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MODEL ENGINEERS' WORKSHOP

Issue No. 82

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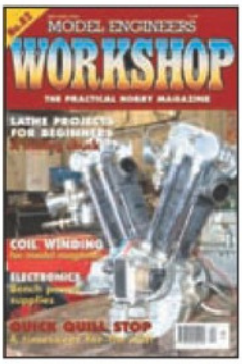
May/June 2002

Paul Boothby has redesigned the Myford Quadrant Arm to permit easy swapping of changewheels (see page 38)



Front Cover

Lee Dove's JAP vee twin engine about to be reunited with a racing Morgan three wheeler (see page 28)

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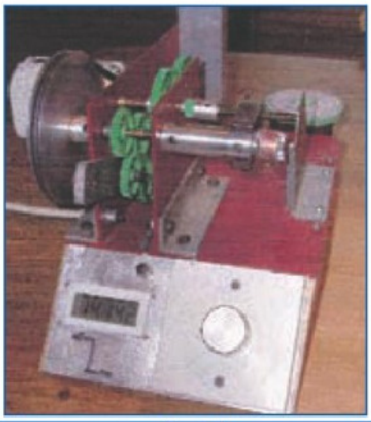

Inside

To produce miniature magnetos, Brian Perkins had to develop this coil winding machine (see page 42)

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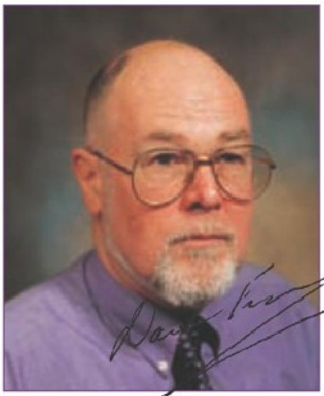

ON THE EDITOR'S BENCH

Small Scale Train Spotting

One notable excuse for a day out recently was the "Model Rail Scotland 2002 " Exhibition at the SECC, Glasgow. While within Scotland, there are a number of Model Engineering Societies some of which do, on occasion, host local exhibitions, there is nothing from a purely ME point of view, to rival the major southern events such as those at Sandown Park, Wembley, Harrogate, Guildford, or Donington. North of the border, a number of model rail shows are traditionally noted in the calendar, such as those at Glasgow, Cupar, and Dundee, and at these it is usual to find a significant Model Engineering, and Live Steam content. The majority of exhibits are of course small scale electric layouts (Z, N, OO, and O gauges) with the rolling stock usually being commercially sourced. While seasoned model engineers may frequently look down their noses at this "watch making" area of the hobby, one must nevertheless give credit to the attention to scenic detail and to the use of electronic and computer technology in both lighting effects and train control.

I was accompanied on the excursion by my brother-in-law, John, who is a keen fisherman. One layout shown by Ian McCready was based on the station and village of Blair Atholl. Seeing this, John immediately exclaimed "Now there used to be a wee shop behind the hotel where we would buy fishing tackle, I bet it's not there!" Guess what – it was. Another exhibit which required long term study to fully appreciate the intricacies was the alpine railway scene prepared by the Euroswiss Group, complete with funicular. Larger scale enthusiasts too were not disappointed. The display assembled by the Model Engineering Society (Motherwell) included a number of superbly built locomotives and traction engines in various scales.

Back in the Workshop

Personal workshop activities over the last few weeks have included becoming reacquainted with a Myford Seven. When I was initially introduced to the ME fraternity in the 1970's, one of the first acquisitions was a well used ML7. Involvement in seven and a quarter gauge encouraged a move up in size to a Colchester Bantam, which gave way latterly to a Chipmaster (Higher spindle speed, bigger bore, and more threads). Bearing in mind the continuing popularity of the Myford, and that as editor I should perhaps be able to speak on related matters from a position of current factual experience rather than fond memory, it seemed sensible not to pass up the opportunity to acquire an ex college machine which became available locally. There is also the question of having one eye to the future, when the workshop of my dotage will be a good deal smaller. As with many machines which have spent time in an educational environment, the problems were those of mild abuse and lack of use, rather than heavy usage and wear. Points immediately noted were damaged teeth on tufnol gears, and heavily chipped paintwork. The gears were replaced, and the paint ignored. It was also thought sensible to make provision for a coolant system, and so a drip tray was knocked up and fitted along with a pair of raising blocks cut from a length of one and a half inch square steel.

I shall now have to embark on a process of re-learning many forgotten techniques to gain best advantage of the versatility offered by the Myford's features, notably the Tee slotted cross slide and the provision for spindle dividing.

Stealth Tax May be Good News for Workshops

General concern over global warming has prompted a number of government measures, one of which is the Climate Change Levy, which in effect raises the cost of electricity to industrial and public sector consumers. Tax breaks are also available in relation to energy saving investment. As around two thirds of all electricity supplied to industry is used to power electric motors, it comes as no surprise that this is an area where higher efficiencies are being sought. In a typical industrial installation, a motor may consume over its life electricity worth around 200 times the original capital cost. The result is that the major manufacturers have introduced new ranges of motors for which the efficiency is pushed up to about 90% against a traditional 85%. For the amateur workshop, power usage and efficiency may not be uppermost in our minds. The cost is not dramatic, and any losses merely contribute to workshop heating. What may be of greater interest however is that in tandem with the advances in motor technology are the efforts to improve and popularise variable speed inverter drives. (An article by Peter Dawes in this issue recounts his experiences of these) This seems already to be feeding through as a stabilisation or even reduction in cost, allied with more advanced features. From a personal point of view, it now seems inevitable that when I do get around to overhauling the Chipmaster, the mechanical speed variator will be replaced by an inverter drive giving the same extent of speed control, but more quietly.

Readers Response

My thanks to the various readers who sent in their Quick Tips. Others will always be welcome. Scribe a Line in this issue features letters in support of the suggestion for a new exhibition category. It seems that the formula which I think was first proposed by Eric Offen is finding favour, most probably as a loan category. For this an exhibit would comprise of firstly a finished part, and secondly the tooling required for its manufacture. The absence of competition pressure might encourage more to exhibit their examples of ingenuity, simplicity and effectiveness.

Corrections

Issue 77

Readers building the self centreing vice featured in issue 77 will have found some difficulty in assembling the components. The problem stems from the dimensions given for item 5, where lower section of the jaw,(which houses the nut) shown as the overall 38mm dimension should be reduced to 29mm, being cut back at the rear of the jaw. Similarly, item 6 should have its cylindrical length shown as 25mm reduced to 21mm

Issue 80

My apologies for the gremlins which came home to roost in the proof reading of the data tables accompanying Philip Amos' article "Measuring Hardness". In Appendix 1, Right hand column, halves have become dashes in lines 4,5,and 7. e.g. 2-2 ?. In Appendix 3, The section under Cast Steel should read Hi Alloy-greater than 5%. The figures 300-600 given for Glass, Crocus in Appendix 4 should appear in the Vickers column, and finally, the six figures listed in Table 1, at the end of columns 2 and 3, should be located in columns 3 and 4. My thanks to Philip for pointing this out.

Forward Planning

This issue of MEW will be published just in time for the model engineering exhibition at Harrogate (10th to 12th May) which I and staff from Model Engineer will be attending. This will be a welcome opportunity to meet readers, contributors, and trade personalities. Looking further ahead, in response to readers' enquiries, the exhibition at Guildford will take place on July 20th to 21st..

MEW Indexes

As the computer becomes ever more popular, more information is available on the internet. The site run by Colin Usher contains MEW related information, and is expected to develop an index feature for recent issues:
http.//members.lycos.co.uk/Livesteam/index.htm

In addition, the update for the DOS based index from CAHW is now available, (see Trade Counter) The full index covers issues 1 to 80, and the update information will be given in issue 83.

