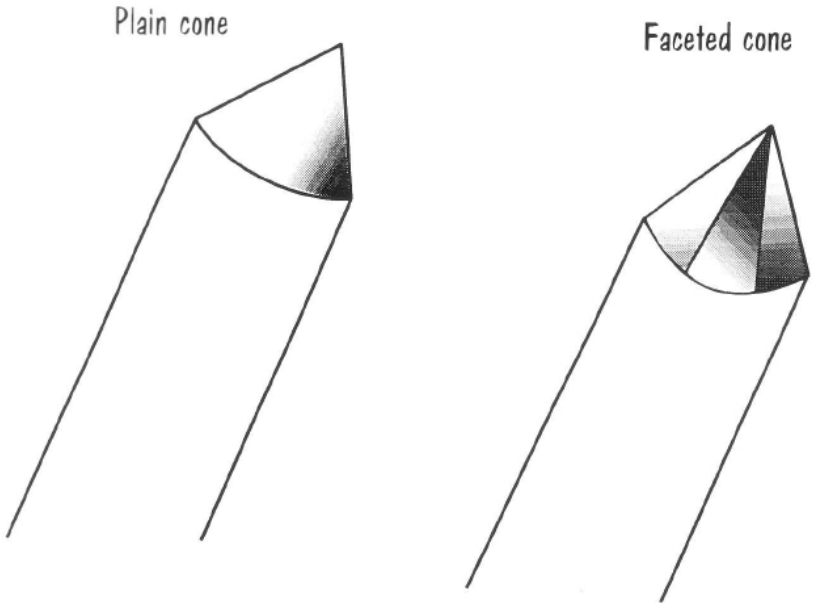


Figure 7 Types of Diamond Point

Because only one width of line is possible, the size of the letter has to be restricted if you are using single line copy. A letter one eighth of an inch in height should be considered the maximum size of job that you would approach with a diamond and single line copy.

Should it be necessary to engrave larger letters with your diamond, there are type faces specially designed to overcome the problem. Type faces that involve more than one cut, usually on the vertical bar of the letter, as in Double Line Roman, gain extra weight as a result. Double lines that are hatched as well, have even more body. "Hatching" is the term given to the infill of diagonal lines. Note that

care should be taken when estimating for jobs which require this type of lettering, as they take far longer to engrave and should be charged for accordingly.

The cutter to employ for the type of lettering described, would be a cone shaped diamond. A cone can only be used for drag markings as, quite plainly, there is no virtue in spinning a cone that has no cutting edge. This type of "plain cone" cutter is available ground to a variety of included angles, the most usual being 90, 120

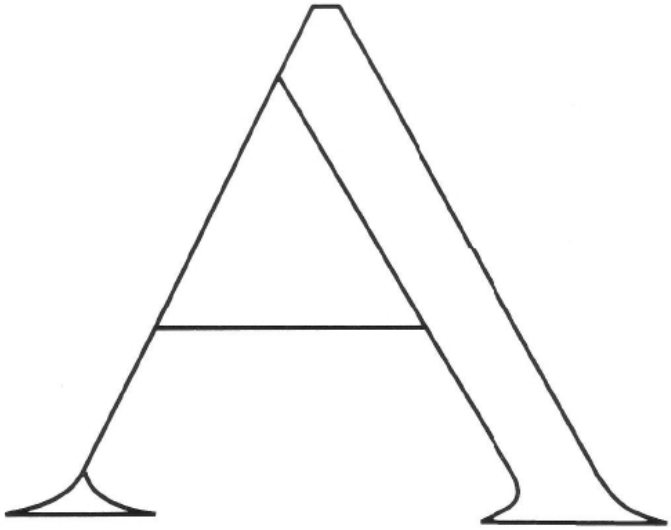


Figure 8 A double line roman style letter

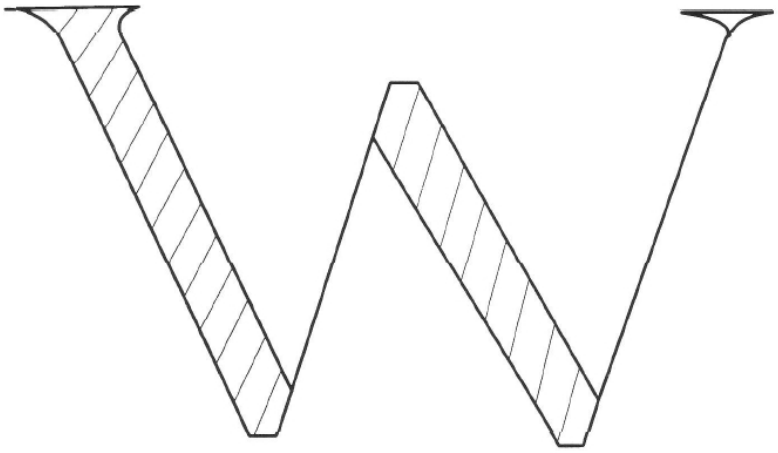


Figure 9 A letter that has been hatched to add weight

and 140 degrees. Of these the 120 is the best for daily use. A small angle will dig deeper and also give better results where you have to follow a curved surface. This latter point also applies to rotary cutters of course and is illustrated in

Sketch No. 10. You can see here that a cutter with a large included angle (cutter A) is less suitable for reaching round curved surfaces than one with a small included angle (cutter B).

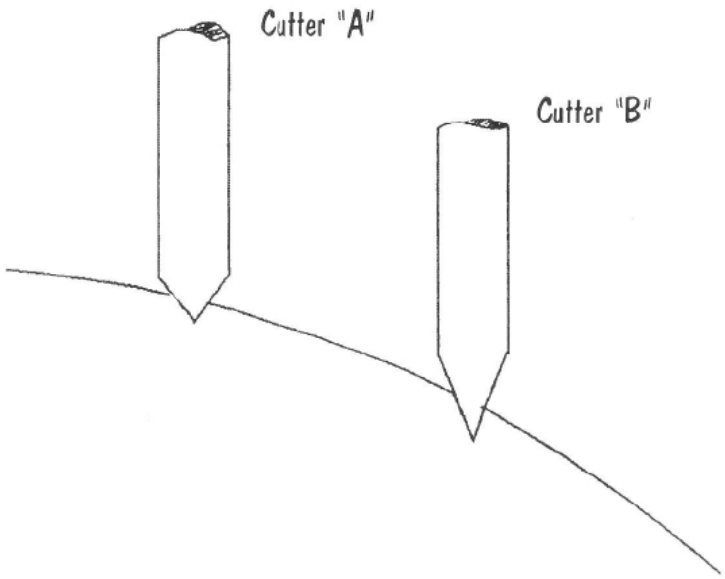


Figure 10 Cup or cylinder to he engraved

A larger angle will be stronger and make a wider mark on soft surfaces like pewter. Faceted cutters are ideal where you have to mark materials, such as fibreglass or the laminates used in printed circuit boards, and should always be used at the maximum spindle speed available.

High Speed Steel (known usually as just HSS) and carbide cutters can, with correct grinding, be used in almost every situation. At the moment, however, we are talking about the appearance of the letter we engrave, we will leave the subject of which cutter for which material for the moment By alterin$_g$ the truncation (the amount taken off the point to achieve the width of cut) of the cutter and, to a lesser extent, the included angle. The appearance of the letter can be changed significantly. To achieve what most of us would consider to be a "normal" letter the width of cut should be approximately one seventh of the overall height of the letter. When grinding the truncation, remember to take into account the depth that you are going to be engraving, refer to Sketch No. 6 to remind yourself of this effect. The thickness of the top surface of the laminate will have some bearing also. A micro surface will require much less depth of cut to one of the exterior quality PVC sign materials which have relatively thick top surfaces.

Let's not lose track of the subject, we are trying to decide which cutter we should use, diamond or rotary. If you use a machine with a floating pantograph and a

nose cone you will probably settle for a diamond on cups and tankards because that way you can dispense with the nose cone and the danger of it ghosting or worse, scratching the bright surface.

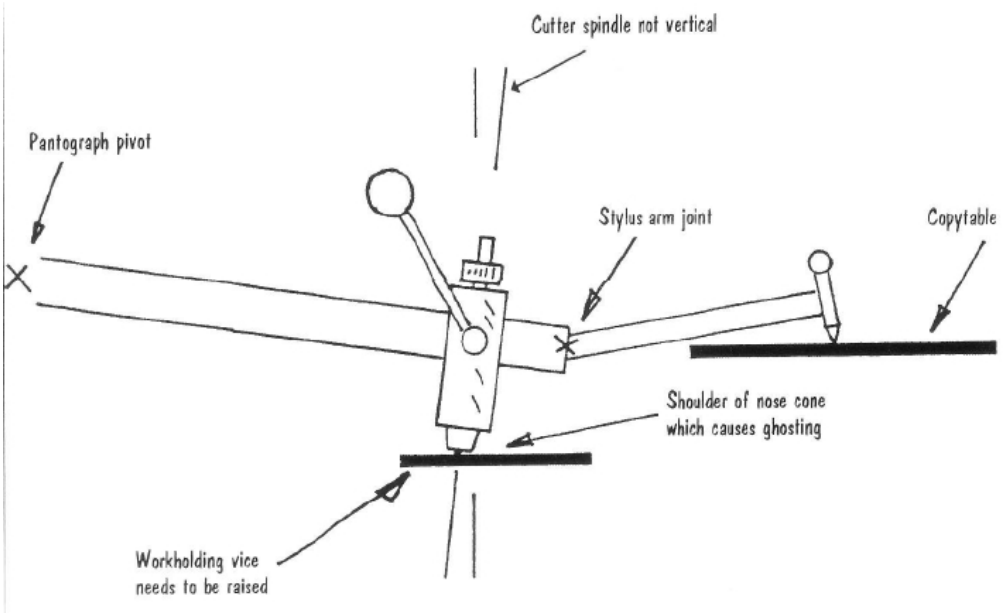


Figure 11 A cause of ghosting

Ghosting by the way, is how I refer to that most aggravating "second letter" that appears adjacent to the letter being engraved. This is created by the edge of the nose cone burnishing the surrounding metal. Usually it can be polished out, but if swarf is allowed to accumulate the cone will scratch the surface as it traps the swarf between itself and the surface being engraved. The problem is most likely to occur when engraving a curved surface as on these occasions the pressure is localised at the edge of the cone.

Ghosting will not occur if you have made sure that the cutting spindle is vertical to the surface of the work at all times. Unfortunately it is possible to set up a machine with a floating pantograph so that the spindle is never vertical, the shoulder of the nose cone will always be exerting undue pressure on the surface of the work therefore, watch out for this easy mistake. A setting device is supplied with machines of this type, though they always seem to go missing!

THE QUARTER GROUND CUTTER

Even today when we have good quality engraving laminate to work with one is occasionally asked to engrave a soft and sticky material which insists on forming a molten blob on the end of the cutter. The laminates currently available to engravers which are mostly mixes of PVC and acrylic engrave superbly, combining flexibility and machinability. The phenolic based rigid laminates have always engraved well although some are more prone to chipping than others, these rigid

phenolics always require the use of a tungsten cutter. It was the discovery the other day of some labels made from PVC that made me think of the quarter ground cutter and the fact that it is not seen so much these days - no doubt because, as I say, the new materials are so much better.

Engraving laminates apart, there are still plenty of occasions when you have to make the best of a difficult material and somehow engrave it despite the fact that it wants to melt or throw up a burr (two problems with a common cause).

The clearance angle on an engraving cutter is the critical angle when engraving soft materials if this is too small the large chip these materials produce will rub and produce heat which in turn will melt the plastic.

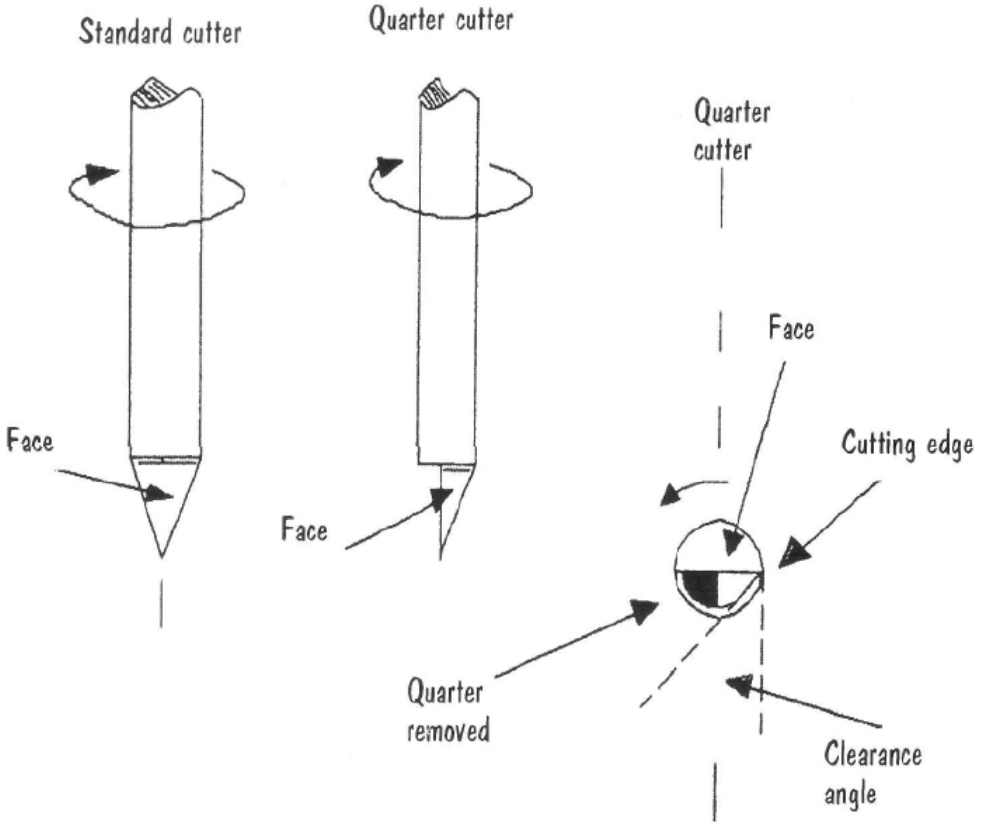


Figure 12 A quarter ground cutter

Sometimes however hard you try and however large you make the clearance the material still does not cut cleanly. Remember that too large a clearance angle weakens the cutter and there comes a point where it is unwise to keep increasing this angle. Quarter grinding entails grinding away the third quarter of the cutter,

see Sketch No. 12, leaving just the section that supports the cutting edge. As you can imagine this leaves the cutter very weak but it does mean that swarf can get away in a hurry and more often than not this will cure your overheating problem. If you don't feel you are capable of this grinding job any company that grinds cutters to order will be able to do it for you. When they regrind your cutters or supply them from new.

In the cutter recommendations I have only mentioned the clearance angle. Back rake and side rake are put on by hand. Usually though, when you buy your cutter grinder, the handbook will tell you how to do this on the machine, a practise you will very soon discard when you discover how easy it is to do by eye. Back and side rake should be increased and decreased along with the clearance angle, let's say between 10° and 25°. Remember increased clearances mean a weaker cutter, so beware of this.

The materials that require a quarter ground cutter will tend to be those that require the use of HSS (the soft materials with a low melting point), don't be tempted to grind a tungsten cutter this way - it will be too brittle and snap off very quickly.

Don't grind all your high speed cutters this way will you? You'll find that while a quarter ground cutter is great for getting you out of trouble on occasions, they are generally speaking too weak for everyday use, especially if they are parallel sided.

If you are going to fill the lettering after engraving, an included angle of 60° or less should be aimed for - 45° is a good average.

CUTTER GRINDING

The sight recently of a "blue" cutter recently made me realise that there is more to grinding an engraving cutter than at first meets the eye. I frequently tell people that there is nothing to grinding a cutter because a grinding machine is designed to cope with the technical side of things. This is true of course, but there are techniques which improve the finish you can achieve and decide heather or not you ruin a cutter by turning it blue.

A blue cutter? I hear you say. Yes, if when grinding a HSS (high speed steel cutter you dwell too long on the face of the stone it will, when a certain point is reached. turn a dark blue or brown. The reason for this is overheating and unfortunately if this does occur the cutter is ruined, because the HSS loses its temper and becomes too soft to maintain its cutting edge. In fact the blue area is usually just at the tip where there is the least bulk of metal or on the cutting edge and can be ground down to good steel. This is a waste of time however and an even greater waste of money.

So how do we avoid this happening to a cutter? There are two main causes of overheating - the first is dwelling too long on the face of the wheel, the other is a wheel that is clogged and needs dressing.

We'll deal with the general technique first and with dwell in particular. The first step towards grinding a cutter is to put it into the holder on the grinder. If you are using a Newing-Hall model G, you will have a holder with an internal diameter that matches the cutter and which incorporates a cam to give you the correct clearance angle (Sketch No. 5 shows you this angle). The holder sits in a crutch (a vee block) and is held there by your hand pressure (thumb).

Place the cutter as far into this holder as possible, right up to the point at which the flat is ground if you are using parallel cutters, you'll have no option if you are using tapered shanks. Holding the cutter as near the tip as possible is important, it ensures that there is the least possible chance of vibration. Those of you using cutter grinders like those made by Gravograph or Scripta should do the same only in this case you will place the cutter as far into the collet as possible. Don't incidentally allow the flat to disappear into the holder or the collet as this will prevent the cutter being gripped properly.

We now have a cutter firmly held as near to the tip as possible. We must now set the clearance angle and the included angle, Sketches Nos. 4 and 5 illustrate which these are. Individual makes of grinder will require different setting procedures and these are described in their respective handbooks. I refer to the actual angles required in Chapter Three when talking about individual engraving materials, as the material we are about to engrave dictates the settings we use.

Switch on the grinder and swing the cutter close to the face of the wheel to make sure that it will pass across this and not bump into the side.

The next step is with one hand to start feeding the cutter into the wheel using the knurled knob that feeds it along the axis of the stone and with the other to start rocking the holder or crutch back and forth across the face of the wheel. Most people would hold the cutter holder in their left hand and the feed, in their right. In fact I'm left handed and do the opposite, which I am told looks most awkward. Refer to Sketch No. 33 which shows the direction of feed and the face of the wheel.

It's most important not to feed the cutter too fast, how fast will depend on the grade of grit your wheel is. The coarser the wheel the faster it will cut. Don't be self conscious, you must pass the cutter quickly over the wheel back and forth, back and forth at least at a rate of about eighty times a minute, never giving it the opportunity to overheat. Pause and you're lost! (this is not to be confused with the feed rate, which is the speed at which you move the cutter along or into the axis of the wheel).

The techniques I have been referring to here apply to the use of HSS cutters and silicon grit grinding wheels only, diamond grinding wheels used for tungsten carbide cutters require a different approach.

Tungsten Carbide is quite a different proposition, cutters made from this material suffer from none of these overheating problems, but neither can they be ground on a white grit wheel. There's a green silicon grit wheel that will tackle carbide cutters but ninety nine percent of engravers would now use what is known as a diamond wheel. The "green wheel" is now hopelessly outdated (you can still buy them) and a false economy. Spend the money on a diamond grinding wheel - you won't regret it.

Remember with the white wheel you can feed the cutter across the face, this will round off the corner, but no matter, it can be dressed in a matter of minutes. Your diamond wheel cannot be dressed and you cannot afford to damage any part of it in this way.

What you must do therefore is feed the cutter INTO and not ACROSS the face (this assumes you have a cutter grinder with a cup wheel). Put another way, feed along the axis of the wheel not across the axis. Because the carbide is not likely to overheat, you can do this without fear of damaging the wheel or the cutter. Refer to Sketch No. 32 again.

The best policy is to feed the cutter in very small increments, ore turning the teed screw again make sure that all the carbide has been removed before feeding it into the face of the wheel again. Twist rotate the cutter energetically making sure material has been fully removed from the back of the cutter not just tram the area of the clearance angle. When you are sure all material has been removed, rock the cutter holder (crutch or collet depending on your grinder type) back and forwards in the same way as you would when using a white grit wheel, this will ensure that the diamond/resin face does not develop a groove and wears as evenly as possible.

What I am saying then, is make sure the edge of the resin face does not receive the bulk of the grinding pressure and that you keep the face flat and smooth by using it evenly. A diamond wheel that has a groove in it or rounded off shoulders is not recoverable, it's scrap. More about Grinding Wheels in Chapter Eight.

CHAPTER 3 - ENGRAVING MATERIALS & HOW TO CUT THEM

We should now look at the materials available to you as an engraver and note some important points about them. Information that will help you choose the correct material for a specific job. You need to be able to advise your customers after all whether or not a material is likely to survive outside, or whether it will be able to be bent around a pillar, and from your own point of view you need to know how to handle them, can you saw it or do you need a guillotine ?

In each section you will find I have told you something about the material in general terms, which cutter you should use to engrave or profile it with and how to cut the material to size. When talking of engraving cutters and specifying angles I have referred to cutter rpm as this is an essential factor in quality of cut. Specific revs have not been referred to because different machines have different ranges. I would consider 3,000 rpm to be slow and 18,000 to be fast, although some machines are capable of 30,000 rpm from a conventional motor.

Computer controlled engravers sometimes use high frequency motors which are capable of spindle speeds of up to 60,000 rpm, though the actual rpm under load is usually considerably lower than this. Where these machines are concerned there is only one cutter to consider and that is tungsten carbide as it's the only material which will keep its cutting edge at these speeds.

Before any engraving can take place, you must have a blank to engrave be it a small laminated plastic label or a large piece of brass or aluminium. An astonishing number of engravers do not actually possess the means to cut blanks and rely on the label cutting service offered by the suppliers of engraving materials. This is very expensive in most cases and an engraver banking on it can offer only stock label sizes or protracted deliveries to his customers. Apart from that, the engraver should be making that profit for himself. I would consider the ability to cut material, an essential requirement in a professional engraver's workshop. Badges are one of the few exceptions, these blanks can be bought from one of the specialist suppliers for much less than the cost of cutting them from sheet material. Your customer will expect to be offered standard sizes.

There are two principal ways of cutting engraving stock, by guillotine or by circular saw. In cases where special shapes are involved you can profile the shape, this last method is a subject on its own, and we cover it elsewhere.

The cut label or plate is the starting point for your engraved product and if this does not look attractive and well finished there is no point in continuing with the job. Remember, as I have said before, you are not producing any old gash label, engraved labels cost real money and must look the part.

Make it a rule that all your labels, plaques, panels, signs, have bevelled edges. Also make it a house rule that any grain in the material (a brushed finish for example) runs along the longest dimension. Grain running across a label makes it look like a piece of scrap picked from under the bench.

The cutting tools, that is to say the guillotine and the saw, are described in Chapter 7.

METALS

Aluminium

General

There are a great many different alloys, all known in general terms as aluminium, each has characteristics that makes it the best for a particular application. Unfortunately, there are usually several different operations along the production line, each of which would be best suited by a different material specification.

Take for example an instrument panel that is being produced on a piercing machine and then sent to the paint shop for stove enamelling and from there to the engraver who probably comes at the end of the line. The manufacturer of the panel will have chosen an aluminium recommended for the punching operation. The unfortunate engraver will then find that he cannot engrave the panel without throwing up an unacceptable burr, because it's so soft.

An engraver who works in the engraving shop of a bigger manufacturing concern, has some chance of speaking to the other departments and coming to some sort of compromise on the material used. The sub-contract engraver just has to do the best he can, if he says that he can't engrave the panel without throwing up a burr, the customer will probable think the engraver is at fault, and try someone else.

It's at this point that the engraver has to know something about the material he is being asked to engrave.