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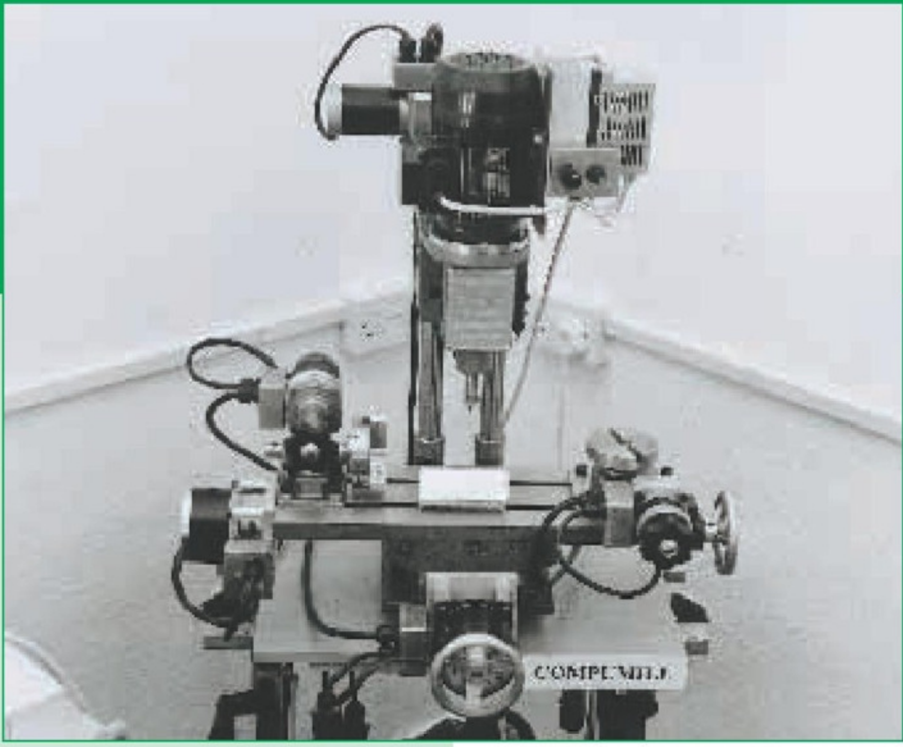


Richard Bartlett continues his description of a budget self build mill, which may be constructed with different levels of sophistication from completely manual to totally CNC.

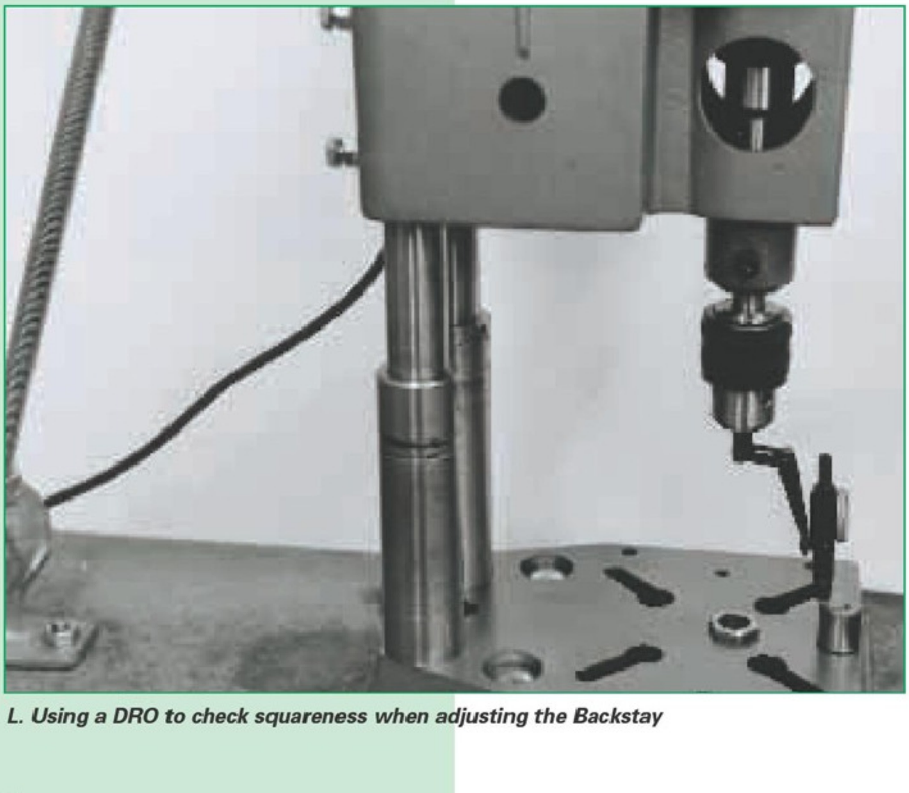
In the previous article we covered the Base, the Bed, the Columns, and made a start on the Vertical Feed. We now continue with work on this aspect of the assembly.

Vertical Feed

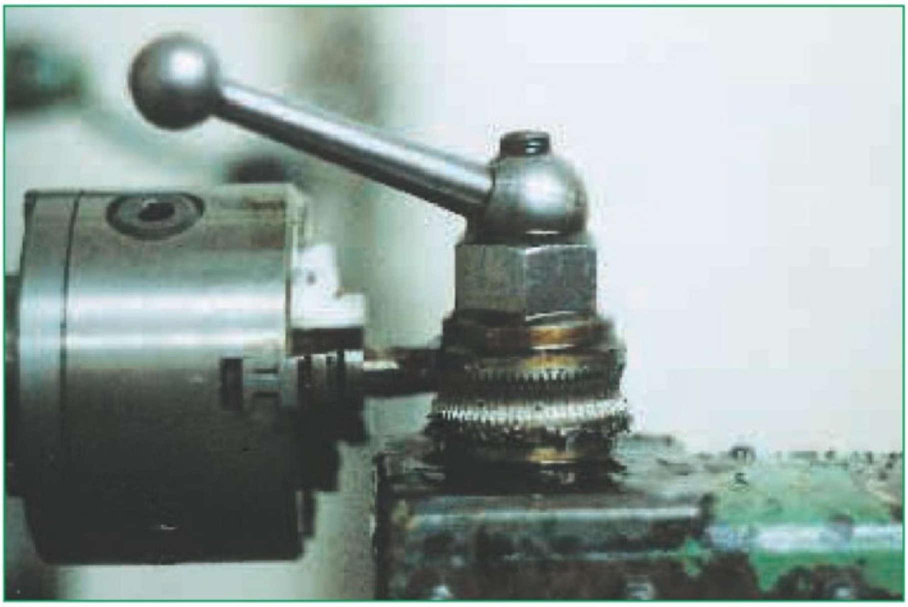
The vertical axis leadscrew thrust plate is also the top brace for the vertical columns, which are tapped M10. By drilling the brace 11mm the columns can be aligned with the bushes in the head casting when the head is right up, and then the brace is tightened. The thrust plate is reamed 19mm for the pair of lipped 10mm bore ball races that form the thrust bearing. The photo K in the previous article shows the power feed assembly in position.

Make the thrust plate which is 13mm (½inch) by 75mm wide (3inch) Alum. alloy stock cut to 190mm long (**Drawing 6**). Even if you are not going to fit the d.c. power feed at this time, it is worth considering boring for the wormwheel gearbox and drilling for the three screws to fix it to the thrust plate. Drill and tap two holes in the end of the thrust plate for a switch box for the power feeder, see photo. Similarly, if you have elected not to fit a backstay it is worth 'hedging the bet' and tapping the thrust plate for the upper backstay mounting allowing a change of mind with least dismantling of the machine, two M6 holes on 50mm centres will do this job. The Boring mill prototype has a 10tpi leadscrew carried on a pair of lipped bearings 10mm bore and 19mm od. These bearings sandwich the alloy thrust plate to take the thrust. The handwheel is a 100T involute form gear which when the idler is slipped down into 'drive' position takes the drive from a 9T pinion on the wormwheel output through the 60T plastics idler to the 100T gear on the leadscrew. The gearing is module 1. The gear wheel is tapped for two handles allowing it its use as a handwheel, and also by using the gear teeth and a fixed index we have a 'graduated' scale of 1/100th turn or 1/1000th inch Z-axis travel. The Buehler 12v dc motors from Proops fit the small worm and wheel gearboxes made by Parvalux as though they were made for each other. This ratio of gearing allows the small dc motor to wind the heavy cutter head up and down very smoothly if a little slowly for initial positioning. For faster movement, the idler gear is raised on its shaft disengaging the drive and allowing the leadscrew to be wound directly giving ten revs to the inch using the handles on the gearwheel.

The position of the idler gear in the power feed train is made adjustable by Loctiting its 8mm shaft into a 1/2 thick rectangular block. Drill and counterbore the M6 fixing holes in the block, then on final assembly of the power feed locate the block to give good mesh between both wheel and pinion. Mark through and tap the thrust plate at this position. Give 1mm clearance on the screw and counterbore to allow adjustment of the gear engagement. If a DRO is required drill and tap an M4 thread in the other (lefthand) end of the thrust plate to take the unit. The anchor for the upper end of the backstay is a standard 16mm clevis screwed onto the stay. The fork-end of the clevis fits over a fabricated TEE piece bolted to the vertical thrust plate. The base of the TEE is 10mm by 30mm mild steel by 80 long, fixed to be



L. Using a DRO to check squareness when adjusting the Backstay



M. Hobbing a Wormwheel in the Lathe

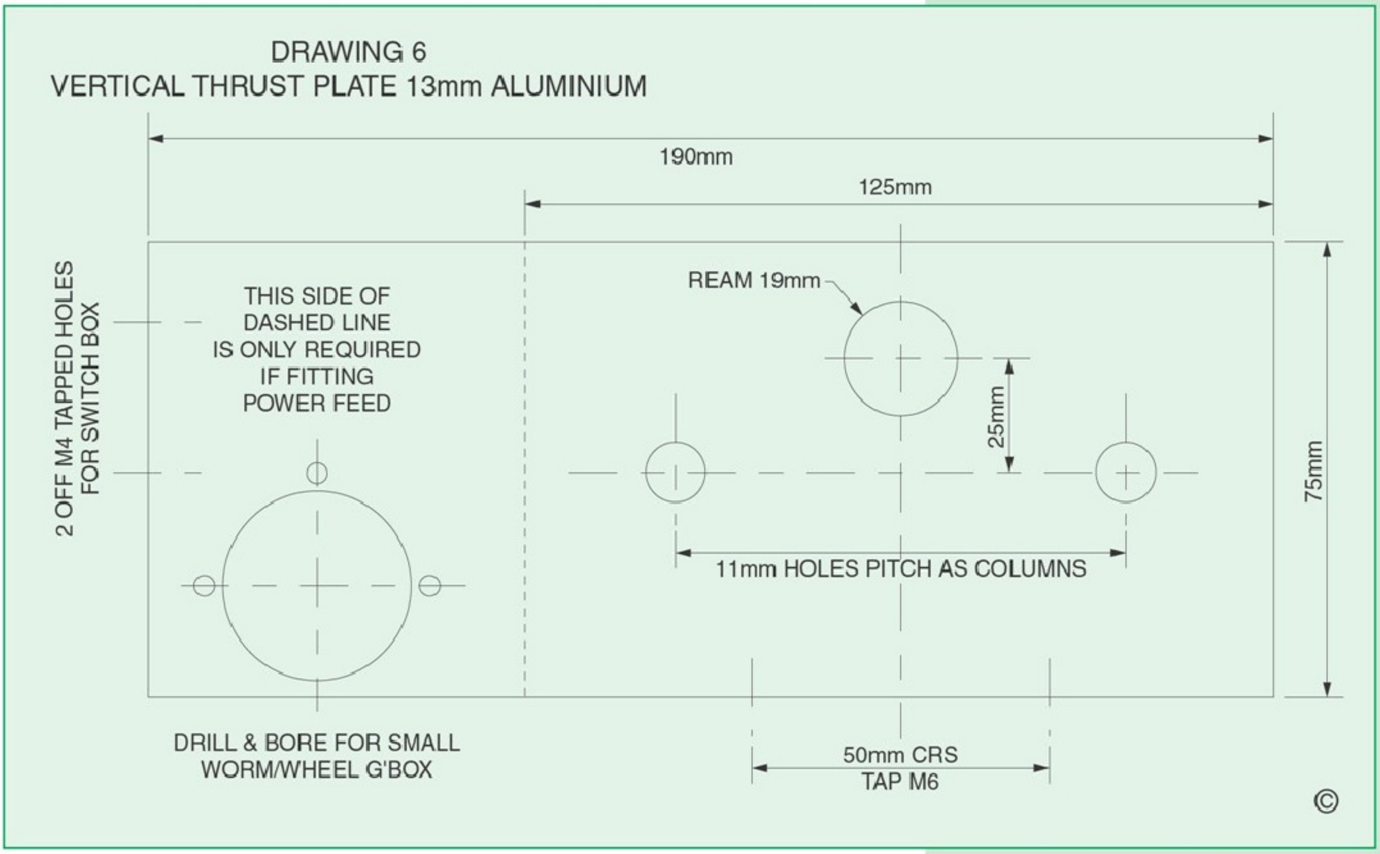
N. Gearbox and power pack for longitudinal feed.

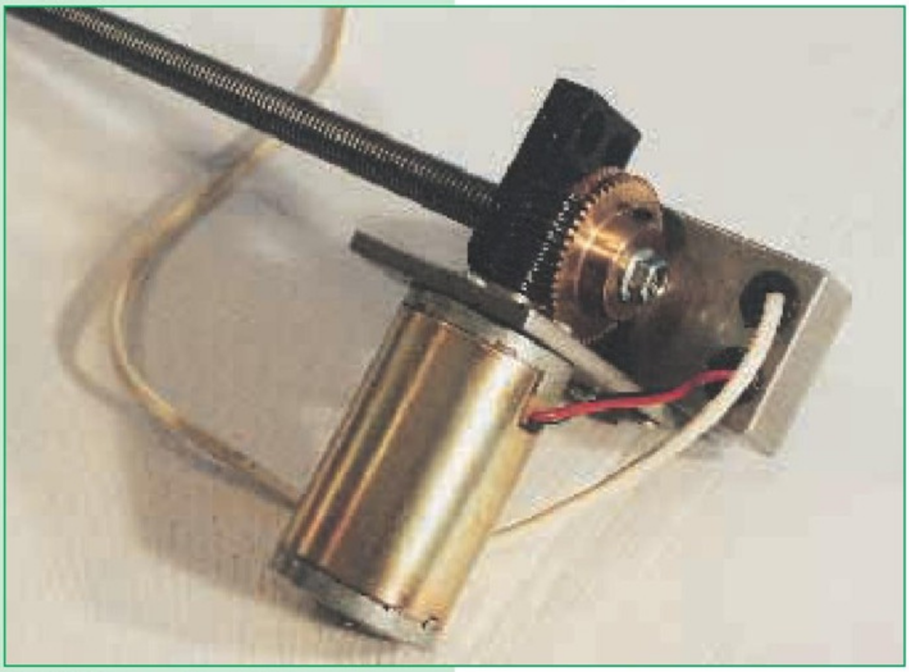
flush with the upper side of the thrust plate. The TEE leg is 50mm diameter mild steel bar, faced to a length which is a snug fit in the clevis jaws. A flat on the diameter locates on the base and is tapped M8 to take a cap head screw sitting in a counter bore in the base. Assembling the backstay at its upper end will allow the position at which the stay must enter the lower scaffold fitting to be marked. Drill the fitting 16.5mm and use two washers and nuts to lock in place. The inner of these washers is special, in that it must be thick enough to take to the 25mm inner radius without distortion which would lock it to the nut. 30mm by 10mm by 40mm long in mild steel forms a neat bridge within the fitting, allowing very fine adjustment of machine spindle to bed plate squareness.