Sheet and plate aluminium is known as wrought aluminium, and it's this type of aluminium that concerns us most, its specifications are laid down in BS 1470 (1987). Cast aluminium is something that the engraver will come across less, and is generally very easy to engrave, as is cast iron and cast brass. The metal we know as aluminium is an alloy of aluminium, copper, magnesium, silicon and zinc with small amounts of chromium, cobalt, nickel, niobium and titanium. Where appropriate, bismuth and lead are added to improve the free cutting properties. Machinability is a difficult thing to define, and different machining processes will demand different qualities. As far as engravers are concerned the ease and speed of cutting possible and the finish achieved will be prime considerations.

There is a very complicated nomenclature, designed to describe the various aluminium alloys and their properties "simply". Unfortunately this has lost its way to some extent over the years and some individual large non-ferrous stock holders, have developed their own codes and descriptions of the materials. The resulting tangle of symbols is very hard to decipher, even we suspect, if one is in the non-ferrous metal business. I have discovered some codes being used that are not known generally and some which are common to all suppliers. I have made sure that the ones that I quote are in general use, and in most cases laid down by the British standards Institution.

- N stands for non-heat-treatable. S, stands for sheet. These two letters are used as prefixes in the alloys that concern us.

- NS4 To British Standard 1470 (1987) Alloy No. 5251. This alloy has reasonable machining qualities although tends to be on the soft side. It is available in a and 1/z hard condition.

- NS41 To British Standard 1470 (1987) Alloy No. 5005. As with its near relation Alloy No. 5251, this metal machines reasonably well. Alloy No. 5005 however is a specification arrived at specifically for its anodising quality. This would be the ideal material from which to make an instrument or switch panel that was going to be finished in this way.

Should you have a component to profile or mill from sheet aluminium then the best material to use would be Alloy Nos. 6082 or 2014a. These are described by the Aluminium Federation as being very good, excellent, and good, in that order. Where nothing else but machinability is required then this is the material to use. Sheet is described as being material up to 0.252" thick.

Pure aluminium is soft, ductile and very resistant to corrosion. We already know from looking around us that it is suitable for the manufacture of a great many everyday objects. By alloying it with other metals, aluminium alloy becomes more suitable for machining purposes, and engineering applications in general. From our point of view, its slowness to corrode, its formability and the fact that it can be anodised are all attractive features.

We see aluminium finished in a great variety of chemical brightening and anodising are probably the most familiar. Stove enamelled panels on instruments were once very common but now seem less so, probably due to the production cost and the fact that there are now so many cheaper alternatives. Plastic laminates have made inroads into this area, these are available in far more finishes and colours than aluminium could ever be.

Bright reflective surfaces are prepared by electrolytic or chemical immersion processes. These methods are used for bright trim and where reflective required specifically. These surfaces are then clear anodised so that the bright appearance is maintained. There are two types of anodising, sulphuric acid and chromic acid. Sulphuric acid anodising gives a clear protective film and in fact the so called "silver anodised" aluminium is no such thing,, it is just "clear anodised" aluminium, the natural colour of the aluminium being allowed to show through. Plain unfinished aluminium while being excellent all weather material, does oxidise (aluminium's equivalent of rusting) this takes the form of a white powder on the surface. All instrument panels switch plates and signs made from this material should have the surface finished, to prevent this.

Chromic acid anodising produces an opaque film and can be dyed to the colours we are familiar with. A point to remember when specifying anodising is that it must be sealed, this is a simple process which involves boiling the sheet in pure water. If aluminium is to be engraved and the letters filled, an unsealed surface will pick up the paint and it will be impossible to clean it off properly. We have all seen engraved letters with a "halo" around them as a direct result of this.

Next time you suffer a piece of unsealed aluminium and find you can't remove the paint completely, mix up a paste of Vim and the appropriate paint solvent (probably turpentine or thinners) and rub this very gently into the stain. We say rub gently not because anodised surfaces are fragile, they are not, but because there is a danger of leaving a dull abraded patch where you have been rubbing. Despite the fact that anodised surfaces are only .0001" to .0004" thick they are very durable. They can certainly be bright and colourful as anyone in the trophy business must know. If there is a grain (a brushed finish) only rub in the same direction as this, not across it.

Saw or guillotine

A circular saw or a guillotine can be used to cut aluminium, which you use will depend on the gauge of the material (thickness). Most of the small guillotines on the market will cut up to about 16 swg (standard wire gauge), that is to say .064" (about 1 / 16"). This all you will require for small labels and signs. Trophy plates are only about 24 swg or .022" thick. Heavier gauge material most instrument panels used in racking are about 10 swg (.128"), have to be cut on a circular saw. You should remember of course that a saw will cut all thicknesses you are likely to need to engrave while a guillotine will not.

Engraving Cutter

A well ground cutter is a good start when setting out to engrave any material, but it's probably more important when engraving aluminium than on any other. Any roughness on the finished cutter will show up in the engraving and a cutter that has a smooth polished finish will impart the same finish to the workpiece. A

smooth finish on the cutter will also make it less likely to collect swarf on the cutting edge, another cause of burring. Tungsten or high speed steel cutters can be used, with a few exceptions, it is essential to use tungsten where the aluminium has been anodised. Most alloys can be machined at much higher speeds than steel and this is also conducive to the use of tungsten cutters, which will last longer also.

When machining aluminium alloys it's important that all tools should have adequate clearance behind the cutting edge. This angle should be experimented with it should be small enough to give the cutter enough strength and large enough to let the chip escape, without allowing the edge of the cutter to rub and create a burr and excessive heat. Tungsten tools are not recommended on the very soft aluminium alloys such as N4, because the high rake angle required makes them too weak.

If you don't know the type of alloy that you have been asked to engrave, start by grinding your cutter with a clearance angle of :35°. Where the metal is very soft increase this until a good cut is achieved. Set the spindle to a middle to high speed of approximately 15,000 to 18,000 rpm. Go straight to the higher setting if you are using a tungsten cutter on anodised material.

Brass

General

The term Brass, covers a wide range of alloys of copper and zinc, which contain small quantities of other elements such as tin, lead, iron, manganese and nickel aluminium and silicon. The properties of these alloys vary from those of nearly pure copper to high tensile alloys with strengths of up to 50 tons per sq inch. The brass alloys that we are interested in are those that we can machine or make specific items from that are of significance to our engraving businesses.

Engravers' Brass is known to old hands as hard compo and indeed it seems that most non-ferrous stockholders use the term also. Hard compo comes under the heading of cold rolled sheet and strip to BS 2870. The hard compo brasses which are CZ120, CZ119, CZ118, are more properly known as the leaded clock brasses, they can be accurately punched to shape with a minimum of distortion and burr. One of their major uses as one might expect therefore is for the manufacture of components for clocks, watches and instrument parts generally.

For the same reasons it is also excellent for engraving. The relatively high lead content of two percent gives it excellent machining qualities. If one is free to choose the materials this is the best brass for engraving, milling or profiling. Engraving templates that are going to be used regularly should be made from hard compo, rather than phenolic or acrylic materials which, although they work well, do not maintain their accuracy for very long.

CZ 108 is known as "common" brass and if you are given a component to engrave which has been pressed into shape and is proving a problem then this is probably the material that you are struggling with!

Saw or guillotlne

All I have said about cutting aluminium applies to brass also. The thinner gauges will guillotine and the thicker ones have to be sawn. Check if you are planning to use a guillotine what thicknesses manufacturers recommend going up to. Brass is generally harder than aluminium and the maximum gauge that can be cut on will be less.

Engraving Cutter

Engraving quality brass can be cut with a HSS cutter and will machine to a very fine finish. Grind your cutter with a 40° clearance angle and use about 18,000 rpm if your machine gives you a choice of spindle speeds. If you have a machine that will give higher spindle speeds use them, hard brass will cut well at high rpm, in this case you should go for a tungsten cutter. One of the most satisfactory materials an engraver is ever likely to be asked to work with.

Gilding Metal

Gilding metal is used less extensively by engravers now, it's not easy to engrave as brass but has a very attractive golden colour. It is used for the manufacture of costume jewellery, amongst other things, as it is also the easiest of the copper alloys to braze and enamel. Gilding metal comes under the same BS known as hard compo and is designated CZ101, CZ102, CZ103, the later being the hardest and therefore the easiest to engrave.

The Gilding metals contain a relatively small amount of zinc compared to other brasses and the various alloys cover a range of colours which go from looking almost like pure copper to a very pale yellow. When so-called bronze plaques were common place on office doors, it was usually gilding metal which had been treated to give it a darker brown colour, gilding metal without this treatment however, makes a very handsome engraved plate.

Left unfinished, that is without a protective coat of lacquer, or any form of plating it tarnishes evenly and still looks most attractive. This applies to other brasses as well. Protective finishes on brass are not altogether satisfactory, because when they become damaged the brass that has been exposed tarnishes and the overall result is a blotchy plaque. Much better, in my opinion, to either keep polishing or leave them to weather in an even fashion.

Saw or guillotine

As for brass and aluminium.

Engraving cutter

The same rules apply as for brass, the materials are very closely related.

Mild Steel

General

Mild steel is an alloy of materials which varies greatly, unless you are what I refer to as an industrial engraver you will not find you are asked to engrave it very often. Usually it is finished in some way, either by plating or enamelling. It is usually thin in the form an engraver sees it and because it is rigid there are often vibration problems, make sure that you clamp the workpiece down securely before attempting to engrave it. If there is a paint or enamel finish on it you must be especially careful as the vibration will throw this off.

Saw or guillotine

Guillotine, if possible order it cut to size. Like stainless it will be too tough for most engraver's equipment to handle.

Engraving cutter

Premier grade HSS cutters should be used, grind with a clearance angle of 25° and increase if necessary. Set the spindle to a mid to slow speed.

Nickel Silver

General

The NS in EPNS, is used in the manufacture of good quality silver plated items, such as trays, cups, ashtrays and of course plinth bands. Nickel silver is a very pale alloy, one often sees shields on very old trophies where the silver has been polished off, that are quite hard to distinguish from their new neighbours. Nickel Silver solders well and can be pressed into shape, both reasons for its use as a base material on silver plated ware. It is designated, NS103, 104, 105, 106, 108, 109, and 111. NS111 has a small lead content which makes it better machining quality than the others, making it the best one to use for plinth bands as these will be engraved.. In the days when cars had radiators on the outside of the bodywork and not hidden behind a plastic grill, these were made from nickel silver, latterly these were chrome plated of course.

Saw or guillotine

In general this material is used in thin sheet form and can therefore be guillotined, although as we recommended with brass check with the manufacturer of your guillotine as this material is hard and the recommended maximum thickness will be on the low side.

Engraving cutter

Treat like brass, although HSS cutters will probably wear too quickly for comfort. In this case increase the rpm and go for a tungsten cutter.

Pewter

General

We will not often see pewter in any form except tankards, and hip flasks and the variations on these. Usually you will engraving these with a drag diamond cutter although it does engrave well with a rotary cutter.

Engraving Cutter

A HSS cutter with a clearance angle of 40° in the mid to slow range, or a diamond drag cutter used without the motor.

Stainless Steel

General

Another alloy, stainless steel comes in a whole range of grades designed for specific applications. None of them are easy to engrave, even those which have been dubbed "machining quality". Like it or not you will be asked to engrave labels and plates from this material. The sheer indestructibility of stainless is the reason it is specified as the material for labels which are going to be used on things like aircraft and oil rigs and of course in situations where there is a risk of vandals destroying an essential notice. Lifts are the best example of this. Brass used to be the material chosen and most engravers would wish that was still the case.

As far as grades are concerned, EN56AM has had sulphur added to improve its machining qualities, EN56D is the steel that you would most commonly find such things as cutlery made from and type 304 is quoted as being as good a machining quality sheet as you can expect to find easily. More often than not you will be issued with the material and will have no choice therefore. You will just have to grin and bear it.

Even the most experienced engravers have trouble with stainless, the bigger and more robust your engraving machine the better. Make sure there is no play in your pantograph or spindle bearings otherwise this will manifest itself as vibration. Because it offers such a resistance to being cut you must make sure that your workpiece is held down very securely, while the material is not particularly hard, its toughness creates tremendous drag.

Never try engraving this material to its finished depth in one pass, feed the cutter downwards in several stages and if necessary use a cutting oil.

Saw or guillotine

None of the cutting machines that you are likely to have in your engraving workshop, unless you happen to specialise in stainless work, will cut it. Order it cut to size, the stockists of stainless steel all have massive guillotines which are designed to cope. Remember though it often comes with a brushed finish always remind the supplier to cut it with the grain running the length of the plate.

Engraving cutter

The manufacturers of engraving cutters produce carbide cutters from a special grade of tungsten carbide specially for stainless steel. These are less prone to shattering than the carbide used for engraving material like rigid laminates. Grind the cutter with the widest practicable included angle for increased strength and give it a clearance angle of no more than 32°. Spindle speeds should be set in the middle to low range although it is worth experimenting and running the cutter as fast as you are allowed, as this suits the carbide cutter.

Silver

General

Silver in the form we as machine engravers see it is usually made up into cutlery and holloware, in most cases we will be drag marking this with a diamond point. However it does engrave easily with a motorised cutter. Remember before engraving a plated item with a motorised cutter, that it will be a different colour underneath!

Engraving cutter

HSS cutter with a 40° clearance angle and a spindle speed in the mid range. More usually a diamond drag cutter ground to a cone.

PLASTICS

Acrylic

General

No, not Perspex, that is the trade name of the acrylic material produced by ICI. The name acrylic is derived from polymethyl methacrylate, the chemists' name for the chemical soup that eventually becomes the beautiful crystal clear sheet that we know.

Acrylic sheet is a delight to use, it engraves well, it saws easily, OEM it can be drilled, tapped, milled and profiled without any problems. Acrylic can be heat formed easily, and fabricated using a readily available solvent. I'm plainly not the only one that appreciates its finer points, as at a guess ninety percent of the signs in the country are made from this material. As a sign material in particular it has

many advantages, it has excellent weathering properties, there is a wide range of bright colours available. The material is strong enough to form part of the signs structure and it can be effectively side or backlit.

There are points to look out for though, the main one being the large coefficient of thermal expansion that this material has, or to put it another way it expands and contracts a lot with changes is temperature. When cutting several panels that are to be butted together to form one large sign, ample space has to be left in the frame surrounding the panels to allow for this movement. As much as 4mm for every metre of panel should be allowed. Remember also to leave an equivalent amount of room around mounting screws, or cracking and warping will occur.

Saw or guillotine

Being a rigid material it has to be cut on a circular saw. When doing this be careful not to scratch the surface, leave the protective paper on it until this operation has been done or stick strips of masking tape to the bench surface. If you are using a small bench top saw where the blade and motor are pulled over the material this problem will not occur as the material remains static.

Engraving cutter

A HSS engraving cutter will cope with acrylic well, although if you have a long run use tungsten carbide, your cutter should be ground with a 40° clearance angle and the revs should be set high, 18,000 rpm if your machine can manage this. If a white foam appears on the surface being cut, which will not brush off, slow down the spindle speed until this disappears. Acrylic responds well to the use

Phenolic

General

These are the resin based materials you find in electrical and electronic equipment, they are excellent insulators. Some companies in our industry sell it as master making material, being cheaper than brass and it engraves well. The content is very similar to that of rigid engraving laminates and it should be treated the same way. You will sometimes find it is referred to as SRBP or SRBF, this stands for synthetic resin bonded paper or fibre.

Saw or guillotine

Saw only.

Engraving cutter

Very tough on cutters, use tungsten carbide, clearance angle of 40° is a good starting point, but like metal alloys these materials vary a great deal. Use maximum cutter revs.

Rigid Engraving Laminates

General

These are the original laminates, designed specifically for he engraver and sign maker. Consequently we do not have to worry whether or not they will engrave. However there are several basic types of laminate which have different characteristics you should know about.

The most significant advantage in using a laminated material, is of course that the lettering does not need to be filled. Engraving through the top lamination you expose the core colour underneath. Hey presto, there's no finishing to be done.

The rigid laminates, are as their name implies rigid and brittle. They will not bend to any great extent and are hard and cold to the touch. Traffolyte became for many years the generic term for this material, made by Formica. Even today people refer to rigid material by this name, although the original Traffolyte no longer exists as a product. There are lots of manufacturers of rigid laminate now, producing some excellent material in a wide range of colours (although not nearly as extensive as the flexible materials).

Rigid laminates are paper based with a melamine face, the core is a close relation of phenolic, that hard black sheet that you buy for making masters from. Formaldehyde resins bind the components together and give the sheet its great rigidity.

These laminates engrave well and easily. A feature I don't like about them is the dust that they give off which is fine and remains suspended in the air for a long time. For this reason you would be well advised to wear a face mask, one of the lightweight variety, especially when using a circular saw.

Saw or guillotine

Because they are hard and brittle, these materials cannot be cut on a guillotine, they have to be sawn, or cut out on the engraving machine.

Engraving Cutter

Tungsten cutter has to be used on these highly abrasive materials HSS will give no service at all. Grind a cutter with the minimum of clearance. say 30° or 35° , and use high spindle rpm, all which suit, the tungsten cutters that you have to use. Very fast engraving is possible on the rigids as there are no problems with overheating or melting surfaces. On some varieties of the material the top surface is rather on the thick side. This means that fine detail can be difficult to achieve.

Flexible Engraving Laminates

General

By far the most popular laminates, these seem to have developed faster than other types, now representing the major group of engraving materials. They come in a massive variety of colours with matt, glossy, satin, metallic, and other clever finishes; even marble. You can also buy these on a translucent core, for back engraving and back lighting.

The best flexible laminates are the ones that contain acrylic as well as PVC. The originals which were all PVC, were crude by comparison. The PVC was prone to overheating unless the cutter was in perfect condition and you kept to a slow traverse speed (speed over the work). They were often inconsistent in their thickness and the top lamination was much too thick for fine work.

A word of warning, although the PVC materials have improved greatly over the years and are now easy to machine. I would consider it a false economy to use them as engraving material because of the extra time required. You will find, in many instances; the manufacturers also recommend it as cladding. Having said that, they must be included as they have some excellent qualities also. They are the only really weatherproof laminates and very flexible. If I had to make a sign that was going into an unfriendly environment this would be my first choice.

The blended PVC/Acrylics sold by all the major suppliers of engraving equipment are a far cry from that and are without doubt the easiest of the engraving materials to both engrave and handle. They have ultra thin top surfaces and will take very fine engraved detail therefore. Another thing in their favour is that they produce a much coarser swarf which falls directly to the ground like that from metal, it does not hang in the air as a fine dust. No mask is needed, this fact alone, would sell it to me.

While I realise that commercially it's good for the engraver, I have a nagging fear that these laminates are becoming so commonplace that a lot of engravers are in danger of forgetting that there are other materials available. Constant use of the same type of engraving stock can lead to a certain blandness in the end product, despite the fact that there is an excellent range of colours available. This sounds like a contradiction, but it seems to me that signs and labels made from these laminates do have an inexplicable sameness about them.

Saw or guillotine

All the flexible engraving laminates can be guillotined easily, although you should check on the limitations of your guillotine. They will also saw, they are the ultimate in easy materials to handle.

Engraving cutter

Once again the PVC/Acrylics, being so vice free, you can use either type of cutter. Set a clearance angle of 40° and a spindle speed of about 15,000 rpm. I always recommend you use a HSS cutter in preference to carbide, but not everyone would agree. Certainly where finely detailed engraving is required on company logos or fancy typefaces HSS would be my first choice. Better I think to have a handful of ready ground HSS cutters by your side.

If you find yourself using a PVC laminate you will have to use a HSS cutter, a clearance angle of 40° and spindle speed of about 5,000 rein, with a correspondingly slow traverse over the work.

OTHER MATERIALS

Slate and Marble

General

These natural materials would not be considered to fall under the general heading of Engraving Materials by some engravers, but those of you who are involved in trophies and incentives will know that slate and marble feature strongly. While most engravers stick an engraved plate onto these materials, they do in fact engrave extremely well. A word of warning, if you are going to fill the lettering you engrave, the surface will need to be sealed first (refer to Chapter Six which covers this subject).

Saw or guillotine

All forms of stone must be sawn, in fact you will probably order these materials ready cut to size.

Engraving Cutter

Use tungsten cutters at maximum revs, a small clearance angle is needed say 30° as the leading edge of the cutter needs to be as strong as possible.

Wood

General

I am often surprised to find people who think that there is some mystique about engraving in wood. Universally there must be more knowledge about wood cutting than any other material known to man, yet introduce the word engrave instead of cut and people take fright. Wood varies enormously in its machinability, far more than different types of plastic or grades of alloy. A modern introduction to the material is of course resin glues and wood containing these, materials such as plywood, need special attention.

The harder the wood and the less stringy the better it is to machine. Woods such as Mahogany, Beech, Oak, are highly satisfactory materials to work in. Softer woods tend to have a coarser and more stringy grain and you are unlikely to be able to make a completely clean cut on these, we will tackle finishing later.

When buying wood to engrave, perhaps for house signs, make sure that it has been properly dried. Green wood will split and crack as it dries and this will be aided and abetted by your engraving, speak to your timber merchant about it he will be able to advise you. The net result will be that you have to pay a little more for a reliable piece of material.

On occasions you may get asked to engrave plywood, boat names are often engraved in marine grade ply and other signs that are going to have to withstand a tough environment. Beware the top veneer, this splinters very easily and can lift off leaving a darker layer beneath.

Saw or guillotine

Saw, without exception.

Engraving Cutter

Maximum spindle speeds should be used and your cutter should be ground with plenty of clearance angle, 40° would be a good starting point, to let the large pieces of swarf escape, also use the largest truncation the lettering will allow. Tungsten carbide cutters will last the longest and give a good cut in most cases, however if you experience trouble with the finish you will find that a top grade HSS cutter will probably be the answer, you will just have to accept the fact that it needs a regrind more often. Sometimes if you are engraving in a confined space, milling a slot for example where the chips have difficulty escaping there is a danger of burning. If this seems likely take fast and light cuts and make sure that you don't let the cutter "dwell" when you change direction.

Nothing but tungsten will do when engraving plywood as the resin glues that are used are very tough and wearing, grind your cutter with the largest possible included angle this will help the problem of achieving a clean edge on plywood. With Tungsten cutters you may have to reduce the clearance from 40° as this makes a rather brittle cutting edge. The wide included angle in effect chamfers the edge of the cut, but of course makes filling the letter more difficult (you can't have it all ways).

CHAPTER 4 - ABOUT ENGRAVERS' COPY

Engravers' copy is the "off the shelf" lettering that you buy in ' sets of numbers and letters, as distinct from masters or templates (two names for the same thing) which you make for a specific job.

Apart from coming in a whole miscellany of styles it's available in many different forms, each one of which has a distinct purpose. Some styles of copy will be only available in one form as this is deemed by the manufacturer to be the easiest way to use it.

All these forms of copy are available on blanks made from a variety of materials, in the main these are phenolic, nylon and brass, I have seen some made from engraving laminate. Brass without doubt is the best quality and will last the longest, it will also cost you the most. Buy this if you can possibly afford it because it is also the easiest to use, brass being naturally "slippery". It would not be stating it too strongly to say that copy made on any other material is a compromise, buy it if you must.

Don't by the way assume that you can "just make a set for myself" I have seen hundreds of engravers fall into this trap when they discover the high cost of a bought set of copy. There's much more to it than at first meets the eve, letter spacing and baselines are critical to within a few thousands of an inch. Leave this copy making exercise for a few months, by which time you will realise that you are commercially better off engraving and leaking the copy making to specialists in this field.

COMPUTERS AND THEIR COPY

Computer driven engraving systems of course don't use copy that bears any relation to the copy used in a pantograph machine. These machines, more precisely the electronics that drives them, have stemmed from a different area of the lettering business altogether and on the whole use printing terminology in their handbooks. For a set of “copy” read a “font”. A pantograph engraver who wishes to engrave a sign in Helvetica has to have a box of letters in that style. An engraver using a computer machine has to have the electronic equavalent.

A computer driven engraving machine will not engrave any style letter – it has to be equipped with the appropriate software. Manufacturers supply this in various forms, sometimes on a disk which you load to the hard disk in your PC when you need to use it and sometimes on a cassette which you use in the same way, plugging it into a port on the side of the machine. Some are permanently installed in the machine’s memory.