See photo L for method of adjustment, the clock is carried at as large a radius as can be located on the bed plate. A roller is used to reference the clock reading at each cardinal point. When the clock reads zero at each cardinal point then the spindle is square to the table. That's the Vertical feed done.

X/Y Table Feeds

You may, of course choose to use the manual X/Y handles exactly as supplied. If, on the other hand you aspire to power feed, then a similar small dc motor can be used with either a DIY or proprietary worm gearbox. The DIY worm and wheel gearing is a bit of fun and the **Photo M** show how the wheel can be 'sort of' hobbed in the lathe using an end mill for relieving the wheel metal on the centre line of the wheel and a tap to cut the teeth on the shoulders of the relief, these are used alternately until the required depth of engagement is reached. This type of procedure was also covered in detail in a recent article by Bill Morris (MEW Issue 78) Anyway, the finished article works well enough, although it is so exposed to swarf that a sheet metal cover is essential, this cover fixes to the tapped holes in the switch box. The worm is screwcut to the size of the tap used as the hob in this case M12. The power feed is fitted to the left





O. D.C. Motor and proprietary gears.

hand end of the machine, and, as I am right handed the original handwheel is conveniently retained at the right hand end. The power feed motor is mounted to a 10mm alloy or 6mm steel plate which pivots on an M10 stud tapped into the bottom of the left hand thrust casting. A flat is filed onto this lower surface to locate the power feed plate square to the leadscrew. **Photo N** shows the completed DIY unit on the mill. **Photo O** shows another completed unit using proprietary gears.

The original intention was to dis-engage the power feed to enter the manual mode by pivoting the alloy plate on its stud mounting until mesh was cleared then lock the stub. The drawback here is due to the time it takes to set the correct engagement each time the gears are engaged, in practice undoing the socket head grub screw that locks the wormwheel to the shaft is much more convenient. This screw must be removed completely, and when re-engaging power feed care must be taken to locate the dog of the screw into the keyway and tighten without rotating the shaft to avoid bruising the 10mm diameter. This way the worm and wheel stay in adjusted mesh. No doubt others will come up with alternative designs for this.

Note, with regard to the torque reaction tending to force a worm out of mesh with its wheel and bend the worm shaft, the Parvalux worm/wheel gearboxes allow a bush to be fitted internally which can centralise an adaptor you have fitted to the outboard end of the worm. This prevents bending of the 6mm motor shaft.

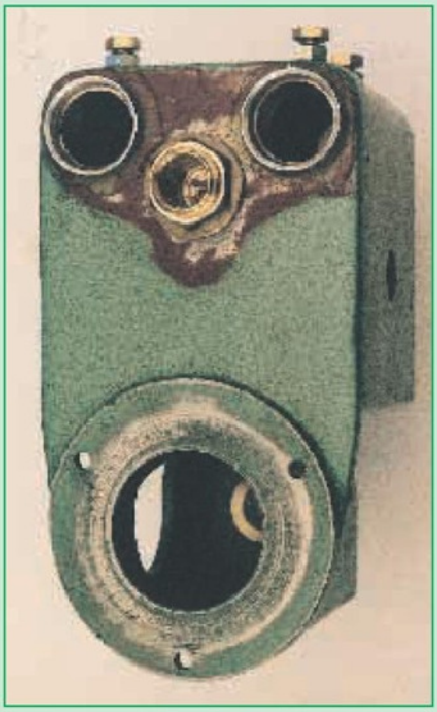
The power to both dc motors also comes from Proops as their drill speed controller, the machine mounted DPDT centre-off switches being wired for Left-off-Right on the X-axis and Up-off-Down on the Z-axis. That's the XY motion done.

Column Bushes

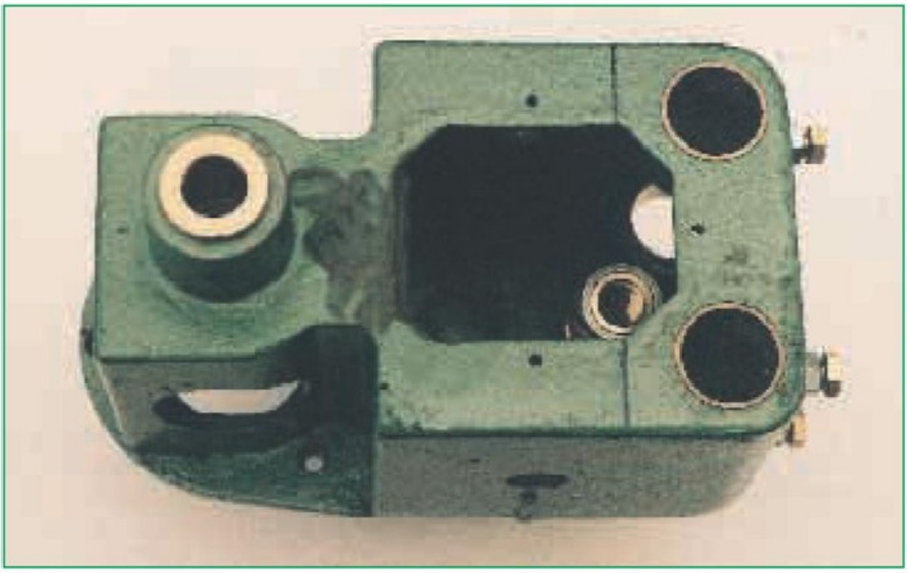
For occasional, light, manual duty it would be satisfactory to use what you've paid for and keep the original bushes in the cutter head casting. Do keep the columns greased, and do not over tighten the bush adjustment screws, there must always be some small amount of clearance on the columns. Failure to observe this rule, and a steel-on-steel bearing could lead to scuffing of the ground column surface. For a more durable setup, I removed the sintered steel bushes from the cutter head and scraped out all the green hammer finish paint that seems to be used as Loctite. Replacements may be turned from oilite bushes or leaded bronze or phosphor bronze bar to give a closer fit on the columns, and give improved wear resistance. Before fitting the new bushes to the cutter head, drill and tap four M8 holes from the rear of the casting, one in the centre of each bush housing. The 20mm long M8 bolts which enter these holes will press on to the thin walled bush causing it to close onto the column. This action will be an adjustment for the upper bushes and additionally will be used as a cutter head lock by tightening the lower bushes. File a gentle convex radius on to the ends of the four bolts and fit M8 washer face nuts for locking. Fit the new bushes with high strength retainer and locate each pair of bushes by sliding the column into the head for alignment while the Loctite cures.

Lubrication is required for the bush/column movements, and this is made easier if generously countersunk collars are fitted over the columns and bonded with epoxy resin to the top of the cutter casting. Make sure the resin does not run under the collar and lock the head to the columns by filing the paint off the top of the casting and providing a flat location for the lubrication rings. These rings can be turned from 40mm diameter alum. alloy and should be 6mm high with a 5mm by 45 degree countersink.

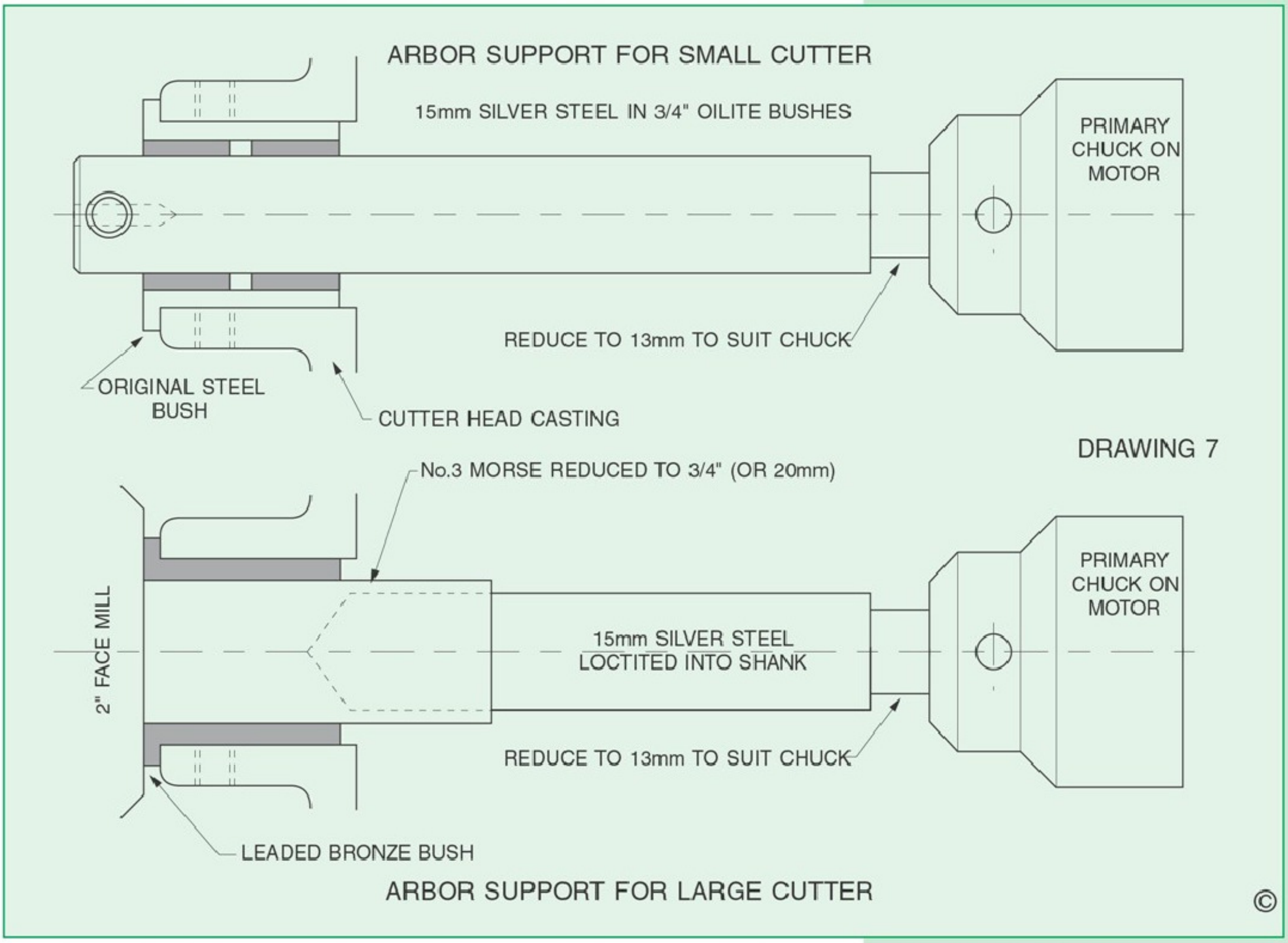
The filing flat of the casting helps when marking out the centre for the vertical nut assembly. This centre is found by assembling the head onto the columns and fitting the vertical thrust plate. Project



P. Top view of Head casting showing nut, bushes, and oil retainers.



Q. Bottom view of Head. The arbor bush, and column adjustment bolts are clearly visible.



through the 19mm leadscrew bearing housing onto the head casting to fix the centre. A piece of 3/4 bar turned to a 60 degree point and polished to fit the housing will dot this centre point easily.

As mentioned earlier, there are several combinations of nut(s) and methods of locating the nut housings to the head casting, each having it's pros & cons. This description will follow the typical Manual machine with a single trapezoidal form 16mm dia. by 4mm pitch nut housed in a 22mm compression plumbing fitting assembled from within the head casting. See **photos P & Q** for top and bottom views respectively.

The vertical nut housing must be firmly located in the head casting and in line with the leadscrew. The accuracy of the internal faces of the cutter head casting cannot be relied upon, so we can tap the casting or bond the housing onto a seat of epoxy putty whilst it is aligned by the leadscrew. If your drilling machine is large enough to accommodate the head casting bolted to an angle plate then drill and tap the fixing hole for the nut housing ¾ BSP. A 22mm fitting with a ¾ BSP male taper will lock into this thread and provide good location. Most Compumill builders will have neither the drill nor the taps, so the bonding method is appropriate. Drill the head casting to suit the pilot of a 26mm tank cutter and cut the 26mm dia hole. It will be found that this grey iron cuts very easily. The nut will be carried in a 22mm tank fitting which is a 22mm compression fitting and a length of ¾ BSP male thread supplied with a large backnut.

The bronze or polyacetyl nut is turned to 25mm diameter and chamfered externally from each end to appear as a short length of 22mm pipe with an olive in the middle. This is locked into the compression fitting just as in a plumbing application. File or grind the paint away to approx 1cm from the hole in the inside of the casting.

Assemble the NM2 bed with its columns, slide on the cutter head and fit the thrust plate. Make a trial assembly of the vertical screw and nut housing, and once the assembly looks OK then remove the thrust plate bolts, wind out the vertical lead screw and remove the vertical nut housing from below the head casting. Using epoxy or polyester putty (Miliput or Plastic Padding types work well) put a generous layer on the face of the compression fitting where it butts up to the inside of the casting. Assemble into the casting and fit the backnut loosely. Re-assemble the vertical screw and thrust plate. At this stage there should be a 'spot face' of the putty filling all irregularities and forming a rigid location with the casting. Do not tighten the backnut, the weight of the head will thin the putty seal until the high spots of the casting touch the fitting. Once the resin is cured the backnut can be tightened Cut a piece of sheet material, almost anything will do 1mm steel to 3mm alum and make a bulkhead to seal off the spindle chamber from the rest of the hollow head casting. Seal this plate in with a thick gasket of P38 or similar. This will retain the oil bath around the lower spindle bearing, and also prevent swarf entering the chamber. That's the Head located

Spindle and Bearing

The Compumill will carry cutters from 1mm to 50mm. (ideally on two sizes of arbor) The cutter head comes bored 27mm in the spindle nose and a steel bush 36mm long reamed 19mm carries the standard NM2 arbor. This arbor has a B16 taper and is supplied with a 13mm drill chuck. Again, the steel-on-steel bearing does not appeal, but for occasional millers who wish to make this a single weekend project, the chuck taper can be reamed to take 'throw

R. A selection of cutters and arbors.

S. Larger cutters and arbors.

away' mini-mills of 6mm or 1/4 shank. A cross drilling is tapped M5 to locate on the mini-mill flatted shank and you are drilling and milling see **Drawing 7**. Do keep the arbor greased.