We talk about computer controlled engraving machines elsewhere, but while we are thinking of copy and the folly of trying to make fonts for yourself, there are

some warnings to take heed of. A font is a very specific thing, just as a set of copy is. When thinking of engraving, you should only buy software that has complete fonts, or for which a good selection of complete fonts is available. A font is a set of letters, the alphabet plus, which are all inter-related and which have been designed to use as a whole. Don't fall for the line "you can make up any font you like".

A graphics package that only has the facility to allow you to produce individual letters is to be avoided therefore. The art of good letter spacing, spacing between lines allowing for the flourishes of letters, not to mention the spacing between different combinations of letters requires a lot of thought. Fonts are designed in the full sense of the word, they don't just get thrown together during the course of an afternoon, after a "notion" to make up a set of Gill Sans.

Remember the limitations that engraving imposes upon lettering, the engraving machine makes its mark with what amounts to a routing cutter each one of which has a fixed diameter and while a vinyl letter cutting machine can produce a flourish that tapers to a fine point, an engraving machine cannot produce a line finer than the cutter in the spindle at that moment.

Some of the more elaborate fonts available are:

Missing text in original.

Make sure that the package you are offered has a single line font included. The work an engraver does is often a lot more mundane than a sign maker and most of your customers will require plain and simple lettering on most labels, instrument panels, and trophy plates for example. The smaller the lettering required the less important the letter style becomes, who after all is going to notice if a letter 1/8" high has rounded or square ends to the stroke? Thanks to the wo^{n}ders of electronics a font supplied as part of a graphics package is infinitely variable you must remember and the equivalent of dozens of fonts for a pantograph machine, condensed or expanded letters therefore should be attainable from one single line font.

SINGLE LINE COPY

This is the most commonly used form and as the name implies it takes the form of just a single line which the engraver follows with his stylus. This copy is only suitable for small lettering, that is to say lettering under about three quarters of an inch, for several reasons.

Being made by a single cut the width of letter stroke is limited to the width of the cutter available. Perhaps more importantly, a single cut with a revolving engraving cutter will leave a round end to each stroke, this is not noticeable on small lettering but quite unacceptable from about half an inch upwards. Diamond

Drag engraving is particularly limited when using this type of copy as the mark made is so thin.

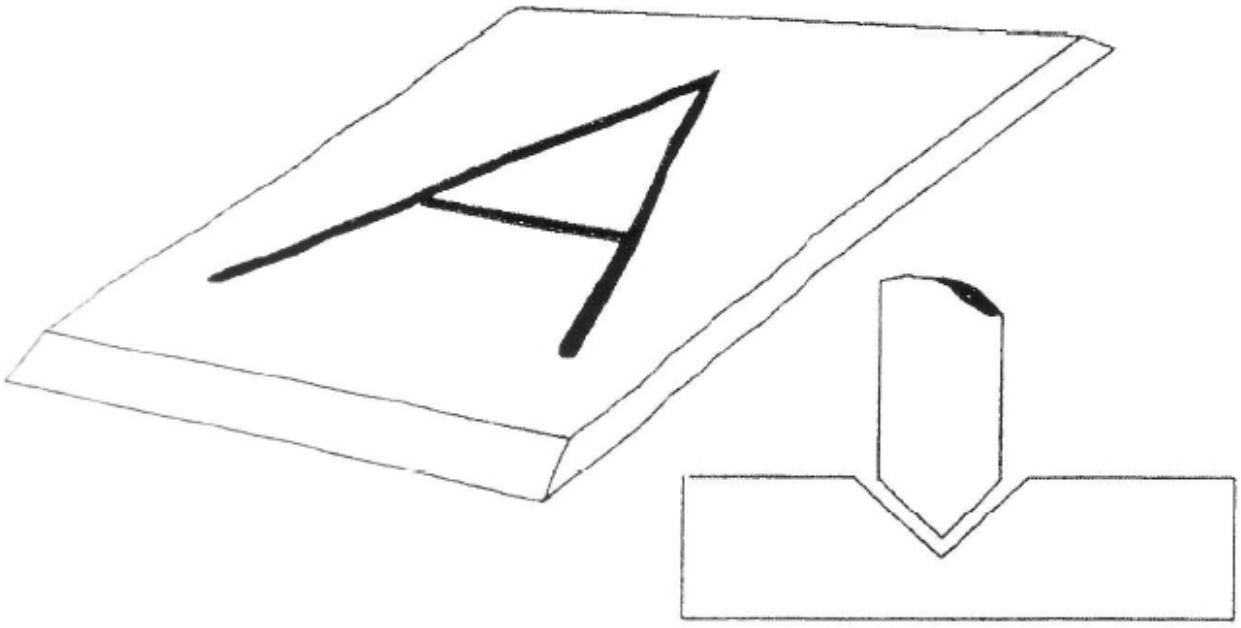


Figure 13 Single line copy

Typical uses for this type of copy would be: trophy plates, labels, instrument panels, instruction plates, and small internal signs. In general the type of engraved product that is not design or image conscious, industrial engravers are the biggest users of this copy which is epitomised by the old Taylor Hobson styles 2A and 2C, A style being the normal width and C style being slightly condensed.

DOUBLE LINE COPY

Where a letter style demands thick and thin strokes, this can be achieved by flowing two lines into or away from each other as necessary. Script is the obvious example of this. Diamond drag engraving is enhanced using this double line form as the two lines give weight to the otherwise thin and insignificant line. The end of the stroke will still be rounded when using a motorised cutter and so you will be limited in the size of letter you can engrave before it begins to look odd.

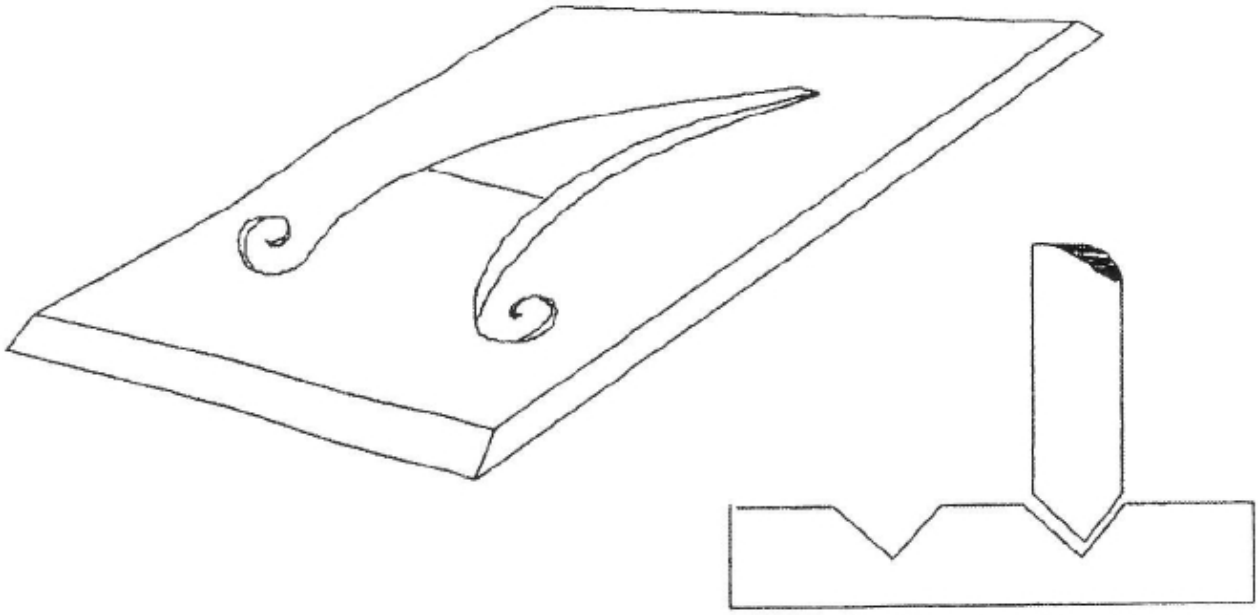


Figure 14 Double line script

Typical uses would be, trophy plates, monograms and the general personalisation of gifts, engraving that will be enhanced by a little bit of a flourish.

SOLID SUNK COPY

When engraving larger letters one needs to pay attention to the end of the cutter stroke, with solid sunk letters a smaller cutter is used to clear out the wide stroke of the letter and this leaves smaller better defined corners. It sometimes pays to use a large cutter with a roller on the style to clear out the bulk of the material and then go over the lettering again defining corners and detail with a small cutter.

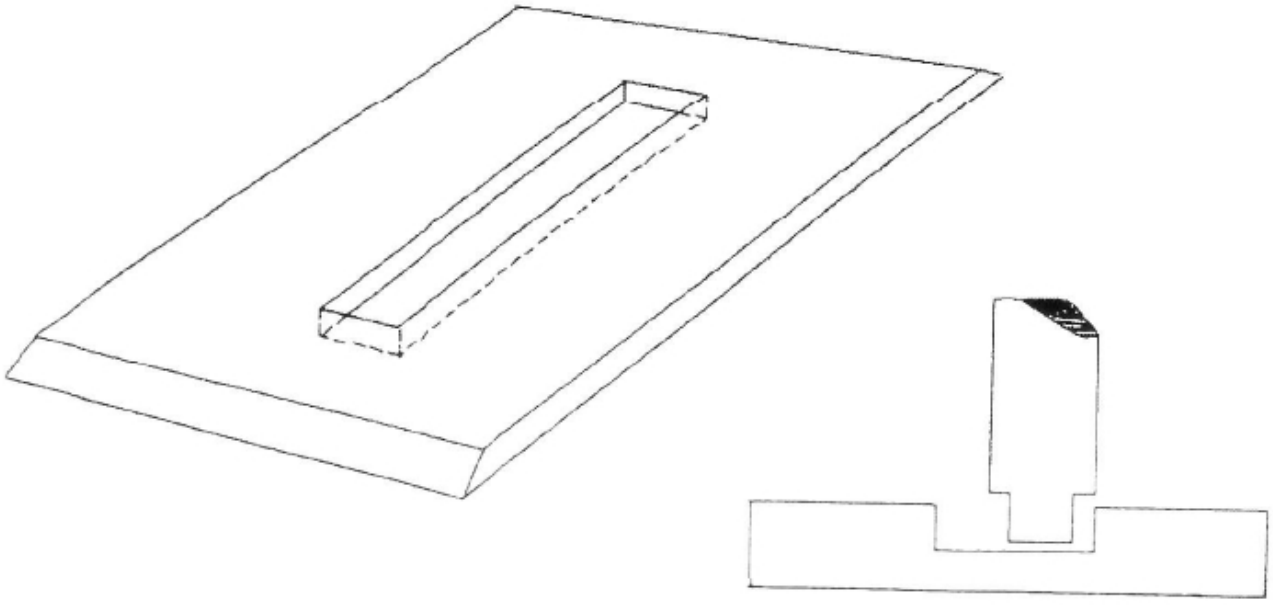


Figure 15 Solid Sunk Copy

Solid Sunk copy can be used to achieve thick and thin strokes in the same way as double line copy, the difference being that lettering engraved with this copy will be solid, i.e., filled in and have no lands in the middle of strokes as with Double Line.

Typical use, would be, sign, plaques, bold headings on instrument panels and in instances where a designer or architect has specified a particular style, such as Helvetica, Times Bold or Microgramma. Typically these styles would be supplied in solid sunk form by the manufacturer.

RAISED COPY

Not used so much these days except amongst diesinkers. This copy is very slow to use because the background to the letter has to be removed and not the material from the letter itself. As with solid sunk copy particular attention has to be paid to the relationship of cutter to stylus so that the proportions of the letter remain acceptable. A roller on the style is useful with this copy also, to enable you to clear a good space around the letter, having achieved this it is best to mill away the background material using the engraver as a milling machine by locking the pantograph and using the handwheels.

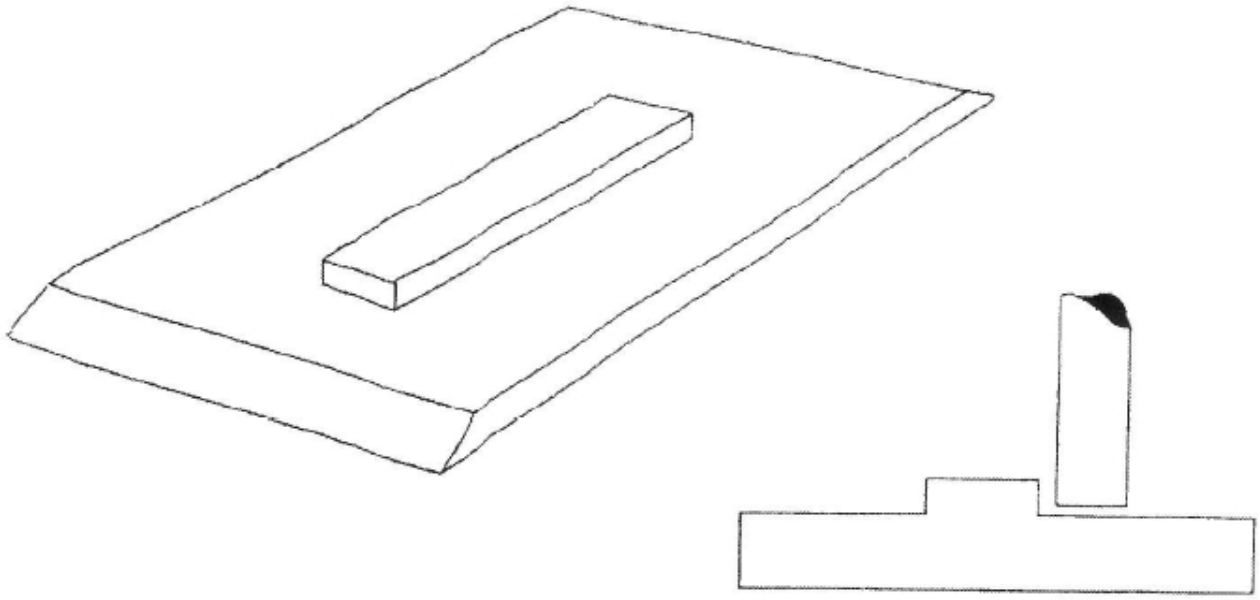


Figure 16 Raised copy

Typical uses would be to produce raised lettering in moulds and stamps.

MULTILINE COPY

This copy can be used in most cases instead of Solid Sunk copy, the exception being where copy has strokes of varying widths. Some engravers prefer Multiline to Solid Sunk because they like having the stylus guided around the letter instead of "pantograph waggling".

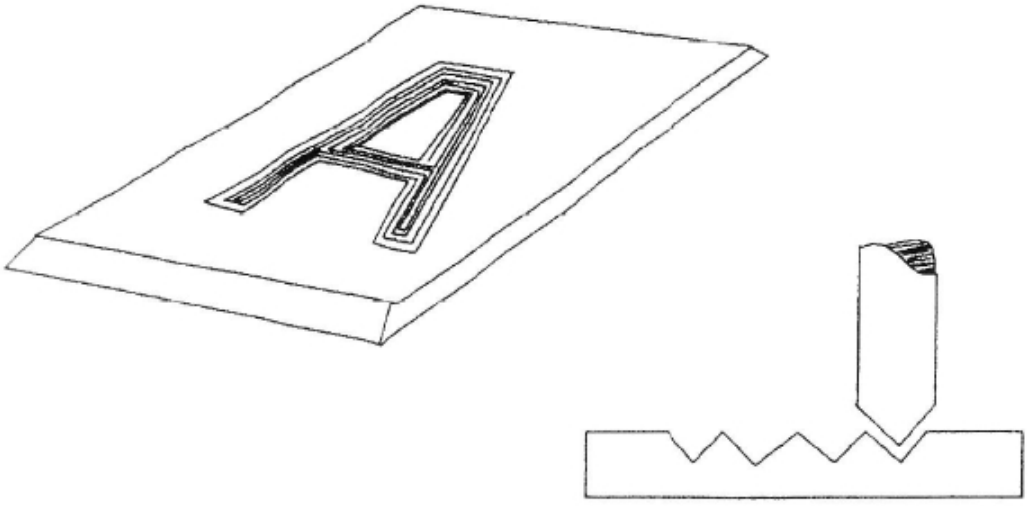


Figure 17 Multiline copy

Certainly there is less chance with multiline of missing something. One must be very careful to use a cutter that is of sufficient width to overlap the previous cut otherwise you will end up with tramlines in the bottom of the letter. This copy should be used in the same situations as solid sunk, it is just a matter of which you feel happier using. "Tramlines" in the bottom of a multiline letter can also occur if the work is not held down firmly.

ENGRAVING MASTERS (TEMPLATES)

Whenever you have to engrave more than shall we say ten, of any identical item, you should male a master. This doe not have to be elaborate nor does it have to be made from expensive materials. It must be quick and simple, if it is not, then the whole purpose of making it is defeated.

Let us suppose that we have an order for fifty signs 8"x4", for example a plate warning of maximum capacities in a passenger lift. This sign will have perhaps six lines of text on it, the top line being larger to draw the attention of the passenger.

Select a pantograph reduction that is reasonable to use, i.e. one that is not going to necessitate making the template too large for your machine's copy table, or the coverage of its pantograph. In this instance two to one would be about right, as it would mean making a template 16” x 8” - any larger and most machines could not cover it.

A piece of material must now be found to make it from, in this case with only fifty plates to be engraved almost anything will be suitable (as there will be no real wear). Should you feel the job is going to be repeated often, use a piece of Engravers' Brass as this will wear well, lasting you for years if necessary. If it is not going to be repeated, then use a piece of phenolic or a piece of scrap acrylic and cut it to size (16” x 8”) mark out your base lines and margins as per the drawing with a scriber and ruler. Remembering to double the dimensions given as you are going to be using this template at two to one, reducing it by half in other words.

The letter height on the top line of the finished job has been specified as 3/8" on the customer's sketch or drawing, therefore we must engrave this onto our acrylic blank at a pantograph setting of 1:1 (one to one) if we are using ¾” copy. Three-quarter inch copy used at two to one will produce 3/8" lettering (3/4” divided by two equals 3/8").

The finished letter height on the remaining five lines is specified on the sketch as ¼” therefore we must engrave the text onto the acrylic template at a pantograph setting of 1.5:1 (one and a half to one), 3/4" divided by $1^{1}/_{2}$" equals $^{1}/_{2}$". This will therefore give us a 1/2" letter on the acrylic template, when used at 2:1. This will produce a ¼” finished letter.

When grinding your cutter in preparation for the engraving of this template remember that it's the stylus on your engraver that's going to have to follow the template eventually. Therefore, your cutter must match its profile to avoid slipping, catching in corners and undue wear and tear on both components.

Manufacturers of engraving machines and copy have different standards, for example a Gravograph machine has a stylus ground to a 35° cone with a tip .025" to .030" wide. British industrial machines such as Alexander and Newing-Hall (Taylor Hobson) have their stylus ground to a 90° cone with a .010" to .015" tip. Whether you are making templates or not, care of your machine's stylus is most important if you are to avoid prematurely worn copy and the considerable expense of replacing it.

Now back to our piece of acrylic or phenolic on which we have engraved letters 3/4" and 1/2" tall. Clamp this to your copy table with some small "G" Clamps or double sided tape. Special low profile G clamps can be bought which do not get in the way of the pantograph arm. Set your pantograph to 2:1 and position the blank plates under the cutter so that the engraving will be centrally disposed. This is made easier where you have to repeat the process over and over again if you clamp the plate against a fence on two sides. This will ensure that the next plate is placed in exactly the same place as the last one.

When proficient, you will be able to conjure up a template like this very quickly, you'll save wear and tear on your copy and each label will be considerably quicker because there will be no need for the adjustment of line spacing or centering. Errors will be eliminated also because there will be no adjustments to make after the first label has been set up and proved. Keep your template lightly oiled, even when made from phenolic or acrylic.

Often a template of this type would be made up where you supply a company or league on a regular basis. In the latter case, where some of the details may vary, just a master copy of the league name would save a lot of setting up time. The same applies to commonly used words and legends, i.e. "Winner", “Runner Up”, “Class", "1992/93".

Most companies who supply engraving equipment produce special sets of funeral directors' copy, this contains masters, ready made up on copy strip of the regularly used words and phrases in the business of funerals such as Rest in Peace, Died, Aged etc., why not apply this to your business, or your customers and have their often used phrases and technical terminology ready made and waiting to be incorporated into their work. For example "Valve No." or name "Acme Electronics", "Power Supply". There are dozens of word combinations used by companies over and over again in their engraved panels and labels.

Brass copy blanks made to fit your particular machine's copy slide and engravers' brass cut to size is readily available from the machine suppliers and wholesalers. Making a master must be something that you do in house, no self respecting professional engraver would give that job to anyone else to do.

Make sure you have at least one machine that is capable of engraving at 1:1 when setting up your workshop as this facility is almost essential when making masters and on many other occasions also.

Let's invent a typical order which has a requirement for a cutout and some lettering on the same panel.

I have sketched a master for a small switch plate that our imaginary customer, Acme Electronics requires in rigid engraving laminate. His drawing calls for a panel 100mm x 50mm with lettering 4mm and 3mm high and three 10mm holes for switches. For the engraving we should always use the largest possible reduction to achieve the best letter quality. If we use, say, a reduction of 4:1 we

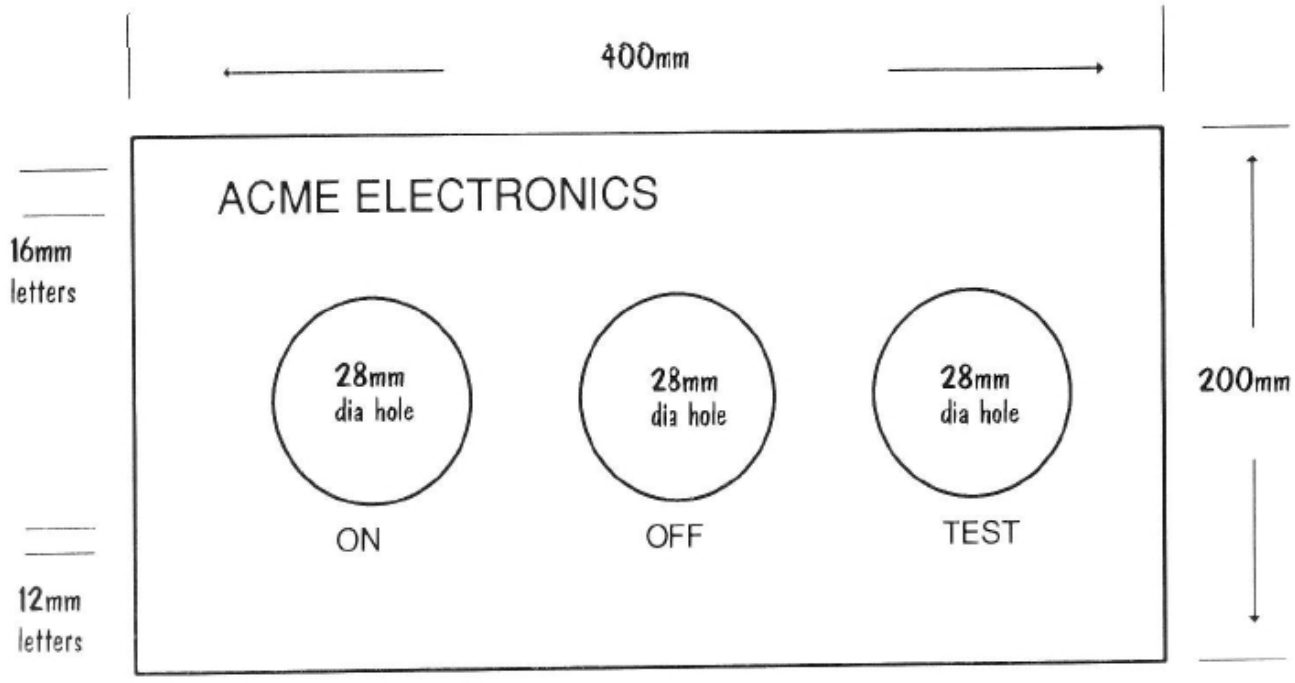


Figure 18 An engraving master

shall require a master 400nun x 200mm. This is quite large enough for comfort on most machines and so let's settle for 4:1.

The actual sizes shown in the sketch are the sizes for the Template, the Master. You will note that the circle that we have shown for the hole cut out is 2mm

undersize, when reduced by four will give an actual engraved circle of 7mm, however we are not going to engrave a circle. We are going to cut it out with a parallel sided cutter 3mm wide. As I have allowed for a 3mm parallel sided cutter for these holes, the finished hole size will be 10mm. If the reason for this is obscure, refer to Sketch No. 20 as this shows how the cutter size and pantogaph ratio relate to each other.

Two cutters are going to be required, one for the holes and one for the lettering. If just three or four labels are required at a time, I would change cutters without moving the label from the worktable. If however, we had to engrave twenty, I would engrave all the lettering and then run them all through again cutting the holes. You have to decide whether it's worth changing cutters or re-clamping onto the worktable each time. The machine you use will be a deciding factor, for example a taper shank cutter is a lot quicker to change than a straight shank cutter with a collet.

Let's assume we are going to make twenty of these labels and that we have made our template according to the sketch, using a circlemaster to make the circles representing the holes on the template.

We must grind two cutters, one 3mm parallel for the hole cutting and another ground to a point for the lettering. Refer to the table of cutter widths and you will find that the ideal cutter for the lettering should have a tip width of just under 0.4mm. I recommend that you grind a 60° included angle on this cutter as the top surface of the rigid laminates are relatively thick and the letter will look better if the cut is not too steep sided. Unless your customer is an absolute perfectionist and you will have to be the judge of that, you will probably be able to use the same cutter for both sizes of letter as they are so close.

Next find a piece of scrap to put under the labels as you are going to be cutting right through the label when you make the holes. Repetitive work means that you will require a fence on the worktable so that you can change label without any realignment problems.

Where a job requires a master to be made, I recommend that you make a separate charge to your customer for "part cost of master", by making it a part cost you can hang onto it for future use. When the job recurs it will be very profitable indeed.

POLYMER MASTERS

A quite recent development, which some engravers are taking advantage of, is that of the rigid polymer plate, very often on a metal backing. This light sensitive material has come to the notice of engravers via hot foil blockers largely, they were using it to make dies long before machine engravers thought of using it to make masters.

The Polymer is sensitive to UV light and when exposed to a measured dose it goes hard. If, therefore, you place a positive film over the plate and expose it, the exposed areas will harden and the protected areas will stay soft and will be able to be washed out with water. You can make very successful engraving masters this way, although the subject matter has to be chosen reasonably carefully and the artwork needs to be hard and positive. By that I mean there can be no half tones or very fine detail involved. This applies to engraving masters whatever their material. I am not going to go into this method of master making in any greater depth, as manufacturers of different polymers and emulsions have a variety of methods that they recommend for the production of dies and engraving masters. It is sufficient that you know they exist. If you make a lot of masters you should consider one of these systems.

Where masters are going to be made by what is fundamentally a photographic process, artwork has to be produced. With the advent of so many computer driven graphic design systems in recent years, many engravers will now have a facility for this type of activity. A most useful tool for the manufacture of instant artwork, are the lettering machines available which produce many font styles on self adhesive tape. These are not quite as versatile but quicker than the rub down lettering available from companies such as Letraset as you don't have to worry so much about spacing and baselines being correct.

EPISCOPES IN MASTER MAKING

Any engraver who gets deeply involved in his subject is going to have to make masters often and a device that saves a lot of work and solves a lot of problems related to drawing out shapes, is the overhead projector or episcope. The original artwork, which might be taken from a catalogue is placed on or underneath the projector depending on its type. These devices effectively all do the same thing and that's shine an image onto a screen, wall or work-bench.

Having projected the image onto the screen the engraver can draw around the image, including or editing out as much of the detail as the job requires and at the exact size he requires. Some projectors come with instructions that tell you if you place the projector 10 feet from the screen the image will be 10 x 2. On others you will have to work this out for yourself, moving the projector back or forwards until the correct enlargement is achieved.

Make the screen a piece of glass and you will be able to copy your artwork from the front or the back, making mirror image artwork from the original if required. Some episcopes are available with stands which enable them to project the image downwards onto a table instead of a vertical surface. The only disadvantage in this arrangement is that it severely limits the distance achievable between the lens and the projected image, unless of course you happen to work in a stairwell!

The customer will very often produce a letterhead when asked for artwork of his logo, or he may have an advertising agent who designed the logo in the first place, in which case you stand a fair chance of being given some proper artwork. The better the quality of the original, the easier it is to copy and the less one has to enlarge it the better. You should have to hand a spirit pen with a fine point, Stanley knife, heavy duty scissors or a pair of tin snips, double-sided tape, a ruler and a set of French Curves.

Take the artwork and place it under the episcope. Now arrange the distance between episcope and screen to give the enlargement required. Always make a master as large as is practical, bearing in mind the size of finished work that the customer will require. Focus the linage as precisely as possible and recheck its size because there is no point in ending up with a mater that requires the pantograph to be set at some unlikely figure. Take a piece of cellulose acetate about .020" thick and stick it over the image, securing it well enough to avoid slipping but not so well that it cannot be removed. With your spirit pen draw as neatly as you are able around the logo, making notes as you go about the design, as this may not be apparent when the acetate is removed.

It may seem very obvious, but remember there is no way that you can engrave half tones. If the artwork uses half tones then a compromise has to be reached with your customer. For the moment we will assume that the artwork is made up of single lines and solids. Having drawn around the shape, we will now have to deal with this piece of acetate in one of two ways, depending on whether it's a profile master or a line master we require.

A profile master is the easiest. Take stout scissors or tin snips and cut around the outside of the shape. When this is done (and your wife has forgiven you for ruining the kitchen scissors), stick the finished shape to a stiff backing piece.

Perspex, rigid laminate or even hardboard, depending on how much use you foresee for the template. You will already have calculated which style or roller to use when deciding on the size of image to project.

A single line master takes a little longer. Make a profile master as just described but of a different size and use it to engrave a line master onto a piece of perspex, moving the style very cautiously, especially around convex curves and sharp corners. This outline master that you have just engraved from the profile master may not be complete because the artwork will almost certainly have lines within the outline. You can in fact at this stage make another profile of the internal lines, and stick this on top of the master, there is nothing to stop you making layer upon layer, this after all is only an intermediate master and if you have to adjust your stylus for depth a couple of times when using it, no matter.

You will probably end up with a line master which is complete, but has some undesirable bumps on the corners, or a line or two which overshoots. Simply

engrave it again, this time it will be much easier and quicker because you will have something better to follow. Finally, engrave a reference number onto the master, note this in a book or on a computer disc, under your customer's name and file it away until it is next required.

CHAPTER 5 SOME USEFUL TECHNIQUES

STYLUS AND ROLLERS

When engraving ordinary line style characters, the width of line we engrave will probably be about one seventh of the height of the character, engraving heavier or lighter lines according to the way we want the job to look. One seventh of the letter height is a good starting point you will find. The profiling of architectural letters, that is to say letters which have some form, and the engraving of raised letters requires greater attention to this aspect. If the line width is changed on, for example, Times Roman, we are changing the design of the letter and inventing a new style of our own, which is fine sometimes but not if the customer has specified the typeface. Raised letters also are sensitive to this, with too wide a cutter it is all too easy to lose the face of the letter altogether. You can also lose the small amount of "land" in a letter such as that in an A, B, or P. There is a simple formula which ensures that you will always keep the proportions of a letter correct.

Diameter of cutter x chosen reduction = diameter of roller.

A point to remember is that the width of the line is measured at the point the cutter breaks the surface. When we divide the height of the character into the size of the copy to obtain the correct pantograph setting, we are going to get a letter oversize by, the width of the letter (the width of the engraved line).

So what exactly is a stylus and roller? As you know by now the stylus is the point that you follow the master with. At least it's a pointed stylus when you are following a single line letter. When you are required to profile a shape, that is to say cut out the shape by machining around its periphery, you require a different shape of stylus altogether. With solid sunk lettering you can use a stylus that is straight sided, possibly the stylus you use for single line letters just turned upside down.

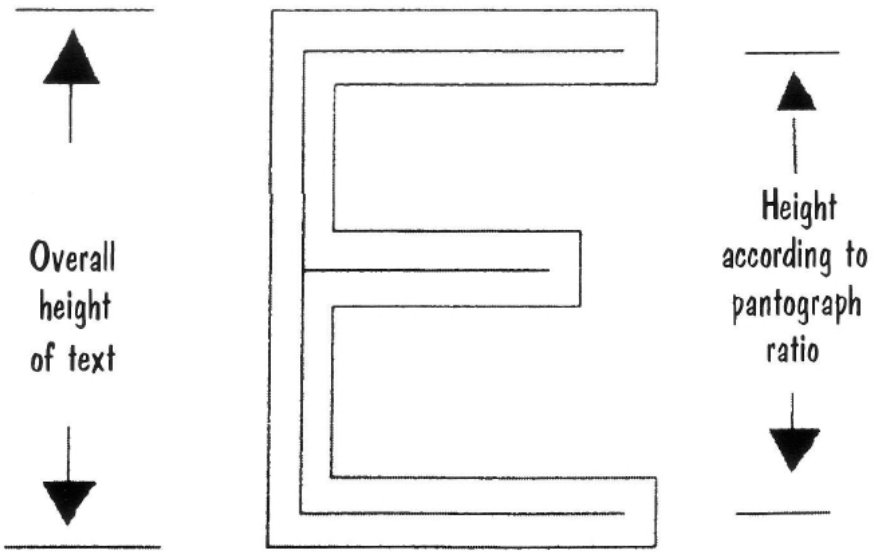


Figure 19 Height of a letter

Usually a shape to be profiled will require a stylus which is effectively much larger in diameter and this is where the rollers enter the scene. You can buy stylus and roller sets from the principle suppliers of engraving equipment, or you can make them up yourself. Frankly having fiddled around with washers and old bushes and bits of scrap from the workshop and wasted valuable time too often, I would suggest you buy a proper set. This will have the added advantage of rollers which are hardened, which fit the stylus and which will be in convenient recognisable sizes.

So how do you decide which size roller to use in a given situation? You start in the usual way by dividing the letter size required into the size of the copy and there's your pantograph setting. When profiling though, we are going to be using a cutter which is not pointed but straight sided and with a significant diameter.

For the sake of the example let's say we require a 1 ½" letter and we know we have 6" profile copy. 1 ½" into 6" is 4, so this is the setting to use - 4:1. Now we need to choose a suitable cutter. A 1/8" diameter should be enough for the job. Multiply the diameter of the cutter by the pantograph setting and this will give you the diameter of the roller to use - an 1/8" x 4 = .5". Obviously you will need to choose cutter diameters which allow you to use the rollers available.

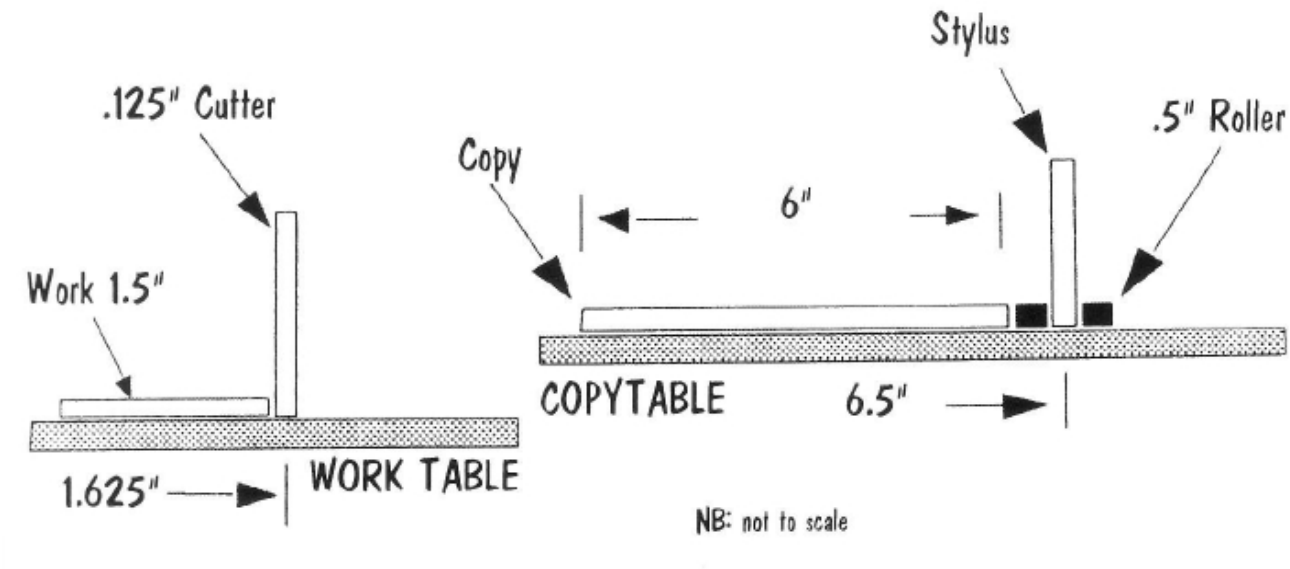


Figure 20 Stylus/roller/letter size

Sketch No. 20, shows the relationship between stylus, roller and copy and the finished letter and cutter. While it is purely diagrammatic, I feel it illustrates the point better than repeated examples.

Should you have a lot of material to remove, it's a good idea to calculate the size of roller you require and then go to the next size up, using this to rough out the bulk of the material, changing to the correct size roller only for the final finishing process.

When finishing a profile it is worth remembering that unless your pantograph is in perfect condition and very lightly loaded, it is going to move off its intended path as the traverse begins and it takes up the load. Make a rule for your workshop, pin a notice on the wall if necessary. Which says . . .

"ROUGHING CUTS CLOCKWISE, FINISHING CUTS ANTI-CLOCKWISE".

The reverse applies, of course, for internal work.

When putting a side load on a cutter, as in bevelling or profiling, you should always ensure that the cutter (or workpiece in the case of bevelling) travels against its rotation when making finishing cuts.

CUTTING A PROFILE

We spend the biggest part of our time cutting letters into material or ENGRAVING IT. There are also times when we have to cut round the outside of the material or PROFILE IT. Successful profiling can only be done on a heavier duty machine of the type I describe as industrial elsewhere, this type of work imposes far greater

side loads on the spindle than ordinary engraving and any vibration that is set up will result in a poor finish. Your cutter will most usually need to be ground parallel although this depends on the finished product. Cut out letters look very nice with a slight bevel on their outer edge. To achieve this you would require a small included angle on the cutter. Grind a large truncation onto the cutter, as a fine point will be dragged off. As we are going to be cutting right though the material a piece of scrap must be found to go under the workpiece and protect the bed of your machine, choose a piece of material that will not wear your cutter unduly or have a cutting problem all of its own. Scrap acrylic sheet is a useful commodity to have in an engraving shop, and ideal for this particular application.

Let's take as our example a simple shape such as a hotel key tag. We shall assume for the sake of this example that the customer has told us that it must be four inches maximum length and two inches maximum width, pear shaped with a quarter of a inch hole at the narrow end for a key ring. Given the choice, it is always best to have what appears to be an enormous hole for the key ring, as this prevents the key ring from breaking the tag when it is twisted. Back to the subject in hand.

First arrive at an acceptable shape and make the tag twice the required finished size from a piece of acetate, take this double sized key tag and stick it to a backing plate made from a piece of rigid scrap material. You now have a raised template and if you use it in conjunction with a cutter and parallel stylus of equal diameter, you will be able to profile out 4" x 2" tags at a pantograph ratio of 2:1.

A raised template like this is fine, but you will find that following a single line is easier. With a raised template there is always a danger of slipping outwards away from the tag. This is not only a waste of material and time but could also result in a broken cutter. An outline master guides the stylus more accurately and because it requires less concentration to use, is quicker. When making an outline, the cutter width and stylus width are critical. For example as your 1/8" diameter (1/8" cutting diameter) cutter travels around the shape to be profiled, it cuts a line 1/16" on each side of its own axis, therefore it will take off 1/16" while travelling along one side of the workpiece and 1/16" while returning along the other, 1/8" in total off the overall size of the workpiece. Before you start to make an outline master therefore you must establish what diameter cutter you are going to use in production and make the master accordingly. Remember the pantograph reduction does not reduce the width of the cutter, only the distance it travels. A 1/8" cutter is a 1/8" cutter at any pantograph reduction. This may sound a bit basic but it is a point that some people do not always grasp when making these calculations.

With this knowledge we can now make an outline master from the raised template that we have already described, or indeed any piece of artwork. I would strongly recommend the purchase of a Style Roller set, if you do not already have one. This is a set of rollers that fit onto a special stylus for your machine, thus when

you follow a raise master you are able by an appropriate choice of roller, to vary the distance of the stylus axis from the shape being followed (see fig.1) to make the outline master for the 4” x 2 key tag. Therefore, one would need to use a 1/4" diameter roller as illustrated in Sketch No. 3. You will then have a master that can be used at 2:1 with an ordinary stylus and a 1 /8" diameter cutter. Earlier I mentioned side loads on the spindle when profiling, you would be well advised if cutting 1/8" thick laminate to go through in about five or six passes. This way you will prevent the tag jumping out when you break through and catching and possibly breaking the cutter on its way out. If you put a piece of double sided tape on the base material, the object you have just profiled will not leap out as you make the final break through.

ENGRAVING SCROLLS

There are many jobs tackled every day by engravers each approached in quite different ways there being no hard and fast rules to observe. One such job being the engraving of scrolls on trophies. Here we suggest a method that is felt to be the best and certainly scrolls engraved this way look attractive, it must be right therefore!

Figure 21 The right way

One often sees the lettering on a scroll engraved in steps around the curve.

Figure 22 The wrong way

This looks clumsy and it is very difficult to arrange the lettering so that the spaces are correct and the finished job visually pleasing.

It is a good idea to commit a set of copy to scroll work permanently. As it will usually be a diamond drag operation, select a set of copy that has body, such as Double Line Roman or Double Line Gothic, these type faces add weight and character to the otherwise thin diamond "scratch". Never use script as this looks dreadful when used on an arc.

Having selected the copy· that you are going to use, mark off and remove the corners from each blank. Making sure you remove the same amount from each one.

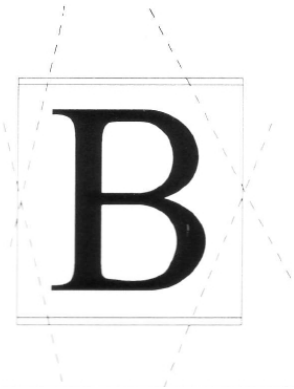


Figure 23 Copy for a scroll

You probably have a standard range of scrolls ready for engraving, in which case you will need to do what follows for each type. Mount the scroll onto a backing of wood or acrylic and place this in the workholding vice. Select the most convenient

ratio to use, bearing in mind the size of scroll and the size of copy, say 3:1 the style with a pen or soft pencil. With an old cutter ground to the style with a pen or soft pencil. With an old cutter ground to a cone (not flat) in the spindle follow the profile of the scroll and draw the scroll three times life size on the white laminate.

This won't be very pretty but it can be tidied up and gone over with a spirit marker pen, making a relatively permanent drawing of your scroll. Now with the maker pen draw in the base line for the engraving and the margins.

Lay out the lettering within the areas marked off. The missing corners will give you greater freedom and allow letters to tilt towards each other. The lettering should be laid out on a thin one quarter inch wide strip of double sided tape, no need for any greater amount, it just becomes a battle to remove the copy when you have finished. This template or guide can be used many times and you could even engrave the guide lines, making it a permanent part of your workshop equipment.

ENGRAVING CUPS AND CYLINDERS

Engraving a cup or a tankard as distinct from a trophy plate is a very easy process once you have established the basic technique and learnt the pitfalls you are likely to encounter.

Let us begin by fitting the cones into the top and bottom of the cup, never take risks with ill fitting cones. Check the cup for roundness, I've never seen one that is perfect, it may be that you can ease it gently with your hands until it fits the cone better. Ascertain whether there are any areas on the cup to be avoided, or hazards like handles that foul the vice when the cup is rotated, rotate the cup to prove to yourself that you have complete coverage of the area to be engraved. Never embark on a job that had to be moved in the vice at a later stage because picking up where you left off will be almost impossible. Having decided where the engraving is going and made sure that it all comes within easy reach of the cutter mark it out on the cup itself with a chinagraph pencil and rule in the base lines of the proposed text and decide on your pantograph ratio. Rotate the cup, holding the cutter down just above the surface to be engraved and make sure that the engraving is going to be in a straight line and not on an arc. If you find that the engraved line is not going to be true, then there are two points you must check.

1. Is the spindle vertical when the cutter touches the work surface? If it is not then you will suffer distorted letters.

2. Is the work surface at the point where the engraving is to be, at right angles to the spindle, if it's not then you will find that an apparently straight line of engraving becomes a gentle arc.

Both combined create a disaster area. Gravograph supplies a setting bar to enable the operator to set the spindle vertical but the degree of tilt required on the cup to achieve a work surface at right angles to the cutter has to be set by eye on all machines. Lay out your text on the copy table and centre each line. Engrave the centre letter then centre the next letter to the right and place the stylus in the letter just engraved. Rotate the cup until the cutter is over the letter just engraved. This will ensure that your letter spacing is correct, important if your line of engraving is going to take up the space that you have allotted it. Engrave the next letter and then repeat the process. When the line is finished return to the centre of the legend and start again, this time moving to the left, by doing it this way we are ensuring that each line is centred above the other. When using a rotating cutter it is only advisable to move one letter at a time, otherwise you will be unable to obtain matching letters due to the change in the angle of the spindle (Sketch No. 10 illustrates this). When using a diamond you will be able to make fewer moves by engraving several letters before having to insert the copy or rotate the cup. How many letters you can engrave at once will obviously be dependent on the size of the letters and the diameter of the cup. Remember that a drag diamond cutter only leaves a very fine line and better looking results are achieved if you use a typeface with some "body" i.e. a double or treble line of letters or lettering that are hatched. Your rotating cutter will need to be ground with plenty of clearance and rake if you are going to engrave a pewter or silver cup as these are very soft metal. One cannot say use a diamond cutter or use a rotating cutter, because this is entirely a matter of what effect you wish to achieve, only experience will enable you to make this decision. You may find that the cup has already been engraved, in which case you will obviously match this as best you can. You will find that when you use a rotating cutter you will only require to use very light pressures as the cutter is doing the work for you, also press to heavily and the nose cone will be in danger of marking the cup. After each letter brush away any swarf that is left on the cup, as if this gets under the nose cone it will cause scratching. When using a diamond much greater pressures are applied to achieve a bold enough line and there is no nose cone to worry about. Therefore make very sure that when you use a diamond cutter the cup is held firmly in the vice. There is no substitute for practise, plated cups are impossible to repair, pewter cups could be repaired by professional silver smiths but at a price. Tins are great to practise on, yes! the things beans come in. Cut off the top and bottom they will fit your cupholder admirably.

On a tankard the correct position for the engraving is facing the drinker, although, of course, this may vary with customer choice. After all, he may wish to let the world know that he is the Kings Arms' darts champ.

BEVELLING

Bevelling labels and small signs should be considered by most engravers as an essential part of the manufacture of that item, and yet it is surprising how many

labels one sees with horribly tatty edges, spoiling any impression of quality that the customer may have wished for, when he specified engraving. An engraved label or sign, even in this age of computer control, is expensive and if customers are going to be prepared to part with their money, they must rightly expect to receive goods that are nicely finished off.