Removing the drill chuck from the taper can be problematic with this 'quickie' setup. A tool bought 20 years ago to remove trackrod ends consists of a forged tapered forked wedge approx 60mm long with 160mm or so handle. This was filed up to allow insertion behind the drill chuck and worked as a chuck remover. An alternative method entails drilling and tapping axially through the chuck body to allow a jacking bolt to be screwed in, forcing the chuck off the taper.

My recommendation, regarding the bearing, is for just a little more patience, and the buying or making of two oilite bushes to press into the 19mm steel bush and ream them 15mm. If these bushes are 15mm long they will have a small gap between them. When a 15mm arbor is loaded into the rebushed sleeve, this gap is filled with grease, the grease seal stops much of the oil from the spindle chamber running down the arbor and flinging from the spindle. For extended cutting periods a standard 24mm od, 15mm id, 7mm wide neoprene oil seal can be let into a counterbore in the steel spindle bush to give improved oil sealing.

'SMALL' cutters locate in these 15mm dia silver steel arbors which are reamed to take the standard size cutter shanks. The cutters are locked by means of an M5 grub screw. Cutters of maximum 12mm shank diameter can be Loctited into reamed 15mm silver steel arbors to give very rigid and concentric location. When using plain 15mm arbors all axial location and thrust is provided by the motor bearings.

'LARGE' cutters which include boring head and face mills require the standard NM2 steel bush to be removed and replaced by a similar bushing made of phosphor bronze and reamed 20mm. All large arbors have a reduced section at the top where they locate in and are driven by the primary chuck on the motor shaft. Ideally this driving spigot should be hexagonal to ensure no skidding in the primary chuck jaws. One way to produce this is to tap the end of the arbor ½ UNF and screw in a tank cutter arbor. Alternatively, skim the corners of a short length of hexagonal bar in the lathe to a nominal reamer size. Ream the end of the arbor and Loctite the trued hex stub in. Please note with regard to the tapping and reaming of these bought in cutter holders, they are heat treated and come 'tough to fairly hard' in the shanks. Leave much smaller reaming allowances and shallower threads than usual.

When using large arbors axial thrust is carried by the bottom face of the spindle nose bushing. This needs to be lubricated so do not fit an oil seal at the bottom of this bush.

The strategy of assembling the arbor to the machine with grease and pouring oil into the spindle chamber works fairly well to controlled 'flinging'. **Photo R** shows a selection of cutters and B16 taper mounted chuck on 15mm arbors. **Photo S** shows larger cutters on 20mm (or ¾ if you prefer) arbors, note this chuck is threaded ¾in.x 16tpi to fit the collet holder. **Photo T** shows a bare but complete drive train from standard motor through primary chuck, through 3:1 home made epicyclic gearbox, through arbor to boring head, this speed reduction is necessary when any off-centre, unbalanced cutters are used, and also to achieve correct cutting speeds particularly for larger diameter high speed steel tools. **Photo U** shows the above drive installed in the cutter head. The bolt on the front face of the head locks the annulus of the epicyclic indicating that low gear is engaged.

The machine elements are now complete, the components must be cleaned, bearing contact surfaces well oiled and the machine frame assembled. An inexpensive 4 inch vice, sold for drilling can be 'improved' enough for most small milling jobs and will allow you to take your first cuts.

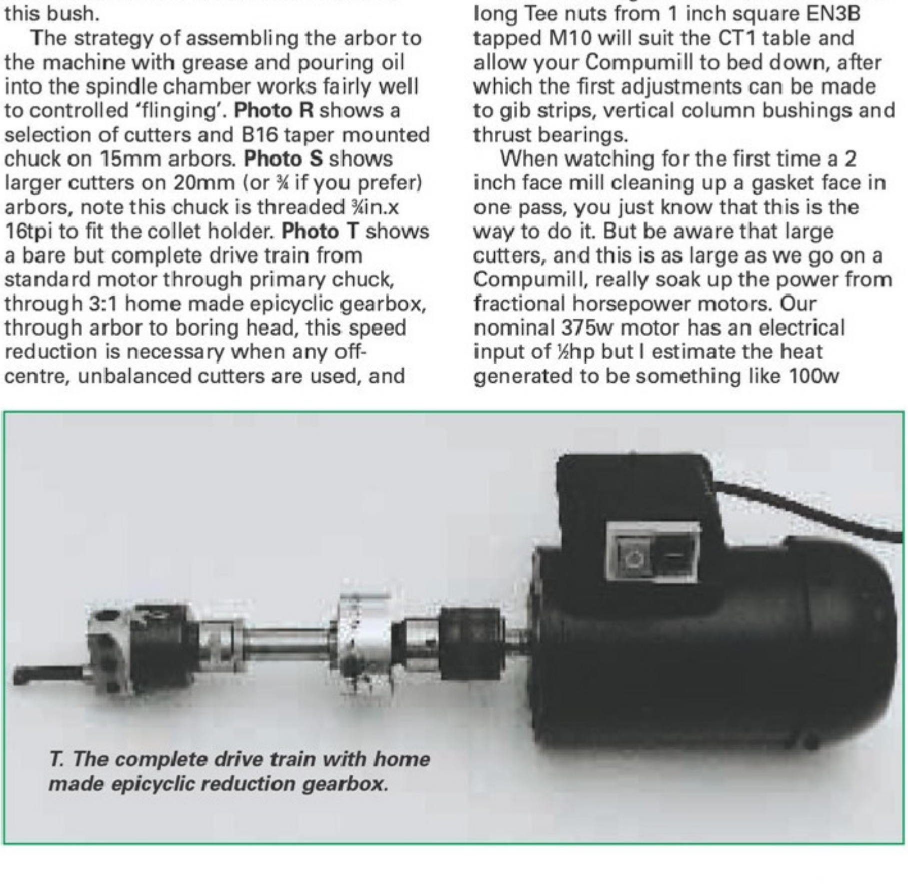
Operating the Mill

I suggest starting with an 8 or 10mm end mill carried in a 15mm arbor, I find this size cutter to be generally useful for all the odd jobs like squaring the ends of bars and flatting shafts that would otherwise have to be filed. The 10mm size gives a cutting speed somewhat above the normal recommended level for mild steel, so use coolant. They need a fair amount of power and the 2.5mm arbor wall thickness is less than ideal for a securing screw, so I Loctite the cutter into the arbor. Knowing that the cutter will not be removed until it is sharpened or replaced, makes the strategy of making a few spare arbors fairly economic in the long term.