There are a number of bevelling machines available from the main suppliers of engraving equipment, to use one of these is the simplest answer. Most have their own system for collecting the swarf created by the operation. The other way of bevelling a label is to set up your engraving machine to do the work of a beveller. Should you have an old redundant machine of the industrial type with a fixed pantograph lurking in a dark corner of your workshop, that will be ideal. You can set up a current engraving machine when required if you can afford to let it stop engraving. This is what you should do.

Find or make a straight edge the same length as your machine work table. At the centre of one edge, machine a slot wider and deeper than the largest bevelling cutter you are likely to use, to allow swarf to escape. This straight edge should be about 1/8" thick. Having done this either bolt or clamp the straight edge to your machine's work table. I would suggest bolts if the machine is to become a permanent beveller and standard work table clamps if it is not, because then the bevelling set up will be quicker to dismantle.

Now grind yourself a suitable cutter to make a standard 45° bevel. I would suggest tungsten carbide as you are likely to be bevelling a wide variety of materials. This cutter will have an included angle of 90° and no truncation. A minimum amount of clearance angle is required as the cutter will have plenty of space around it for the swarf to escape and the smaller the clearance angle the stronger will be the cutter.

The next step is to set the pantograph. Any ratio will do, that allows the cutter to be placed adjacent to your straight edge. Lock the pantograph into position by dropping the stylus into the hole in the centre of the copy table for this purpose, or by using a lock and slide attachment if you have one. Now using the handwheels, manoeuvre the cutter into the slot that you have made, with the axis of the cutter just inside the outside edge of the fence. The height of the cutter above the work table or the Z axis adjustment will depend on the thickness of the material to be bevelled.

Make sure that you pass the workpiece from left to right when bevelling so that you are moving against the rotation of the cutter. If you feed the label from right to left, there is a danger that the label will be picked up by the rotation of the cutter and be spoiled.

You now have an excellent bevelling machine with a heavy spindle, a powerful motor and probably a larger work table than any ready made beveller. With a

little ingenuity you could rig a dust extractor to it also. Try experimenting with different cutters, a cutter ground parallel to give a flat bottomed cut makes a very nice border around a label. To do this you would need to bring the axis of the cutter out and away from the straight edge.

ROTARY (CYLINDRICAL) ENGRAVING

When we engrave a cup or tankard, it is usually a case of "if it looks right, it is right". Very rarely are precise measurements involved. I am not suggesting however, that the job is easy. Making a job look right requires particular skills and experience which is not easily definable. The purpose built trophy engraving machines of the type supplied by Gravograph, Scripta and Kirba, are excellent for trophies, the operator places the lettering by eye and the vice of the machine allows the cup to be rotated on its axis

Let's look now, at a job that has to be engraved to an engineer's drawing, a cylinder divided into a specified number of sections and each one marked with a number. Depending on how much of this work you envisage doing, there are several pieces of equipment which make life much easier. Which you buy will depend on this and on how deep your pocket is. First of all we will look at the most basic, the dividing head.

These come in various degrees of sophistication but to be of any use for this purpose they must have a catchplate and an easily manipulated chuck for holding the workpiece. The catchplate is a plate with a fixed number of notches machined into its periphery. When the plate and chuck are rotated a pawl "catches" in the notches. These plates can be bought in a variety of standard forms or made to order quite cheaply, usually by whoever supplies the dividing head itself. The whole device is mounted on your machine work table and arranged so that the axis of the chuck is aligned with the centre line on your copy table. When using this method of dividing, there is no need to make a template, because we are going to be placing each individual division as a separate exercises.

Begin by placing the index lines around the periphery. There may or may not be a specific starting point relating to a keyway or some other feature on the workpiece. Roll the chuck to the starting position. Place a letter "I" or purpose-made stroke of the correct length on the centre line of the copy table and engrave your index line. Release the pawl and move the chuck around to the next position on the catchplate, engrave the next line.

Having engraved all these lines you must now engrave the numbers. These can either be placed individually on the centre line of the copy table as required or engraved on a piece of brass copy strip. The latter is the best method, as once done it eliminates a likely area of error. Scribe a line through the centre of each number to make alignment quicker (see Sketch No. 2). Incidentally, if your machine does not have a scribed line on the centre of the copy table, I

strongly recommend that you make one, it's very useful in all sorts of situations. Having engraved one number, release the copy stops and slide the brass strip along until the centre of the next number is adjacent to the line on the centre of your copytable. Rotate the chuck to the next position and repeat the process.

A useful accessory, a circular copy holder, is made by Newing-Hall (Taylor Hobson). This is a set of copy engraved on a disc which can be rotated so that each letter or number can be brought onto a centre line. It bolts onto the machine in place of the standard work table. The discs can be changed quickly and are available in a number of copy styles.

The rotary (cylindrical) engraving device works on the rack and pinion principle. As you move the stylus along your master the rotary attachment rolls the work along the rack to match your movement, the spindle of your machine being fixed to a collar on the attachment. When you first use this device it is rather unnerving as it takes a while to get used to the work moving under the cutter. As your workpiece is rolled by the attachment, the speed at which it rolls is dictated by the diameter of the gearwheel on the rack. Work requiring very accurate reproduction requires a gearwheel exactly the same diameter as the workpiece. These can be ordered specially, but for less accurate work you can probably use the nearest standard gearwheel, and there are plenty of alternatives.

Using a gear smaller than the diameter of the workpiece will increase the surface speed in relation to the movement of the pantograph and therefore make the lettering wider than standard. The opposite will apply with a gear wheel larger than the workpiece. Index lines are not affected because they are usually engraved along the axis of the cylinder. It must be pointed out that this piece of equipment is designed to be used on specific engraving machines and must be fitted individually to a machine of any other manufacture. In the case of a Taylor Hobson D machine, it is a simple case of turning a collar to alter the spindle housing diameter.

In the UK the most commonly seen rotary engraving devices are those that were made by Precision Grinding the company that used to make Alexander Engraving machines. Neither these nor the engraving machines are manufactured now, however like all industrial engraving equipment it can still be bought secondhand and reconditioned. Kuhlmann the German engraving machine manufacturer still produces these cylindrical engraving attachments, if you have the right kind of work for them, they are indispensable

When using this device rotary work becomes, once set up, as quick as ordinary flat engraving, in fact one has to think of each job as being a flat plate because the master is made in exactly the same way. I bought one of these devices in the sixties when I had to produce hundreds of calibrated handwheels for a machine tool manufacturer, and it paid for itself very quickly.

The first requirement is to find the length of the master, and to do this we have to know the length of the workpiece. In this instance that is the distance around the circumference of the cylinder. My schooldays are a long way back in time, but like me, you might just remember that the circumference of a circle is 2πr. For example let's say the workpiece is a cylinder of 1.25" diameter.

π= 3.1416
r = radius

Therefore to find the circumference we have the following calculation.

Circumference = 27πr = 2 x 3.1416 x .625 (the radius) = 3.927"

Having established the circumference (the equivalent of the length on a flat workpiece), we can establish the most convenient pantograph ratio and the size to make the master therefore. With a workpiece 3.927" long, we could easily make our master three times that size and it would not be too unwieldy. I would suggest 16 swg brass is the best material where accuracy is required. Cut a piece about 18" long and slightly wider than necessary to allow for clamping although if the job dimensions allow, a piece of blank copy strip is marvellously convenient.

Having established the total length of the master, we must now divide this length by the number of sections called for on the drawing. Let's say that 60 divisions are required. The job length is 3.927" x 3 (the pantograph ratio we decided upon) = 11.78". Divide that by 60 and you arrive at .196". We now have the size of each division on our master. Always make an extra division or an extra index line so that you can check your calculations. If they are accurate, the start and finish will be exactly on top of one another. Watch out for an accumulative error creeping in when you are marking out these divisions. A height gauge is the best device to use, or of course one can use the engraving machine like a small vertical null and divide the master using the calibrations on the handwheels. Computer driven machines will have a facility in the software for dividing scales and dials etc. If this is something you do often and you are buying a computer engraver make sure this function is easy to operate. Some industrial, computer driven machines have their own purpose-built rotary engraving devices which obviously have to be accommodated in the engraving software. Dividing dials, scales and handwheels is a very specialised business which only a handful of engravers undertake on any scale. You would probably find that if you were to equip yourself to do this type of work it would become your speciality.

CHAPTER 6 - HOW TO COPE WITH..

LONG LINES

Too short a copy table, too big a sign, not enough ratios on the pantograph? Whichever one of these you attribute your problem to it usually manifests itself as your inability to engrave one line of copy at one setting. The most important thing is to recognise the likelihood of this happening before you start the job, if in doubt lay out the doubtful line of copy on the work-bench before you start engraving and measure its total length to see whether it is going to fit your copy table or slide.

You should also before starting to engrave a job, move the style around the periphery of the lettering laid out on the copy table to ensure that the pantograph will cover that area, at the chosen ratio. I must confess to have often got nine tenths of the way along a line of copy to discover that the pantograph won't reach any further along that particular line.

When faced with a label or sign that contains a line or lines of copy that are too long for your table, lay out all the copy on your bench, if you have enough copy lay out the whole sign. We will describe the method for one line, but if the line spacing on your copy table is suitable for the job you could apply this to several lines at once. Mr. Murphy, who's laws we are all familiar with, usually dictates that standard line spacing is not suitable however.

Having laid out the offending line of copy on your bench, measure the centre point of the line and mark it with a chinagraph pencil. Now put this line of copy into your copy table leaving off the ends that will not fit, making sure that the chinagraph pencil mark is adjacent to the centre line of the copy table and that there is enough room at each end for the copy clamps.

Those of you who use the more lightweight machines will have scales on your copy slide, those of you who use industrial machines will have scribed the centre line onto your copy tables, if you haven't, I hope you will do that now.

Take the workpiece and clamp it in the workholding vice or onto your machine bed. Set the pantograph to the desired ratio, make the check I referred to earlier to see that the pantograph will coyer the lettering, and engrave everything within easy reach of the pantograph, it's essential that you do not start to engrave a letter that you cannot finish. Now remove the centre portion of the copy from the table, leaving the last letter that you engraved at each end and adding the copy that was left out. Place the style into this last letter engraved and adjust the worktable so that this letter is under the cutter again, you can combine this with adjustments on the copy table also. Never ever try to re-engrave this letter, merely use it as a datum for the letters that have not been engraved, if there's a letter, a few

characters in from the end of the lettering that you have engraved, that has some vertical lines in it, such as an E or U, use this as your "datum letter", the verticals will be much easier to line up with.

Those of you that use a machine with a depth regulating nose cone will have to remove this to ensure accuracy. Having lined up with this "datum letter" engrave the remainder of each end of the line in turn. Beware, users of industrial machines, do not touch the worktable handle that adjusts the "Y" axis. It is better to remove this so that it cannot be used. It is very difficult to reset a baseline as the eye picks up the slightest discrepancy. A lot of very experienced engravers make a habit of removing the worktable handles or, in the case of a Gravograph type machine, the vice handles after setting a job, this ensures that the engraver cannot be reset by mistake - someone brushing past it perhaps.

The system described will enable you to engrave lines of infinite length, without losing track of where the centre is, it takes time however, a lot more time than a job which can be engraved at one setting and it is important to recognise a job like this at the quotation stage if you are going to get the right price for your work.

You may decide that it would be quicker to make a template for the job, even if it is a one off. The template will be made to fit the copytable and you will have peace of mind, because you will know that what you are engraving will fit and is correct in every way, barring slips out of the copy, the job is done.

MACHINE ENGRAVING ALONGSIDE HAND ENGRAVED LEGENDS

We have all experienced that sinking feeling on discovering that the casually delivered plastic bag of trophies "just dropped in on my wav to work" contains some solid silver hand engraved relics of a more elegant age. Your first concern is that being solid silver they are worth a fortune and your second is that they are hand engraved and you don't happen to employ anyone with that particular skill.

The situation is not as bad as it at first seems. Today one rarely finds a trophy that hasn't got a mixture of both hand and machine engraving on it. The trouble is that the machine engraver works to precise measurements and the hand engraver places the legend by eye, very often countering optical illusions quite by instinct, and when we go to place a name and date beside his, it seems somehow to be crooked or out of line.

My advice in this situation, is to throw away your ruler and mark out the area to be engraved with a chinagraph pencil, by eye. If necessary move your engraving area away from the position you know to be technically correct until it looks correct. This is definitely a situation where if it looks right it is right! Having decided on the position of the legend, engrave it very lightly onto the cup, there is no need for a heavy cut as the lettering is not going to be filled. Just break the surface.

You will find that most cups have been hand engraved in a form of Roman or Gothic capital. Do not try and match this by engraving with a diamond drag cutter, even if you have a set of copy that you consider to be similar, the finish achieved by the diamond is quite different to a hand-cut line. Engrave the legend with a rotary cutter.

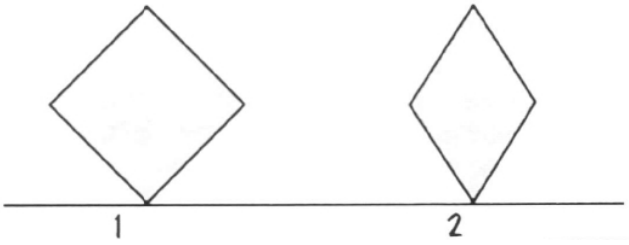


Figure 24 End view of Square 1 and lozenge section 2 gravers

Now this is where the cheating begins, we take a hand graver and embellish the machine engraving. Gravers are available from suppliers of machine engraving equipment as they're used in many ways when finishing off templates, and in intricate corners. I am not suggesting that you become, nor am I qualified to teach you to become, a hand engraver, merely to use a graver as a finishing tool.

Take a graver with a lozenge section rather than a square section and on your Arkansas oil stone grind a flat on the underside to achieve a set-off angle of about 15°, at the same time you will be increasing the width of cut to rather less than the width of the cutter with which you have just engraved the legend on the cup.

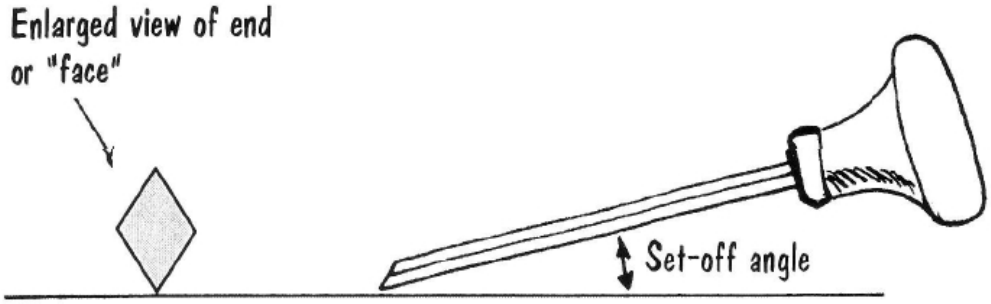


Figure 25 Set-off angle on hand graver

The set-off angle prevents the cutter from digging into the metal too harshly and with some practice you will find that you have to use very little effort to make a cut. Experiment with the set-off angle and find an angle that you consider comfortable to your hand. Find a piece of copper (this has a very similar feel to silver) and practise simple cuts on it. Tilt the graver to one side and you will find that it makes a narrower cut, practice making cuts which get wider and narrower as you twist the graver on its axis. Next, machine engrave a legend on the copper,

lightly remember, and add serifs to the vertical bars of the letters with your hand graver. Remember, all we are trying to achieve is a less clinical look for the machined letters, thus enabling them to blend with the hand engraving.

The other anxiety is that because they are silver, what happens if we slip? When engraving a plated cup, one obviously goes through the plating to the base metal and this is a different colour to the surface. There is no way that an error can be removed because you would finish up with a bare patch on the surface. With any solid material, one does not have this problem. Should your unwanted mark be very shallow you may be able to remove it with a burnishing tool, which merely "flattens out" any blemish in the surface of the silver. This handy device is like all hand engraving tools extremely basic and could be likened to a Swiss file with no teeth!

If that is not drastic enough you will have to use a scraper to remove some of the surrounding metal then burnish and finally polish on a mop using jewellers' rouge. When scraping make sure not to be too local, after all, you must not create a sort of canyon where the blemish was, blend into the surrounding metal. Mistakes are embarrassing and difficult to remedy, unfortunately they do happen. There is no virtue in being good at putting them right, one must concentrate rather on not making them in the first place.

UNEVEN SURFACES

Curved and uneven surfaces do not always matter when engraving, in particular when you are drag-marking a trophy plate or cup with a diamond. Diamond cutters do not machine their way into the material being engraved. They merely scratch the surface, and to make a heavier cut you go over the line again and make the "scratch" a little deeper. Diamond drag-marking cutters are available with different included angles at the cone. The smaller the included angle (say 60°), the deeper it will cut, and the wider (say 140°), the shallower. Most people use a 90° cone as this is a good tool for general use but it's worth remembering that the others are available. However, that's getting off the point (no pun intended). Back to uneven surfaces.

When engraving a panel in laminate with a rotary cutter one has to be most particular about depth of cut. If your engraved line is not a constant depth it will vary in width and look most unsightly. The panel will be a complete disaster if it's a multi-layered engraving laminate because you'll break through into the phenolic core and end up having to fill the lettering with paint to hide where the black shows through. No engraving system is foolproof. If you have a machine that takes a nose cone you will not have this particular problem, but you will have others in its place. Without a depth regulating device there is no fear of scratching and you can see the cutter engraving. I remember when I first used a machine with a nose cone I was horrified not to be able to see the cutter in action.

Let's assume you are using a machine that has no facility for nose cones (depth regulating noses). You must either clamp the work absolutely flat or use a great deal of skill in feeding the cutter and sensing the correct depth of cut. This will only come with experience. Should your machine have a worktable of 20" x 14" and you need to clamp a piece of laminate, say 10" x 16" onto it, you will only be able to clamp around the edges of the workpiece, not sufficient when there is a bow in the middle of the material. Although standard worktable clamps fail to solve the problem, long reach clamps are available up to about ten inches long which are most useful on these occasions, as you release them a spring raises the clamp, protecting the surface from scratches.

Sketch No. 26 shows how easy it is to make a simple version of this clamp provided you have the facility to drill and tap holes or know someone who has. With these clamps you can reach the centre of the bow and flatten the work. Remember to clamp the centre first and then the clamps on the outer edge. When you make one of these clamps, be sure to take off any sharp corners at the clamping end. When dealing with delicate easily marked surfaces, wrap the end of the clamp with masking tape. However, do not leave the tape on when you have finished the job as it is likely to collect grit and scratch the next item that you engrave.

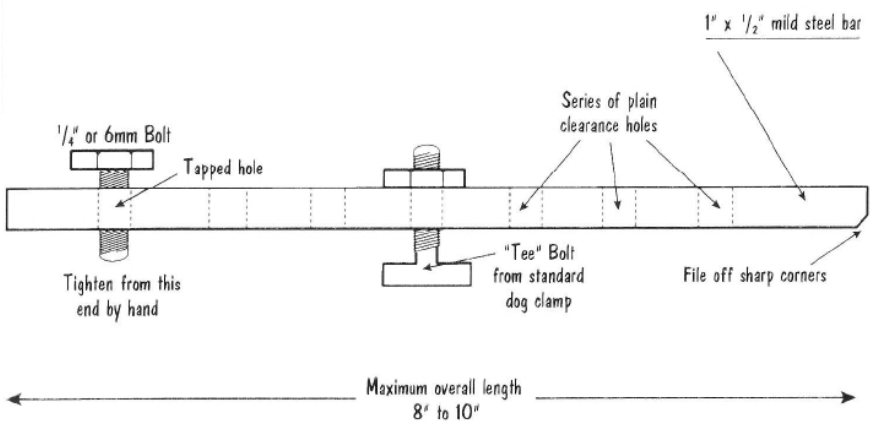


Figure 26 Long reach clamp for engraving machines with slotted worktables

Engraving machines which clamp the workpiece from the edge trophy machines with vices) can create problems by bowing the plate either upwards or downwards. On a flatbed machine with an edge clamping system, a small piece double-sided tape in the centre often helps to stop the plate lifting and keeps it flat. On a trophy machine that has air space under the workpiece, a jig that supports the underside of the plate being engraved is a good idea. If you do not have one of these or cannot make one, a temporary answer is to cut a piece of scrap and use it as a backing thus making the work more rigid. Again, it may be necessary to put a piece of double-sided tape between the work and the backing plate.

For Newing-Hall machines there is a device called a presser foot available. This is a stop that is attached to the spindle and behaves in very much the same way as a depth regulating nose. I have to say however, that there is no substitute for experience and if you can avoid using devices like this your engraving will benefit. Any device that touches the face of your work is a potential source of scratching especially where there is a chance of swarf becoming trapped between it and the work.

When preparing to do a job where the depth is critical, you can make things a great deal easier for yourself by grinding your cutter with the smallest included angle possible for the particular lettering. As you will see from Sketch No. 10 the cutter with the smaller included angle will have far less effect on the width of cut when variations in depth occur. A final note about using a depth regulating nose, With the average engraving job you will have no problems but on anything like computer keytops, w here there is an extreme curve, the shoulder of the nose rides up the curve and pulls the cutter up out of the work. The swivel nose cone available for Gravograph machines is a useful device and cuts out this problem.

A compromise always has to be reached between depth of cut, width of nose cone and included angle of cutter.

The only truly safe way for the inexperienced to engrave an uneven surface; is with a drag diamond cutter. But that's cheating because it's far too easy! There are so many occasions when drag marking is just not suitable, those of you that have machines with a fixed plane pantograph, should persist and train yourselves to feed the cutter. Most computer driven engravers have the option of using a depth regulating nose or not. If the panel to be engraved is obviously going to be troublesome then use the cone to begin with rather than find out half way through the job. It's almost impossible to hold any engraving laminate truly flat if it's less than 3mm thick, the exception being labels up to about 100 x 50mm.

LETTER FILLING

Unless engraving one of the laminates specifically supplied for the purpose, such as Rowmark, Gravoply or Formica, one is faced with the necessity of filling or colouring the lettering in order to make it stand out from its background, by giving it a contrasting colour. Filling can be done several ways, usually the job dictates which method and filler to use, as each has its own particular virtue.

When engraving a label that you know has to be filled, make sure that you go to sufficient depth (at least .010") and that you use a cutter with a 60° included angle or less. preferably 45° otherwise it will be difficult to fill the lettering. And the filler will have nothing to key onto.

Paints and inks

The most commonly used fillers are paints, either air drying synthetic enamels or cellulose. Let's begin with these. The safest filler by far is an ordinary enamel such as Humbrol, which can be bought in very convenient little tins, made with model makers in mind. I say “safest” because there are a great many materials and paint surfaces which will pickle when cellulose is applied.

Never use cellulose paint on Acrylic materials or PVC. Some of the plastics used for keytops go tacky when cellulose is applied and lose their shiny surface. Never use cellulose paints where any other paint has to be covered because the chances are it will pickle that also, on contact. I would find it impossible to list all the combinations that are dangerous; indeed I don't know them all. All I can do is to warn you of the more obvious ones and having been warned, you can then take precautions and test combinations which are likely to be troublesome.

Having warned you off cellulose paint, let me say that it has plenty of advantages also. It dries to the touch almost instantly and therefore does not collect dust, although you can wipe it off a panel up to about half an hour after application, with a cloth dampened with cellulose thinners. Incidentally, use this paint in a well ventilated area, otherwise you will dope yourself with the fumes, which are considerable.

People try all sorts of clever and complicated ways of applying paint filler, but in my opinion the best way is also the simplest. Here's how. Take a label to be filled. Paint roughly over the lettering with a small paint brush, put the label aside and start the next. After ten minutes or so go back to the first label and with your index finger (suitably clothed in a lint-free cloth) wipe off the surplus paint. The wiping cloth should be damp (not wet) with the appropriate thinner, which will probably be turpentine or cellulose. Each wipe should be fast and light and should be with a relatively paint-free piece of cloth. In other words the cloth must be on the move the whole time. Some people use a piece of stiff card for this initial clean up operation.

You will now be left with a label its engraving filled with wet paint and streaks of paint liberally spread about its surface. Now go back and put the first application of paint on the next batch and after ten minutes return to the half finished batch. Take your lint free cloth and fold it into a firm smooth pad, with no corners which will pull the paint out of the engraving. Dampen with the appropriate thinner and clean off the labels completely.

If the lettering is not holding the paint easily, another way to clean the paint off is to dampen a piece of smooth card with the thinners, put this on a smooth surface, put the label face down on it and gently wipe it across the surface. The card will be less likely to pull the paint than a cloth. I once had a pile of old cards from a redundant card index system and these were ideal for the purpose.

Don't use too much thinner or you will make the paint run. If it does run leave it to dry for a while, and start again later. On materials such as anodised aluminium the surface of which may not have been sealed properly, the paint is sometimes reluctant to be cleaned off and if you rub too enthusiastically you will make a permanent halo around the lettering. In difficult cases such as this make a paste up using the thinner for the paint and a household cleaner such as Vim. Rub this very lightly over the stain and you will find it comes away without damaging the surface finish.

This method of letter filling may sound awfully laborious but once you have got into a routine you will be surprised at how quickly you can cover the ground.

A good substitute for paint is screen printing ink. Some surfaces just don't want to accept paint. Screen printer's ink can be bought specially formulated to adhere to almost anything. some etch permanently into the surface to which they are applied.

Paints and inks are easy to use. Sometimes though, the concave surface which is left when they dry is not acceptable. To achieve flush filled letters one must use one of the waxes or Vitreous Enamel.

There are systems on the market which are designed to help you to fill letters, they consist of small syringes attached to an air supply and they allow you to apply small drops of paint or ink just where you require them. If you have the occasional six labels that require filling then the capital outlay would certainly not be worth it. There is a good deal of cleaning involved although some of the syringe bodies are disposable. These letter filling kits appear to be very expensive for what they are and because of this will not be considered unless you have a great deal of filling to be done.

Soft Wax

The most commonly used of the waxes, easy to use but limited in its application. Soft wax, as the name implies, never goes really hard and remains about the same consistency as a candle. Perfect for shall lettering on labels and panels. One merely rubs the wax stick over the lettering making sure the engraving is completely filled, and then with a clean cloth you wipe away the surplus. Wax that wants to stay on the surface can be removed by using a small amount of paraffin on a cloth. Soft wax should not be used on lettering over 3/16" high as it becomes too easily picked out and damaged. Key-tops look good filled with soft wax because of the flush finish, making the keytop look as if it was a two shot moulding. One should always try to use a colour darker than the background and then any dirt collected in it will not show so badly, this applies to all types of filler. A word of warning, keep your sticks of wax clean, a piece of grit embedded in a wax stick can make

wonderful patterns on your newly engraved panel! Each stick of wax should be kept in its own wrapping and never ever left lying on the work-bench.

Hard wax

Rarely used these days but still sold. With care and a certain amount of dexterity, lettering filled with hard wax can look beautiful. The surface of the label must be base material, i.e. not plated or finished in any way. One begins the process by heating the label or plaque on a hot plate to about 100c. When a sufficient temperature is reached the wax is applied to the lettering and runs into the cavity. The plate is then allowed to cool. When cool, the surface of the label, and the wax, is sanded flat, finishing with as tine a grade of paper as you wish or polishing it on a buff. Having smoothed the surface and checked for any imperfections, re-heat the plate until the wax melts again. This will of course give the lettering a beautiful gloss which remains as the plate is allowed to finally cool. Highly suitable for professional name plates and commemorative plaques.

Vitreous enamel

Not a job that can be done by just anyone, as a lot of very specialised knowledge and equipment is required, not least of which is a kiln. Vitreous Enamel is like coloured glass and is just as hard and brittle. The finished job is second to none. All professional name plates were enamelled once upon a time, as were a lot of general purpose signs that had to be durable. Now to be found in trendy antique shops.

BLACKING FLUIDS

For small lettering on aluminium or brass there is no better way of colouring lettering black than with one of these strange liquids. Blacking fluid is an acid which turns raw aluminium or brass black by an oxidising process. Simply engrave your label, dab on the fluid with the applicator provided, wait for a couple of minutes while the lettering turns black, then wash off any surplus under a tap. The blacking fluid must be applied as soon as the label is engraved because if any oxidising takes place before the blacking fluid is applied it will be less effective. The surface of anodised aluminium is protected by the anodic film everywhere other than the engraved letter and so no extra protection is required. Brass however needs to have a lacquered surface otherwise the whole label will be dyed a patchy black.

Be careful when using these fluids and follow the supplier's instructions to the letter as they are rather unpleasant and dangerous acids.

A final note on filling generally. When engraving a label that you know has to be filled, make sure that you go to sufficient depth (at least .010") and that you use a cutter with a 60° included angle or less a 45° included angle would be better. If

you do not, you will have difficulty filling the lettering as the filler will have nothing to key onto.

CHAPTER 7 - EQUIPMENT TO CONSIDER

ELECTRIC ETCHING

Electric etching takes several forms, the most commonly seen is the javelin etcher from Newing-Hall. The old Taylor Hobson company introduced this device many years ago, and only quite minor modifications have been made to it over the years, like all electrical equipment it has become smaller and neater, and the large drum transformer that triggered off this train of thought has done just that.

The device itself takes the place of the engraving machine spindle, which is easily removed. The principal is very simple, when the current is switched on a series of minute electrical arcs are formed at the point of a rapidly vibrating electrode the Javelin, these "sparks" leaving a burn in the metal. One could compare the system to a highly miniaturised arc welding system. You will appreciate from the above description that it will only work on ferrous metals; the strength of the mark can be adjusted by varying the voltage from the transformer, this is adjustable between 2.5 and 10 volts.

The Javelin floats freely and is vibrated by an electro-magnet when the current is on, because of this freedom of movement in the Z axis you can etch uneven or curved surfaces. The Javelins, as you might imagine, slowly burn away and replacements are available in boxes of varying gauges.

The original Javelin etcher was designed specifically for Taylor Hobson C, CB, CX and CXL machines but can now be supplied to fit the whole range of machines produced by Newing-Hall including their computer driven machines. There is a certain amount of practice required to produce a reasonable mark with one of these devices. Move too slowly and the electrode tends to stick to the surface or burn the metal, move too quickly and you tend to end up with the dots too widely spaced. A constant traverse speed is essential.

Unlike most machine engraving accessories which get put on the shelf when their owner buys an all singing all dancing computer driven machine, the javelin etcher has actually come into its own, and in tact works much better on one of these than it ever did with a pantograph! The reason for this being that the traverse speed on a computer driven machine is constant, unlike the hand of an engraver using a pantograph.

So why should you ever want to mark metal this way? Electric etching creates no burr or cavity in the object being engraved. It will mark tool steel, an engraved line, which must have a depth however small, is unacceptable and could be regarded as a stress point or a "rough" patch, however well it was done. It is commonly used to mark small engineered components, take a look at some of

your bits or taps and dies and you will probably find they have been marked in this way.

Newing-Hall are not alone producing electric etching devices. We have just highlighted the javelin etcher as this is the most commonly seen in the U.K. Gravograph produce an accessory known as the Electrograph and versions of this are available for the whole range of their machines. They also produce an accessory called the Pyrograph. This works in a different way altogether and burns the mark into the metal with an heated tip.

THE CUTTER MICROSCOPE

The cutter microscope produced by Precision Grinding Ltd., who manufactured the Alexander range of pantograph engraving and diesinking machines, has x25 magnification and with it you can inspect a cutter either while being held in a vee block or while still in the spindle. In most cases it would be quite acceptable to remove the cutter from the machines and use the vee block provided to locate the cutter under the lens. For occasions where extreme accuracy is required you can remove the spindle and cutter from the engraver and mount the spindle in a bore in the casting of the microscope. This way the cutter can be ground and checked for its geometry and concentricity without ever leaving the engraving machine spindle. It has to be said though, to do this you would require to buy a special optional workhead for your cutter grinder, which would normally hold the cutter in a collet, not the machine spindle.

When the cutter is mounted under the microscope, a built-in graticule enables the engraver to check cutter radii measurements and position against a series of concentric graduations and a broken 45° line used in conjunction with the 90°, scale beneath the eyepiece. The microscope is carried on a micrometer slide so that diameters and off-set radii can be determined.

There is a small adjustable mirror underneath the cutter, and a tiny 6V 3W spotlight shines on this causing the cutter to be seen as a silhouette and easily measurable therefore. The microscope stands on a U-shaped base. This means that it can stand on the workpiece itself and used to study engraving in detail.

Newing-Hall manufacture a microscope for use with the model G cutter grinder. It is a free standing bench model and incorporates its own low voltage lighting unit with a green optical filter light and separate surface lighting. The microscope is fitted with a 10x eyepiece with a 2x objective lens (a 4x objective lens is available as an optional extra). It stands 12" high.

The graticule is available in British or metric linear graduations which are very easy to read. The operator sees a silhouette of the cutter through the eyepiece. When setting the microscope up for the first time, he has to position the cutter against the graticule, making sure that the vertical datum line is

correctly aligned and that the point of the cutter is coincident with the centre of the graticule.

There's a vee block under the lens and this takes the cutter, still in its holder, from the grinder avoiding the necessity to remove the cutter. The cutter should not be removed from its holder after grinding, or during the grinding operation to check its condition under the microscope. Keeping the cutter in its holder removes an area of likely inaccuracies.

I mentioned the fact that the cutter width as viewed without the aid of a microscope is not going to be the actual width of the cut. The diagram of the graticule in this microscope and the image of the parallel cutter. Sketch No. 6 illustrates this well. You will notice that the cutting edge (the right hand edge in the diagram) appears to be offset and yet the actual shank of the cutter is central. This is because the cutter grinder has created a clearance angle on the cutter, making it impossible to measure a cutter's width of cut just by holding it against a handheld eyeglass with a graticule, because these do not relate to the axis of the cutter.

Some of you will know that cutters can sometimes become almost impossible to grind correctly as they get near the end of their life. This is usually due to the cutter's flat having been ground back from the axis of the cutter shank. Repeated rubbing of the face on an oilstone after grinding, while essential for giving the final burr-free finish to the cutter, must be done with great care and with as light a touch as possible, otherwise the cutter will suffer this way. A microscope will show whether or not this is occurring, if you rotate the cutter through 90° you can compare the cutter's flat with the axis of the shank.

You will, without a doubt, be able to live without a cutter microscope, but it is the only way of checking your cutter dimensions, for accurate reliable repeatability.

MILLING AND FORMING ATTACHMENTS

Engravers who buy new engraving machines from the manufacturer know what accessories are available for their machines, as presumably this will have been considered when coming to the decision to buy. Thousands of engraving machines are bought and sold privately each year. Sometimes machines go to people who have never engraved before or who are new to the business and just do not know what their machine is capable of.

The milling and forming attachment available for the model K, and the forming attachment for the model D, are both very similar. Most people when viewing one of these machines for the first time, assume that at they can only engrave in one plane. This is not so, operators worth their salt will have often engraved on a curved surface by careful feeding of the cutter, but because of the concentration required to do this, it is bound to be slow and could not be contemplated for large

quantities. This is where the forming attachment comes into its own. The area that can be engraved and the depth of the contour is limited, but for engraving on the curved surface of a mould, key tops, or medals, it is ideal. The maximum area that can be covered in the direction of the worktable slots is restricted by the milling and forming bracket to a distance of three inches, and the other direction the coverage is limited only by the swe[e]p of the pantograph and the setting you have chosen.

The milling and forming bracket, bolts to a machined face on the body of the engraving machine. This bracket holds the former, i.e. the shape that corresponds to the concave or convex surface which you will be engraving. The maximum depth of contour that can be engraved is 3/8". The screw feed on the top of the cutter has to be removed and in its place a new feed fitted which incorporates a "forming stylus". This is fed upwards by spring pressure and follows the shape of the former. As the cutter spindle is moved by the pantograph the cutter will rise and fall accordingly. Two styli are provided, one of 3.8mm tip radius and the other of 2.3mm tip radius. Which of these you use will depend upon the detail in the former that you are following. When setting this attachment up, one can lock the spindle carrier (as for milling) to the bracket, thus enabling one to line up copy, former and workpiece accurately. When doing this it is good policy to use a cutter ground to an absolute point, with no clearance or truncation, to establish centres correctly. Former blanks are available from the manufacturers and if you are not equipped to turn the shape required yourself any of the better known suppliers of engraving equipment will do it for you. To use your engraver as a light vertical milling machine, the whole spindle assembly can be locked to the bracket. This takes the strain imposed by milling off the pantograph and the work is fed by using the hand wheels of the worktable.

COPY TABLES

There is no standard copy table as one might expect, each manufacturer makes tables to his own specification and if you have several different machines in your workshop you will know how diverse they are. An ideal engraver's workshop will have several different types of machine, each one with its own merits.

Newing-Hall (Taylor Hobson) and Alexander engraving machines both have a similar system. These machines have as standard, cast iron tables that have the type slots machined into them.

They can be turned through ninety degrees enabling the operator to engrave at right angles to the work table if he wishes.

On other types of machine the worktable or vice is rotatable. A point to watch out for is the different pitch between the lines. On the tables designed for 1.25" blanks, (Taylor Hobson No. copy) Newing-Hall mill the copy slots on a 1.440" pitch and Alexander on a 1.775" pitch. Fine, who's to say which is best, but don't learn

about this difference the way I did many years ago. To get through a long production run in a hurry I put one operator on a RTH model D and one on an Alexander model 2B. Both sets of labels were perfect, but had different line spacings!

To stay with these two manufacturers for a moment, their copy tables for other sizes of blanks, are made the same way but have correspondingly less slots as the size of the letter required increases. The Newing-Hall table 110/24 is 24" long and can only accommodate one line of copy, albeit on 3" blanks. One 24" line of three inch copy is as much as any pantograph machine can cope with at one setting. Both these companies produce circular copy holders, and appropriate copy plates to go with them. These holders facilitate the changing of lettering when it is necessary to keep each letter on the same centre line. For example engraving on an arc or on a cylinder, usually in conjunction with a Dividing Head.

These British copytables are produced to take copy blanks of the following sizes, they are all bevelled to 20 degrees off the vertical.

1.25" blank for .	75" copy
2.25"	1.5"
3.5"	3.0"
4.5"	3.0"

You will notice that 4.5" blanks are also recommended for 3" copy. It is essential to buy a copytable that will accommodate 4.5" blanks if you envisage using upper and lower case in this size. The extra blank size is required so that there is room for the downward stroke of letters such as the lower case "y". This is an important consideration when setting yourself up with copy and copy tables and you may consider it worth spending the extra on the larger size if you plan a lot of sign work.
Gravograph, Scripta, Kantograph, Hermes and other machines of that ilk use an entirely different system. They have a flat copytable which accommodates copy slides which can be placed anywhere on it. As with other systems there are arguments for and against. On the plus side, this system allows much greater freedom when composing a sign or label, as the line spacing can be adjusted freely, it will often be possible to avoid making a master thanks to this versatility. Against the method is the ease with which they can become misaligned. Engraving is fraught with potential errors and anything which adds to that risk must be questioned. These copy slides are available in the following sizes and all have a bevel 30 degrees off the vertical:

18.45mm blank for	6,12, and 15mm copy
31.75mm blank for	8 to 27mm copy
69.85mm blank for	36 to 60mm copy

Remember what I have been saying about master making, if you have a repetitive job making a master will take away these potential errors when working from loose copy. This is a good habit to get into, saving as it does save wear and tear on the copy and the likelihood of mistakes.

There are copy tables available for the industrial engraving machines that have "T" slots in them instead of machined copy slots. These tables are very much easier to secure masters to with dogs or G clamps, and if you have a lot of profiling work or similar, one of these tables are worth their weight in gold. Engravers with machines that have copyslides of course, only have to remove these and they have a flat uncluttered table for their template. No "T" slots but convenient for G clamps.

Gravograph produces an extensible copyslide, which could be simply described as a copy slide slit in half lengthwise. This can therefore hold any size copy blank and is ideal for their large 150mm and 300mm blanks. These are excellent when there is a need to make a one-off sign which has several different sizes of lettering, as there is a strong chance that it be able to be laid cut at one setting. Do Not, however, buy these slides as a substitute for ordinary slides or tables in the mistaken belief that they will cater for all your needs.

They will not. Laying out copy in copy slides such as these is much slower. Before one can engrave there are many more checks to be made, as regards alignment and tightness of copy.

In a perfect world, manufacturers of engraving copy would decide to make it all in metric and or imperial sizes and all with the same bevel on the blanks, but it is not. The wide range of copy holding systems is to the advantage of the engraver, the greater the number of ways of tackling a job the better. When buying another engraving machine it is worth considering which copy it takes, you might save yourself buying a whole lot of copy only usable on one machine.

THE GUILLOTINE (SHEAR IN AMERICAN ENGLISH)

The guillotines you choose should have as straight a blade as possible, not a curved one in the style of some officepaper guillotines. Curved blades usually impart their shape to the material they are cutting and thin aluminium labels such as those used as trophy plates, curled up like autumn leaves, are not very impressive!

Your guillotine must also have an adjustable back stop so that when you have a run of labels you are able to make repeat cuts accurately. Look for a guillotine that works on the same principle as its larger brethren, the big industrial treadle and powered machines. You will notice that these all have straight blades that are

almost horizontal when they cut the work, and do not cut with an exaggerated slicing action.

The flexible laminates cut very easily, these materials are designed specifically for engravers and sign makers and can be stocked in sensible sized sheets and cut to the customer's requirements, in house, at the time of ordering. Most small guillotines available to the engraver will also cut anodised aluminium. However, a blade constantly used for metal will not give a very clean cut on plastic for long.

In a perfect world you should have one guillotine for plastic and another for metal, but most people will put up with the compromise. The blades on guillotines are changeable but in my experience the effort would be too much to contemplate between jobs.

Although these materials tend to be amongst the most expensive engraving stock, they are in fact the cheapest to handle. By that I mean, the flexible laminates are all best engraved with High Speed Steel cutters which in turn are all sharpened on a white grit grinding wheel, and of course the guillotine itself is a relatively cheap piece of equipment, compared to a circular saw. The guillotine does have its limitations, most of those recommended to engravers will be limited to a cut of about 1/16" thick (16 swg) and of course hard and brittle materials cannot be cut this way however sophisticated the device is.

CIRCULAR SAWS

There are several makes on the market, and they fall into two categories each with their own advantages and disadvantages. The

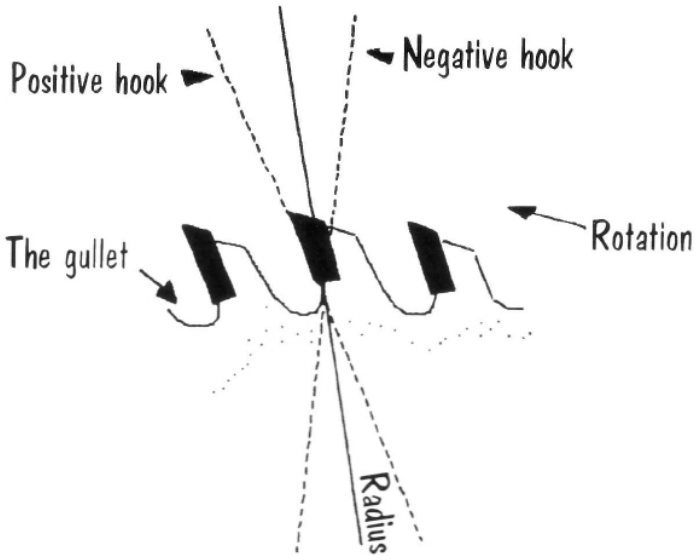


Figure 27 Sawblade terminology

"Benchtop" saw and the "Sawbench". The latter of which as the name implies is free standing and incorporates its own cabinet or bench. The Benchtop saws (the smallest category of saw) should have the capacity to cut across a 4' x 2' sheet. They are all compact, utterly safe and usually collect their own swarf. The motor in all cases is suspended on linear bearings above the material and runs on a rail, the operator pulls the motor and blade unit towards him and over the work being cut. The cutting unit will not lift high enough for the operator to inadvertently place a finger or hand in front of the cutting edge.

The Startrite Sawbench (the most commonly seen) and other similar floor standing machines, come into the machine tool category

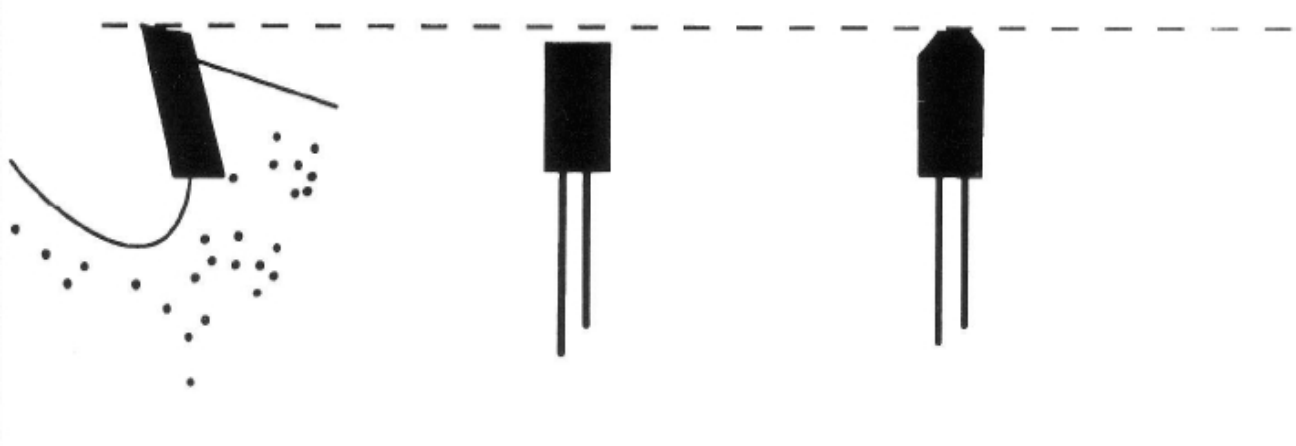


Figure 28 Triple chip teeth

and are altogether sturdier. Extension arms are available enabling one to cut a 4' x 4' sheet comfortably and a 8' x 4' sheet with a small amount of ingenuity. While I'm sure this type of saw complies with the relevant factory safety regulations, they require a great deal more care in their use. Sawbenches such as these can cut almost any material you are likely to be asked to engrave and although they are not as easy to use as the Benchtop variety for cutting labels, they are on the whole much more versatile. A jig for holding small pieces of material can be easily made.

The circular saw will of course cut all the flexible laminates and much more besides. Materials such as the rigid laminates, phenolics,

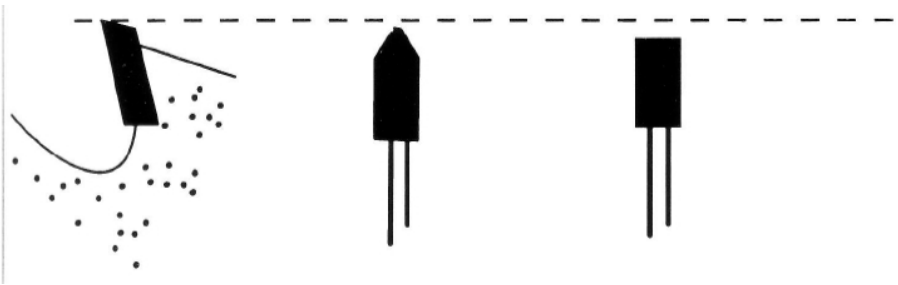


Figure 29 Double chip teeth

brass, aluminium and acrylics all cut with a chip-free finish. Tungsten blades must be used and these should be ground to one of the recognised specifications for plastics or metal. Not something you have to worry about. But you should tell the supplier of the saw what you are planning to cut with it. This applies especially when buying a floor standing machine as these go into all types of industry. The benchtop saws tend to be sold into the engraving and circuit board industries anyway and it would be assumed that they were destined to cut plastic.