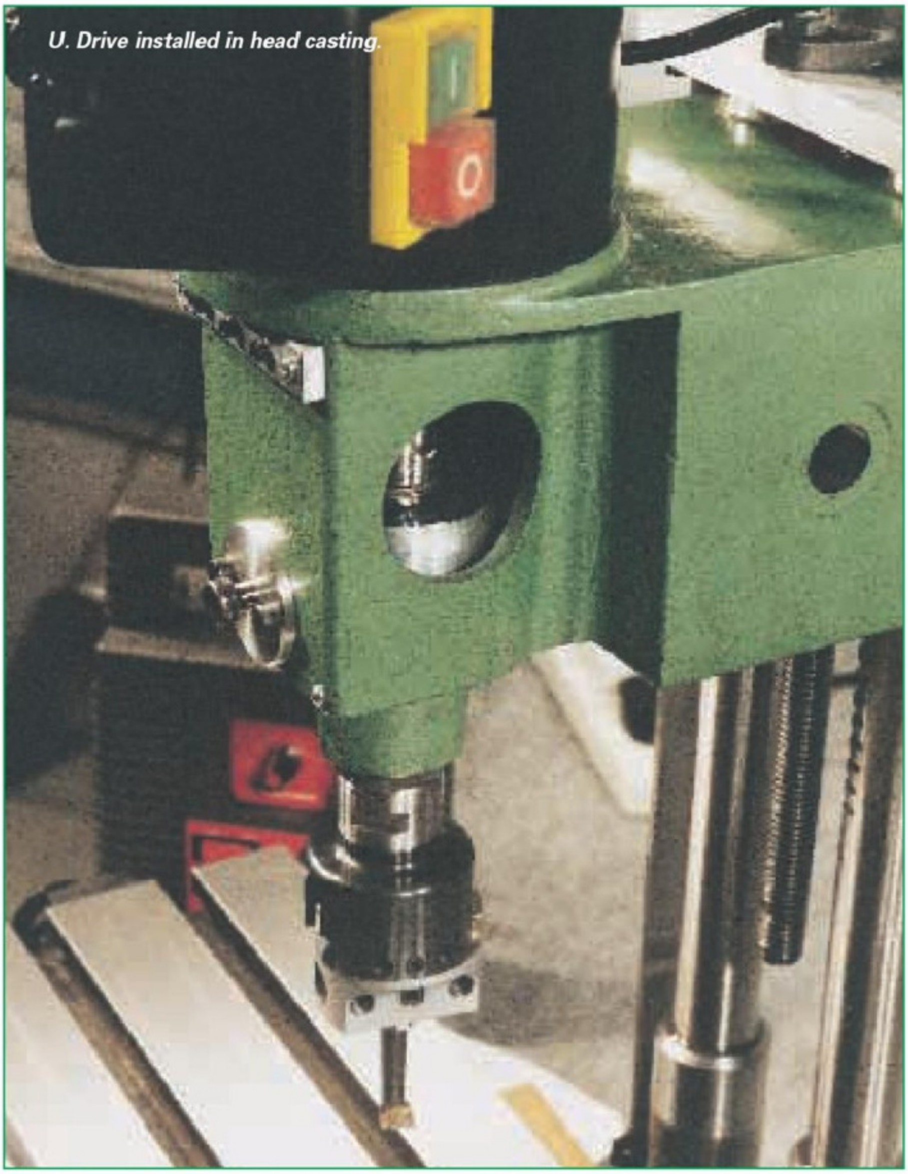
Throw-away' mills such as FC3 and Mini-mills are ideal in sizes up to 6mm, but be aware that the popular American Weldon shanks are flatted at a different length to UK types. It pays to standardise on imperial ¼inch from Weldon or metric sizes from just about everybody else. As the USA seem to be increasingly metricated your first minimill arbors could be reamed 6mm and M5 cross screwed at a length to suit locally available cutters from Dormer, Clarkson etc.

Job 1: Making a few sets of four 1 inch long Tee nuts from 1 inch square EN3B tapped M10 will suit the CT1 table and allow your Compumill to bed down, after which the first adjustments can be made to gib strips, vertical column bushings and thrust bearings.

When watching for the first time a 2 inch face mill cleaning up a gasket face in one pass, you just know that this is the way to do it. But be aware that large cutters, and this is as large as we go on a Compumill, really soak up the power from fractional horsepower motors. Our nominal 375w motor has an electrical input of ½hp but I estimate the heat generated to be something like 100w



T. The complete drive train with home made epicyclic reduction gearbox.


U. Drive installed in head casting.

which leaves us at best, with about ⅓hp. We need to think about what speeds, feeds and cutters get the best out of this power. Face mills of this diameter are intended for high rates of metal removal OR they are made as easily/cheaply as possible. If you buy a cheap inserted tooth end mill, it is likely that the pockets housing the cutting inserts are milled out radially. It is just as likely that the supplied inserts are parallel slabs of carbide which when used together give zero to negative cutting rake. I call these inserts 'clunkers' because they knock, rather than slice, the chips off the work. This is apparent when the chip metal is examined, the chip is very compressed and blue indicated that much of our 1/3hp is soaked up in deforming the chips. The cost of 'real' positive rake tooling is out of the range of occasional users, so buy what we can afford but consider changing the inserts to positive rake when cutting steel and tougher materials. Also be aware that tips sold for positive rake cutting do NOT necessarily have any rake themselves, they may have extra clearance to allow their use in holders which present them to the work with positive rake.

To put real numbers to this, when milling mild steel with the tips 'as supplied' with an affordable 40mm endmill, an un-stayed Compumill gave a best result of 1.5 cubic inches per hour with blue, well squashed swarf, at this depth of cut and feed rate the machine frame deflection just became apparent in the surface finish. The same holder with 12 degree positive rake inserts allowed a four times increase in depth of cut (6 cubic inches per hour), with curled silver swarf, other factors of speed and feed rate being constant. It will be no surprise that the ground micro-grain carbide inserts were more expensive than replacement inserts from ROC, but I expect them to last a long time.

Chronos sell a 40mm end mill with plain shank and 3 clamp-on tips. Having clamps allows one to choose from clamp or screw-on tips. The conversion to suit Compumill is similar to that described for the cutter below. This cuts a 90 degree sharp (allowing for insert radius) corner.

Machine Mart sell a useful 2 inch positive rake face milling cutter with three indexable inserts. This has a steep chamfer on the inserts so cannot cut into a corner. It can be modified from No.3 Morse taper to 20mm parallel to run in Compumill. Remove the cutting inserts and chuck the holder true in the lathe. The threading in the end of the taper spoils the centre location, so bore a slight chamfer giving a 60 degree location for the tailstock centre. Turn the diameter to 20mm to suit your bronze No.2 arbor bush. Polish to arrive at size as a good finish here will give a long life to the bush. Shorten the shank to 70mm long, then bore to a few hundredths under 15mm dia. for 30mm deep and ream 15mm. Turn 13mm dia by 30 on a 60mm length of 15mm silver steel. Loctite the silver steel into the cutter shank.

Finally, and just for information, a backstayed Compumill can absorb all available power from its 375w motor. This represents a maximum removal rate of 10 cubic inches of steel per hour. I do not recommend cutting rates of this order on this machine, but the fact suggests a fair balance in the design between the mechanism and its power source.

The last photo U shows that facilities including 5-axis CNC with programmable cutter speed can be made and bolted on as required, and just as importantly, can be removed and tucked under the bench when the work does not need a computer. If the prospect of further developing your Compumill appeals, there are more photos on our web site at www.compucutters.com.

Any problems, or suggestions then e-mail compucutters@compuserve.com or phone 02476 473851 or write enclosing a stamped, self addressed envelope.

Suppliers

CT1 cast iron compound table
Approx £150
Axminster Power Tools
(also stock an NM2 clone as a Perform product) Tel 0800 371 822

NM2 cast iron morticing machine
£110
Screwfix
(latest cat shows this as a Ferm product, same price)
Tel 0500 414141

12vdc Buehler motors/Power supplies/ Bronze bushes:
Proops
Tel 0116 2403400

Gears, worms/wheels
HPC Gears
Tel 01246 268080

Leadscrew LFM164 / Nut LRM164 :
Ondrives
Tel 01246 455500

Bearings 540-312 / Worm 262-2400 / wheel 262-2393:
RS Components
order on-line from http://rswww.com
(pay by credit card)

End mill using 3 inserts on 40mm dia, Tee nuts 3/8 UNC, range of standard small angle plates, vices, rotary table, dividing head:
Chronos
Tel 01727 832793

Face mill using 3 inserts on 2inch dia 06072260 0:
Machine Mart
Tel 0115 956 5555

GRINDING HEAD FOR ADEPT HAND SHAPER

Dick Chawner from Cheshire suggests a straightforward accessory to achieve basic surface grinding using a shaper.