When cutting laminates set the blade as low as possible so that the angle of attack is very fine. this will give a better finish in most

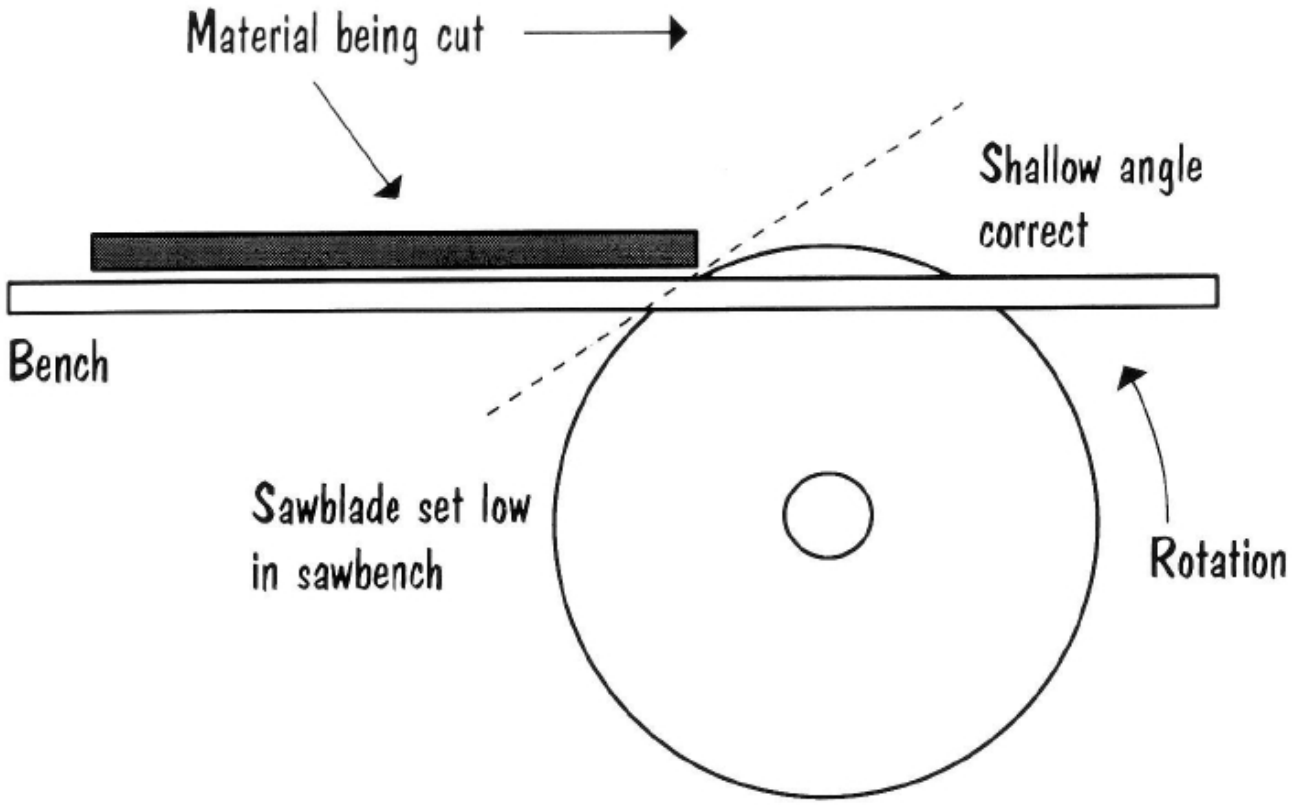


Figure 30 Angle of Attack

cases. With the blade set low, the sawtooth will exit from the material at an oblique angle and be less likely to take a chip out of the back as it leaves. Conversely a blade set so that it cuts at right angles to the material will be highly likely to chip the material as it leaves. The sawblades on benchtop saws are fixed in their housing and cannot be adjusted to anything but a shallow cut, which is fine.

When using either a saw or a guillotine one is bound to be in danger of cutting the label out of square. However accurate the saw is. A piece of grit embedded in the fence will not have a noticeable effect over perhaps ten labels, but over a hundred the cumulative effect could cause you to scrap half the job. One way to cancel out this effect is to constantly turn over the strip that you are feeding into the blade.

When setting up your first engraving workshop undoubtedly the cheapest way to begin is to buy a guillotine and a stock of suitable Flexible laminates. However, if it can be managed on the budget, then I would suggest a circular saw is the greater asset, it will after all cut

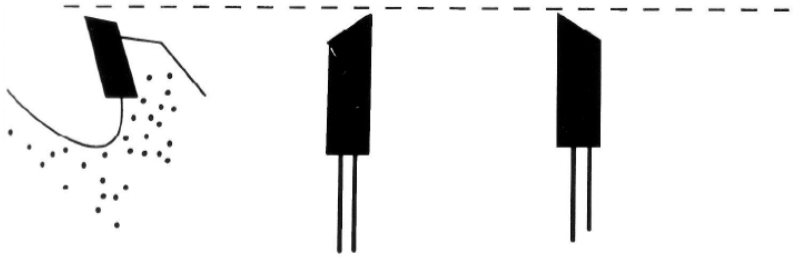


Figure 31 Alternate bevels

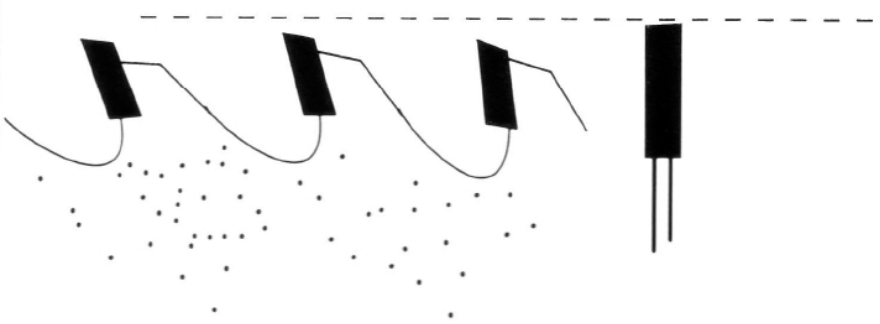


Figure 32 Flat topped teeth

everything you are likely to need. One does have to cater for "Murphy's Law" which says that if you buy a guillotine, the first person that crosses your threshold will want a sign made from acrylic sheet.

CHAPTER 8 - SOME USEFUL INFORMATION

SWARF

Swarf is the strange name given to the dust and shavings created when we engrave. This takes many forms and if you are producing swarf in large amounts you should, if you have not already done so, install a proper extraction system. Those of you who are profiling letters from acrylic will be amongst the biggest producers of what in that case looks like snow!

We are all much more conscious in the nineties of the safety aspect of our work and some swarf needs considering carefully in this light. Materials which produce large pieces of swarf which fall straight to the ground are the easiest to live with, a brush and pan at the end of the day is all that's required. Acrylic, flexible engraving laminates, aluminium, brass, steel are all materials which produce swarf that is heavy and does not hang in the air.

Materials which produce swarf in the form of a fine dust, the phenolics, the rigid laminates are much more worrying, as if there is not a proper extraction system the air in the workshop becomes heavy with a fine dust. This not only settles on every shelf and working part of the engraving machine - it cannot be good to breath either.

An engraving machine is a relatively easy subject for a dust extraction system, as the spindle is small and this is the only source. Circular saws of the floorstanding variety are more difficult to deal with as the cutting action is fiercer and dust, is ejected from several place at once.

A great many years ago in a certain engraving business which shall remain nameless, the circular saw was in a tiny room which was thick with dust. The operator wore a face mask when he remembered and used a very specialised technique for keeping the level of dust down to a minimum. Tea leaves. These were ceremoniously spread over the floor after each brew up along with the remaining tea in the pot. However this hi-tech system of damping down dust failed with the advent of the tea bag. Back to the drawing board.

Quite seriously though, in this more enlightened age it's madness to work in an atmosphere filled with dust and if you find you are using materials which create airborne swarf you should consult a specialist if the machine you are using does not have a ready made swarf extraction system available for it.

Be prepared for the specialist dust extraction company to tell you that a hose and an industrial vacuum cleaner is not good enough. They will tell you this if you are mixing certain swarf in the same system, as some combinations believe it or not are explosive. Think of the static electricity you find in acrylic swarf and mix that

with wood flour (the fine dust given off by wood when it's being machined) which is actually used in the manufacture of explosives and you cannot fail to realise the potential danger.

Swarf, dust, call it what you will is not to be ignored, always wear a face mask if it's in the air and if this is a situation that occurs often consult the experts on the subject.

CUTTING OILS

Cutting fluids are usually thought of as only being used in machine shops, engravers who are involved in profiling apertures in panels and cutting out letters from unfriendly materials will already know that they can save a lot of problems. A cutting fluid should be used to both cool and lubricate, although the free machining alloys can usually be machined dry, there is sometimes an advantage in using a fluid where an excellent finish is required or where there is a danger of a burr pushing off a panel's finish.

A burr is the last thing you can risk if you are engraving a panel that has been stove enamelled (it will lift the enamel). There was a time when engravers avoided cutting oils (because they stained their work) and a mixture of lard oil and paraffin was used. A lovely smell when it was warm, but oh what a mess! Non staining cutting oils are now available in small bottles with easy to use spouts. Always consider using a cutting oil on the softer alloys that are the hardest to machine.

There is a great deal of misunderstanding about cutting oils or coolants as they are sometimes called. In fact it's the word coolant that is probably most responsible for this. The tendency amongst a lot of engravers is not to use it unless there are obvious signs of overheating. The inability to get a perfect finish must be one of the first signs that you should be using it.

There are lots of good reasons for not using cutting oil, many which do not relate to the job that has to be done, the prime one being the mess that it makes. When badly managed it also makes a terrible smell. Very often when walking into an engineering shop first thing in the morning, the smell that sometimes greets you is not the drains, but bacteria breeding in the emulsified oil and water in the sumps of the machine tools. Not a problem that an engraver will encounter unless he has a lathe or mill in his workshop that has a sump.

There are three very important areas where cutting oil will show big advantages. These are longer tool life, better surface finishes and closer tolerances. The removal of heat will be the least important feature in most jobs that an engraver considers it for. There are other gains to be made but they have less significance in our case. Can a lathe for example the use of cutting oil will show big reductions in the power consumption. As the motors on most

engraving machines are only a fraction of a horse power and the loads very light, we need not consider this aspect.

The cutting oil is usually carried in an emulsion and this is miffed by the purchaser according to the manufacturer's instructions. Sometimes as thin as 45 parts of water to one of oil. Very few engraving machines are equipped the facility to use cutting oil and when it is necessary to do so it has to be applied by hand. An old paint brush is the best.

Keep a tin of ready mixed oil in the machine bed and "paint" the oil onto the workpiece in the path that the cutter is going to take. As engravers it would be wise to choose an oil that has as little sulphur in it as possible. This is the ingredient that can sometimes stain non-ferrous metals. It would be a shame to defeat the burrs on the lettering of an instrument panel only to leave it covered in stains! Try to avoid its use if you are to use a blacking fluid afterwards. It's very difficult to remove all trace of oil and unless you do so, the oxidising agent (blacking fluid) will not take.

Next time you are milling or profiling get out the cutting oil and see how you improve the finish. Next time you are trying to engrave fine lines in steel, a scale perhaps, use cutting- oil. Next time you are trying to engrave one of those soft brass or aluminium components and you find you cannot avoid a burr, use a cutting oil.

Some of the soft PVC-based engraving laminates melt very easily under the cutter. This is one instance where fluid is required primarily as a coolant. You will find that paraffin or pure turpentine work well as the cutting/cooling agent on these materials. Incidentally, where fluid is only required for its cooling properties, with soft plastics which are inclined to melt under the cutter, you can used compressed air or one of the devices available which produce cooled air specially for this application. An engineers' supply shop will be able to advise you on the manufacturers.

Never mind the mess, it's the quality of your engraving that counts!

Different types of oil or cutting fluid suit different materials the manufacturer of cutting oil will advise you on their particular grades. The following is a guide to types of oil to be used with the materials you are likely to be working with. Materials not mentioned are not likely to require a coolant of any sort.

Aluminium

Paraffin or proprietary brand of emulsified oil.

Acrylic

Water with a touch of washing up liquid. Paraffin works but is difficult to clean off.

Brass

Engravers' Brass requires no oil, however some of the softer and tougher alloys require an emulsified oil. Paraffin works but a proper cutting oil is better.

Flexible laminate

The most popular flexible laminates require no coolant, the PVC based materials which would also come under this heading, do suffer from overheating especially where high cutter rpm is unavoidable.

Compressed air is the most effective. Once again paraffin works but wil require laborious cleaning off afterwards.

Gilding metal	Paraffin or proprietary brand of oil.
Mild steel	Emulsified oil.
Nickel silver	Emulsified oil.
Phenolic	Compressed air. Avoid liquids as it will absorb them.
Stainless steel	Specific grade of emulsified oil.
Gold	Paraffin.
Glass	Water, with just a touch of washing-up liquid.
Slate and marble	Water as coolant and for damping down dust
Tool steel	Specific grade of emulsified oil

MORE ON GRINDING WHEELS AND GRINDERS

As with most new activities there are a lot of dark corners not covered in official handbooks which tend to be rather austere. Your selection of grinding wheel is made simpler by the manufacturer of the grinder who will be able to supply specific wheels, but a little background knowledge is no bad thing.

There are three types of grinding wheel that you will be presented with. Let's begin with the white grit wheel, this wheel is made from aluminium oxide and designed for grinding materials such as high speed steel and high carbon steel. The white wheel is the softest of the three that we use and because of this it requires more regular attention. Grinding wheels become glazed over and clogged (like glasspaper) very quickly if not attended to and when in this condition they will overheat the cutter almost as soon as contact is made. "Dressing" the wheel is the way to cure this.

All proprietary makes of cutter grinder have the facility for using a diamond dressing tool, this may come as standard or be an accessory you can buy. It takes different forms, but essentially it is like a large diamond cutter which you pass

across the grinding wheel and which cuts the stone back to a fresh face. There is no saying how often this should be done, but you will prolong the interval if you make sure never to handle the face of the wheel or to lie it face down on the workbench. When you change from silicon grit to diamond wheel, put the other away in a box or a drawer to keep it clean.

White wheels are available in various grits, the coarse end of the scale represented by the smaller numbers. Coarse grit wheels remove more material per pass and generate less heat and are therefore easier to use but by their very nature they will not produce such a fine finish.

The Diamond wheel, as the name implies, is very expensive. It's also extremely effective. The face of the wheel the body of which is aluminium, is coated with industrial diamond dust set in resin, this coating is usually about .100" thick. Most people's reaction when first taking delivery of a wheel like this is "Hey, what a swizz! This wheel won't last five minutes". An understandable but wrong assumption.

The high cost pales into insignificance when you experiennce their speed and efficiency (perhaps one should experience a green wheel first to really appreciate them). The diamond wheel cannot be

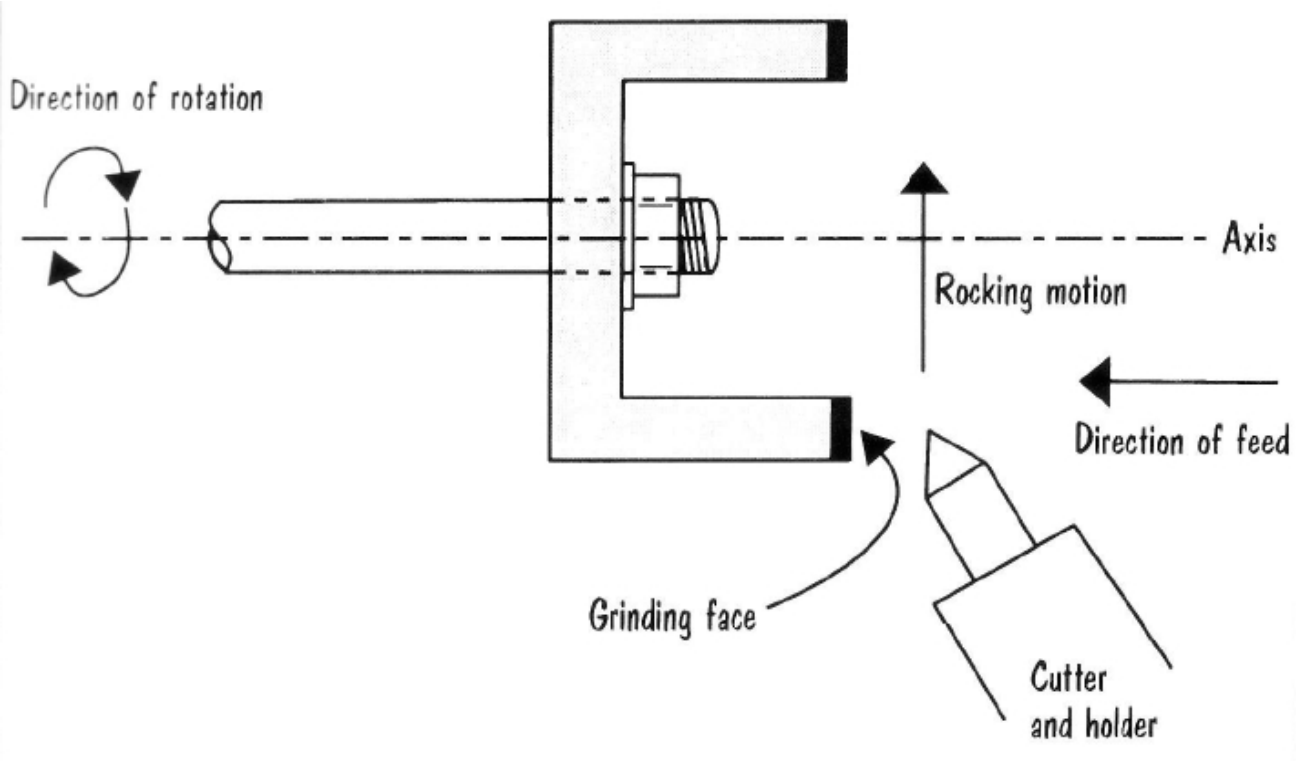


Figure 33 Grinding wheel and cutter

dressed and must be handled in such a way as to avoid unnecessary wear. When removing a lot of metal from your tungsten cutter feed the cutter directly into the face first then rock back and forth, this avoids putting undue wear on the outside corner of the grinding face and will help keep it square longer. Never ever try to grind high speed steel cutters on this stone. High speed steel will clog the very fine grinding surface almost immediately and render it useless. Old diamond wheels can be given a little boost in efficiency from time to time by having their face cleaned up. The best way to do this is to find a piece of plate glass and some fine grinding paste. Take the wheel off the grinder and lay it face downwards on the glass. Using a circular motion and very little pressure rub the grinding paste into the face of the stone, cleaning it off, afterwards with paraffin. Grinding wheels are potentially very dangerous, they're not just lumps of grit, they're sophisticated in their make-up and require proper handling and use. The synthetic abrasives, aluminium oxide and silicon carbide, are generally used in their manufacture. Silicon carbide is used for grinding the hard and brittle materials such as cast iron, and rather strangely some of the very soft materials such as bronze and copper this is just background knowledge however, as we don't have engraving cutters made from these materials. There's another version of silicone carbide that is coloured green and this is used for grinding the cemented carbides (tungsten carbide) these are the not so familiar now, green grit grinding wheels.

Aluminium Oxide is the abrasive used for making wheels to be used for grinding tough materials such as high speed and carbon steel. These "white grit wheels" have a very high rate of surface breakdown (sometimes referred to as their sacrificial rate) and require constant attention with a diamond dresser.

I would certainly not encourage you to make your own cutter grinder although there are plenty of them about, because of the importance of this piece of equipment in the engraving workshop and the fine unseen detail that goes into making one that works well. Should you have inherited such a beast make sure that it turns the grinding wheel at the right number of r.p.m. The speed at which a wheel turns has a profound effect on the way the wheel performs. A wheel will become effectively softer by turning too slowly and effectively harder by spinning too fast. Never use a flat grinding wheel like that found on a bench grinder, because as this wears, the peripheral speed of the wheel will be reduced, and the original calculations if there ever were any, will become meaningless. Proper cutter grinders always use a cup-shaped wheel, where the peripheral speed remains the same regardless of wear.

Thankfully most of these decisions are taken away from us because the manufacturers of engraving cutter grinders have already done their homework, the correct rpm for a grinding wheel will always be marked on it along with codes indicating the type of abrasive and the grit size. The grit size is shown by a number code that goes from eight to eight hundred, the most suitable grit for

grinding engraving cutters would range from about sixty to two hundred, the smaller numbers being the coarser. Those who have little experience of cutter grinding should begin by using the coarser grades of wheel as these are less prone to overheating the cutter and ruining the temper of the steel.

Like a lot of very hard things, a grinding wheel is in fact very fragile in the sense that it's brittle. You should keep your grinding wheels in individual boxes or on a wooden rack designed for the job. Never leave them under a bench where they can be kicked, here they ill also get dirty and clogged. Put them down gently. Occasionally give them a tap with your knuckle, you will be able to hear if they have a crack in them, a grinding wheel that disintegrates in use can be dangerous, especially as in our case the operator has usually got his face very close to the work, always wear safety specs therefore.

Grinding wheels that are mounted on spindles should never be overtightened, they are very unlikely to come loose as the thread on the retaining nut will always be working against the rotation. Always make sure that there is a large washer under the nut and a paper washer under that, to take out the irregularities in the stone, blotting paper was always the favourite material for these washers, and would still take some beating.

I believe that every engraver should have a cutter grinder and that it is impossible to carry on the business of engraving without one. If you are making do with a home-made grinder, we recommend that you relegate it to your home workshop and use it for sharpening your garden tools.

TAKING CARE OF YOUR INVESTMENT

Your engraving machine is probably the most expensive piece of equipment that you possess, looked after properly it will last a lifetime quite literally, and if it is one of the industrial machines it will probably last longer than that. There are a great many of the original Taylor Hobson machines, model C's, *CB's, Ch's* and C\L's still earning a living for their owners up and down the country, especially the later which did not go out of production until the end of the fifties. We will deal with the care and maintenance of pantograph machines, as the computer controlled machines have less in common with each other and are best dealt with individually.

Time should be set apart for maintenance and cleaning, perhaps the last half an hour on Friday afternoons. I realise that life's not like that, but one has to try to get' it right at least in theory! When you go home on Friday cover the machine with a dust cover, there is a tremendous amount of dust in the air and by Monday morning it will have settled on your newly cleaned and oiled machine.

The one component you should never touch is the cutter spindle. Depending on your machine this revolves at between about four and thirty thousand r.p.m. It is

very finely adjusted and with too much grease packed into it there is a danger of overheating and with too little ... well, either way you are in grave danger of damaging it and costing yourself a great deal of money. The only maintenance you should give your spindle is to occasionally remove it from its housing and smear a light film of grease over the quill, the feed screw and feed nut. Return the spindle to the manufacturer at the recommended intervals, some companies have spindles that they will lend you while they overhaul yours.

The pantograph and cutter frame links are the area that will benefit most from regular simple attention. Pantograph joints should have a drop of oil applied to them at regular intervals, if the machine is being used all the time once a week would be a sensible period. There are two schools of thought here, one says that oil attracts dust. The other, and I think this one is right, says use the oilcan liberally. The oil that you put on the pantograph bearings will wash through the joint and help get rid of grit and abrasive dirt that has collected. Afterwards make sure that you wipe any surplus oil off, in fact go back ten minutes later and wipe off any drip that has formed. It will only be the surplus oil that collects the dust. On some later machines the pantograph bearings are sealed and should not need to be touched.

The arms of the pantograph are unprotected steel, some people have what are known as "rusty hands" and a few hours after handling steel there is a rusty fingerprint left behind. For this reason you should wipe the pantograph with a slightly oily rag whenever you think of it, and that should be at least once a day. When oil is left it builds up over a long period into a sort of brown varnish, this in turn obscures the setting marks on the arms. When faced with a pantograph in this condition on no account must you try and get rid of it with anything more abrasive than a Scotchbrite pad and even this should be used only rarely. Best not to let the stain appear in the first place. I once saw someone cleaning an arm with emery cloth.

This will also clean off the setting marks! The Slider Body (the part that clamps the pantograph at the right setting) must also cleaned with great care. The edge of this component which one sets adjacent to the mark on the pantograph must be preserved very carefully, if one wears it away with excessive rubbing down, then every setting you make will be a few thousands of an inch wrong. Over the lifetime of one of these machines a very significant amount of metal can disappear from this area.

The cutter frame and link on early machines (the hinged iron casting that supports the cutter spindle) should be checked for play every few months, this linkage takes the stresses imposed by the cutting action and any play here will cause chatter when taking heavy cuts and distorted letters when making fine cuts. Check this linkage by holding the spindle with both hands and trying to lift it. If there is any play you will be able to feel it as you push upwards. The links on the early machines are pivoted on a part known as the

cutter frame link centre, this is a centre with a male cone ground on the end which locates in a female cone in the iron link itself. If you find wear in a machine of this age the chances are that the centres will have been replaced many times and the wear will probably now being the link itself, which will have to be replaced. Some machines have a shaft as a hinge pin and a female centre ground into each end of this which locates with a male phosphor bronze cone, this is a better arrangement because when wear occurs there are smaller less expensive parts to be replaced. At the top of this shaft in the iron casting you will find a small grub screw, this is a greasing point. Every week give the screw half a turn, when it reaches the bottom of the thread. remove it and replenish the grease. Sometimes when oval wear has occurred in these areas it manifests itself as an apparent fault in the ,worktable, by causing the cutter to cut deeper at one end of the table than the ether.

Your work table should be kept clean and free from oil stains and rust by treating it the same way as the pantograph, with an oily but clean cloth. Check the table slides for wear by taking hold of each end of the work table and trying to tilt it and pivot it. If any play is apparent, the gib strips probably require adjusting. The gib strip is the piece of metal in the slide between the main casting and the dovetail of the work table. You will notice that this is adjustable. The arrangement for this is fairly obvious when studied. The table should wind in each direction for its full travel without any stiff areas, if you cannot find a compromise between having a stiff area (high spot) and the table having noticeable play in it, then the assembly needs to be looked at by a qualified service engineer. The work table is moved by a lead screw and lead screw nut located underneath it, the life of these components will be considerably increased if the lead screw is kept free of abrasive swarf. On later machines these screws are protected by bellows or sliding covers, but the on the older ones they are exposed. An air line is ideal for cleaning off excess swarf, but if you do not have one of these a redundant tooth brush is ideal. Follow this up by liberal oiling, once again wiping off the excess. The lead screw nut will need replacing long before the screw itself which might never need to be replaced. Replacement bronze and acetal nuts are available, the later being considerably cheaper. Before taking on the job of replacing this nut think it through and read your machine manual, you might well feel it wise to call in someone to fit it for you.

Pulley systems that have had a lot of wear sometimes develop sharp edges on the wheels. These are not only dangerous but can wear out drive belts at a tremendous rate. Check for these and if you find any remove them with coarse emery cloth or a file. The Jockey Wheels, the wheels that guide the driving belt, require very little attention. On some machines these require oil on the bearings and some grease, for your own sake do not be over zealous with the grease gun because they will throw it back at you, splattering grease or oil on ceiling floor and you!

The more lightweight engravers used in the trophy trade to a large extent, require much the same attention. Most of these machines have cast aluminium pantographs which also support the cutter spindle, and which "float", by that I mean they are not fixed in one plane as on the industrial machines. These pantographs because they are made of cast aluminium are in danger of picking up bits of abrasive grit, a careful check must be made to seen that they are free of swarf and that nothing is embedded in them. Do not clean these pantograph arms with anything but a lightly oiled cloth.

The spindles on these machines are easier to service and are not packed with grease, however my advice still applies and I would advise sending them back to the supplier when new bearings are required. The depth regulating nose cone fitted to these machines must be kept very carefully, any slight blemish on the surface will scratch the surface being engraved. These cones are made from very hard steel and highly polished. A mechanical buff if you have one, is perfect for restoring their finish, but if this is not available, and your cone is scratched replace it. There are nylon nose cones available and a lot of people buy them under the false impression that because they are soft, they will not scratch. This is simply not so. The soft material picks up swarf and that does the scratching. While on the subject of spindles, there is one other recommendation that I would make as regards the spindles on the industrial machines. Always make sure that the taper, both the male and female halves are kept clean and free from abrasive swarf. This applies to collet and taper shank cutter spindles, although on the later the cutter will simply not stay in if there is any grit present, these parts are ground to very fine tolerances and if they are damaged, at worst the spindle will have to be replaced and at the very least it will cause the cutter to run off centre.

Trophy and bench top engravers do not have work tables, but have a vice instead, these are mounted on sideways that are equipped with gib strips and fully adjustable. The same criteria apply to the adjustment of these as with the work tables on the larger machines. These vices stand on steel columns, make sure that they are kept lightly oiled and free from "rusty hands". A great many of these machines are supplied with dust covers, these should be used, dust is always abrasive to a greater or lesser extent.

Once or twice in a year you should have your engraver checked over by a service engineer who specialises in these machines. We have covered the points that you need to attend to in order to keep your machine running smoothly and efficiently. But parts do wear out eventually and when they do have to be replaced then there are usually other adjustments to be made, that are associated with it. This guide to looking, after your engraving machine is in no way intended to be a service manual but if you follow these few guidelines your machine will give you long and trouble-free services.

I refer to industrial engraving machines, as an investment; they are, lasting as we say several lifetimes. For this reason I have felt justified in mentioning one or two pieces of equipment which are no longer made, in particular those manufactured by Precision Grinding who made the Alexander range of engraving machines until recently. Items such as their Rotary Engraving Attachment and Cutter Microscope can still be bought from companies who specialise in this type of engraving equipment and from machine tool merchants generally.

IN CONCLUSION - AND NOW TO ENGRAVE

GETTING COMFORTABLE

Let's now assume that you have decided upon and bought an engraving machine and you now know how to grind your cutters. Relax and try to engrave something, anything, we'll forget about the complexities of which kind of cutter and which material or the hazards of making templates, these things have been covered in the manual and you can learn about them and go back to them as and when you need to. For the moment engrave anything just to get going.

Whether you are using a bench top or a floor standing engraving machine, it is essential to be comfortable. Give your comfort proper thought, don't just sit down and say "Yes, that's fine". Is your back straight? Stooping for long periods will soon take its toll, when you're concentrating you tend to forget you are in an uncomfortable position. An adjustable typists' chair is the best, as these have adjustable height and back supports. If you set the chair slightly lower than you first thought, you will find that you have to keep your back straight. A very slight reach upwards is better than a stoop.

LIGHTING

Is there enough light? It's best to have the machine positioned near light from a window, in front of the line of your shoulders not behind you, natural light is a hundred times better than electric light, you will obviously require a machine lamp as well and it's worth considering buying lamps which are colour corrected, these are more expensive but much easier on the eye, and worth it. When pondering on a purchase like a lamp or a chair you should remind yourself just how much of your life you are going to be spending working at your machine. This is not an area for economies. While on the subject of you, the engraver, as opposed to the machine, I would consider it wise to wear a pair of spectacles to protect your eyes. You can buy specs with plain glass or plastic in the lenses if you do not need an optician's prescription.

EYE PROTECTION

I say spectacles because no one I know would make a habit of wearing goggles which anyway would be an overkill for use with an engraving machine (except perhaps when you are milling or profiling and there is an exceptional amount of swarf about) and are uncomfortable for everyday wear. Every engraving machine throws out swarf, even those with dust extraction systems and the natural tendency is to peer at what you are doing. Twice during my period as a practical engraver I have found myself in the outpatients department of the local hospital with "engravers' eye". I sometimes feel that we have all gone a bit over the top with safety regulations, which now govern every aspect of our lives and statements like "what price your eyesight?" and suggestions that you don't value your child's

life if you don't buy a certain kind of car seat are all forms of emotional blackmail with unlimited potential for the salesmen. One has to be practical.

Talking of being practical, if you wrap a small piece of masking tape around your cutter so that it juts out like a flag, it will keep the area immediately under your cutter completely free of swarf and save you stopping to brush away debris to see what you are doing. However only fit this fan if you are wearing eye protection as obviously the swarf is being thrown out and is potentially dangerous.

SLIPS

Recently I watched a new and rather nervous engraver, nervous possibly because she was being watched, struggling with a pantograph. It looked as though the pantograph was stiff to move and indeed it was. The problem, it transpired, was caused not because the bearings required attention, or because the machine was old and neglected, but was simply the result of the stylus pressing very hard on the copy. Set deliberately like this, in the belief that it would prevent slips occurring because it actually had to be lifted with some effort out of the groove before it could be moved to the next letter. This is a matter which only concerns users of industrial engraving machines or those with pantographs fixed in one plane, which have their stylus clamped rigidly in the end, the pantograph arm. Machines like those manufactured by Taylor Hobson, Newing-Hall, Alexander and Kuhlmann.

It's commonly felt among inexperienced engravers that if you set the stylus hard against the master and even flex the pantograph upwards before clamping it, so that it gives positive downwards pressure, it will automatically be less inclined to slip out of the letter. Not so. An operator using a pantograph this way will find that when the stylus comes to a junction in a letter (a change of direction) he or she is tempted to press harder to make it move past the resistance that this offers. The certain result of this is a slip out of the copy.

The copy stylus should be set so that it only just touches the master, the weight of your hand will be all that is required to keep the point in the groove, while you are engraving. Another good reason for not letting the stylus bear too heavily on the copy, is that it will wear it out. Nylon and phenolic copy requires cherishing as it wears so much more quickly than brass.

Now here comes the hardest part to get used to. Train yourself not to look at the copy, but at the workpiece (the object being engraved) with the stylus just touching the master (copy). It will be much easier to feel your way around the letter, the areas where resistance is met will be clearly defined and you will be able to tell exactly the point you have arrived at, by looking at the work. Don't lift your forearm off the copy table any more than you have to, make as many movements as possible with your wrist and fingers. When your arm is lifted from the table you have much less control and the danger of slipping is increased tenfold.

WORK METHODS

The reason I advise you to look at the engraving and not the stylus is easy. This is the end of the operation that matters, if you are cutting too deep or not at all, you need to know instantly. If the point has been knocked off the cutter or it is throwing up a burr, you need to know instantly. Looking at the work you are engraving, your brain will soon relate your hand movements to the pattern being engraved and despite the fact that on most industrial machines these are movements in the opposite direction, you soon forget this and know instinctively which way to move. Don t dismiss this as being unnecessarily difficult. Watch an experienced engraver and you will see that he looks at the work he is doing most of the time and not the copy table. The sooner you can train yourself to do this the better.

These points noted, you are now sitting at your machine (this description applies to an industrial pedestal-type machine). Make sure the work table is wound downwards away from the cutter and there is no danger of damaging the workpiece, then switch on the engraver. Next place the stylus into the copy, it must be in an area that is going to be engraved, not between, above or below the lettering. Now with your right hand on the stylus, wind (or lever) the cutter to the downward extremity of its travel with your left hand. With your left hand start to wind the work table upwards and as it approaches the cutter start to move the stylus back and forwards over the part of the copy it's located in. As the workpiece approaches the cutter, which is being moved gently, wind the table upwards more slowly, extremely slowly in fact as the cutter breaks the surface of the material. Because you are moving the cutter you will immediately be able to see the depth and width of cut that you are making (if you held it still you would only have a dot to look at). When this looks right for the height of the letter raise the cutter using the lever or the screw feed.

On a small pantograph machine where the cutter depth is controlled by a depth regulating nose cone set the cutter well up into the cone so that it does not touch the workpiece, then turning the cone a few clicks at a tune lower the cutter onto the work until you find it is cutting to the right depth. You might find it preferable to have a piece of scrap handy and experiment on that before moving on to the actual object you are planning to engrave.

By starting to engrave a job this way, you have guaranteed you are not going to plunge the cutter too deep into the work, because it was already at its maximum depth and you have established the correct depth and width of cut on the first letter. Cutting too deep because the cutter was incorrectly set is a common error.

Having arrived at this point remove the Z axis handwheel (work table up and down). In most cases they are on a square drive and just slide off. This done, the cutter will not be able to go beyond the correct depth as it was at its maximum

downward point when the table was raised to meet it. Without the handwheel no passer-by or casual fiddler with machines will be able to alter this situation.

ESTABLISHING A PATTERN

Now in your own time start to engrave. Begin by placing the stylus in a letter and moving it about, as you do this lower the cutter into the material and ease the stylus on its journey around the letter, trying not to look at the stylus follow the letter making sure it is fully engraved and the cutter has removed all the swarf, you will probably find yourself making two or three circuits of the letter. This done, raise the cutter and then move the stylus to the next letter. Always in this order. Remove cutter from work then move stylus, otherwise it will be a case of "look at my joined up writing" and capital letters don't look very impressive when joined up by squiggles!

PRACTICE

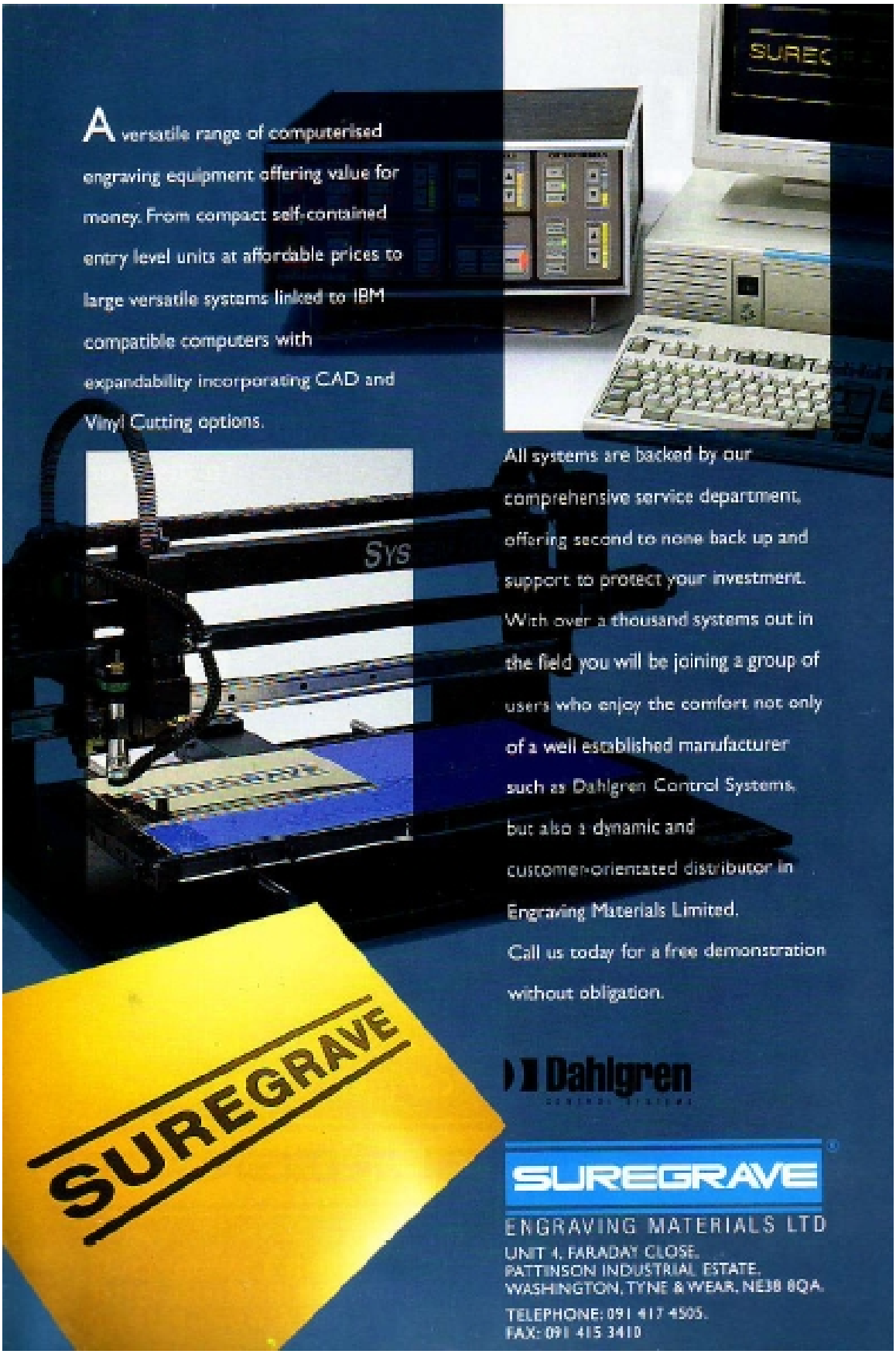
I recommend you practice engraving the simplest things over and over again, make nameplates for the office doors, your children's bedrooms, toolboxes, lunch boxes and lavatory doors, anything you can think of, before you launch yourself at an unsuspecting customer. So remember these points, reset that stylus so that it barely touches the master, watch the work not the master, make sure the copy is lightly oiled, keep your forearm on the copy table and I guarantee you will slip only rarely.

Not to slip must of course be every engraver's ambition and to feel confident when tackling an engraving job is half the battle, some beginners get very nervous of making a mistake and this in itself leads to the likelihood of a mistake being made.

Whether you are using an industrial machine or a trophy machine you must make sure that the cutter is in its safest position (inside the nose cone or wound down fully if no cone is being used) before you position the stylus and wind up the work table to meet it and you must always, whatever kind of machine you have, make sure that the stylus is in the copy before you let the cutter near the work surface.

It matters not, if engraving is your hobby, your business or just a small part of a production line in which you are involved. You will find the pantograph engraving machine an endless source of fascination and interest and the longer you are associated with it the more indispensable it will become.

VENDERS AND RESOURCES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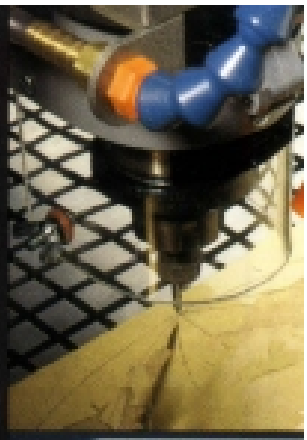

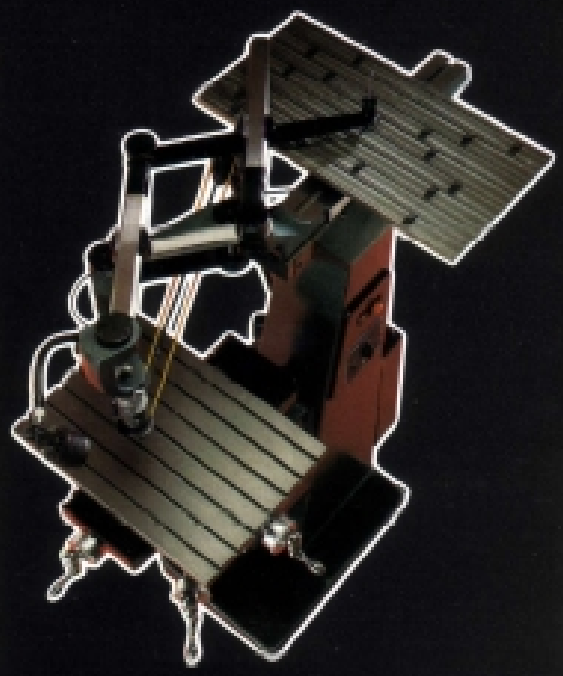

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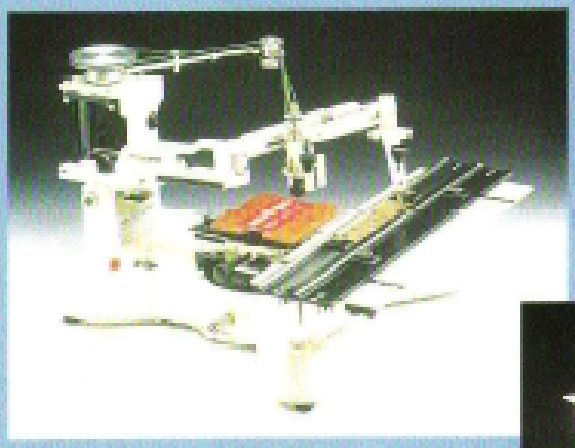

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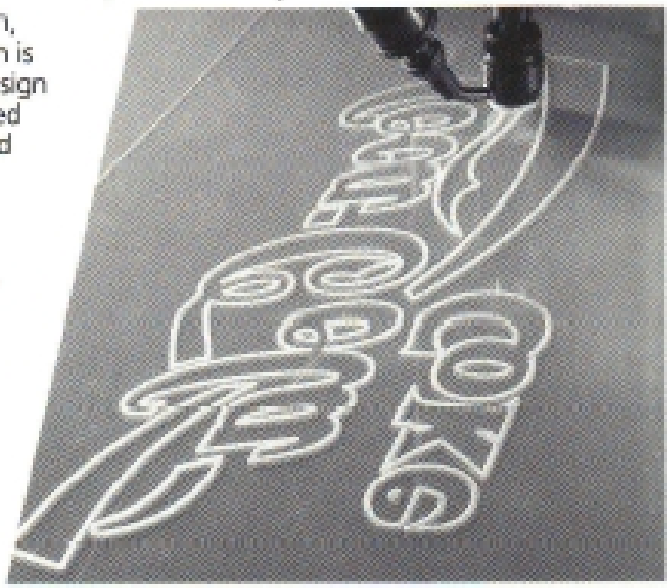

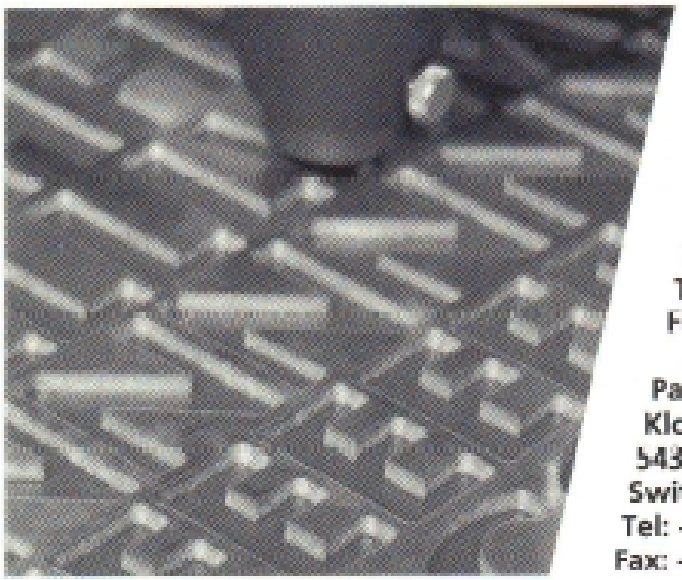

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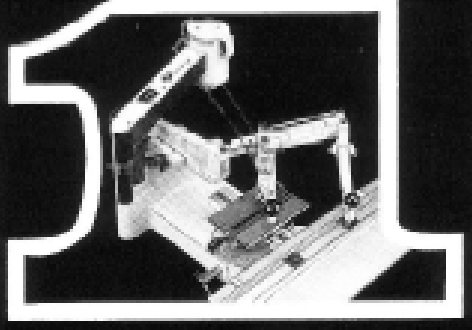

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