Background

The tool post grinder for cylindrical grinding in the lathe is an attachment familiar to most readers, and use of the vertical mill for occasional surface grinding was described in MEW issue 68. The device to be described provides a means of accomplishing basic surface grinding by using an Adept No 2 Hand Shaper, as shown in **Fig 1**, and the accompanying Photo. The design was kept extremely simple, and power is provided by a commercial flexi-drive. Clearly the basic principle can be applied to other machines, by adjusting the dimensions to suit. It may also be deployed as a lathe mounted toolpost grinder. This arrangement is depicted in **Fig 2**. **Fig 2A** illustrates my setup for achieving "Best Curve" for the flexi-drive.

The design as presented uses oilite bushes as spindle bearings. The speeds and loadings are relatively light, and these were found to be satisfactory for my purposes. Others may choose to employ alternative bearing configurations, perhaps along the lines described by Harold Hall in his Milling Spindle design. As my unit was built a number of years ago, it may be worth checking with your local bearing stockist for bush/bearing size availability, and, if necessary, adjusting the sizes to suit.

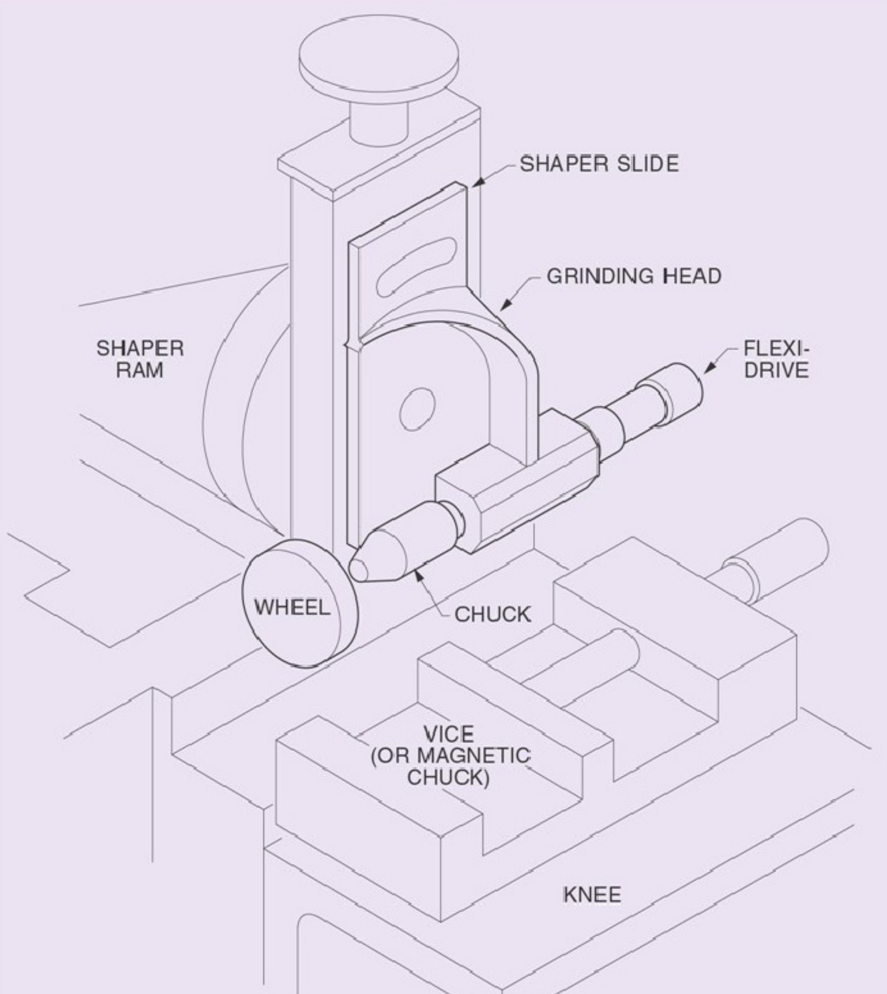


FIG. 1. GRINDING HEAD ON SHAPER

Safety

As my grinding head was operated at 2900 rpm using small wheels and mounted points, I did not feel that a wheel guard was necessary, and this was not included in the design. If you want to adapt larger or faster then a guard is a must.

Construction

The general arrangement is illustrated in **Fig 3**, from which the construction can be considered as two sub assemblies :-

a) the stationary components, principally the slide plate and spindle boss
b) the rotating spindle and drive sleeve

Stationary Components

Slide Plate (Fig 4)

This is marked out and sawn from a piece of 3/16in. thick steel plate. I prefer to use black rather than bright as I find it more stable. The hole, slot, and face relief are then machined. Note that you may choose to omit the rear face relief, and consequently the spacer described later. I felt that the arrangement as drawn suited my setup.

Spindle Boss (Fig 5)

This is cut from rectangular steel bar 1¼in. by 1in. If this size is not to hand the sizes are not critical so either adjust or cut from larger. Chuck in four jaw, face and profile ends, and drill through in preparation for the ½in. reamer. Do not ream yet.

Rib (Fig 6)

The function of this component is simply to offer increased stiffness to the slide plate. An off cut of 16 gauge or 2mm steel plate will do nicely.

Spacer (Fig 7)

Almost any metal of appropriate thickness will suffice, depending on the contents of the scrap box.

Assembly

Locate the spindle boss on the slide plate to the dimensions given, leaving ⅟₃₂in. at bottom and side for the weld fillet. For the welding operation, I made a temporary fixing using a couple of 6BA screws, but you may be happy to locate with G-clamps or Mole Grips. After welding on the spindle boss proceed to weld on the Rib. If it is not exactly the right length, (say a bit short) don't worry, it doesn't matter. You now have the "Fabricated Casting" and can proceed to ream the ½in. bore. Fit a pair of ½in. OD x ⅜in. bore oilite bushes leaving a grease cavity between them, and finally finish ream the ⅜in. bore.

As noted previously, I did not include a wheel guard. You may choose to make a guard from similar material to the rib, say about 1½ or 2 inches wide, and of length to suit the wheel periphery. Attachment might be by bracketing back to one of the existing bolts.

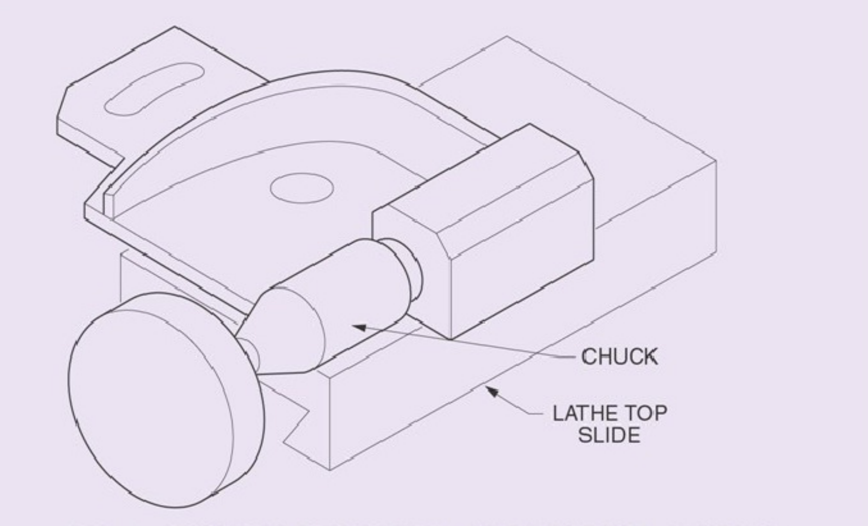


FIG. 2. GRINDING HEAD USED AS TOOLPOST GRINDER (FOR HARD CENTRES)

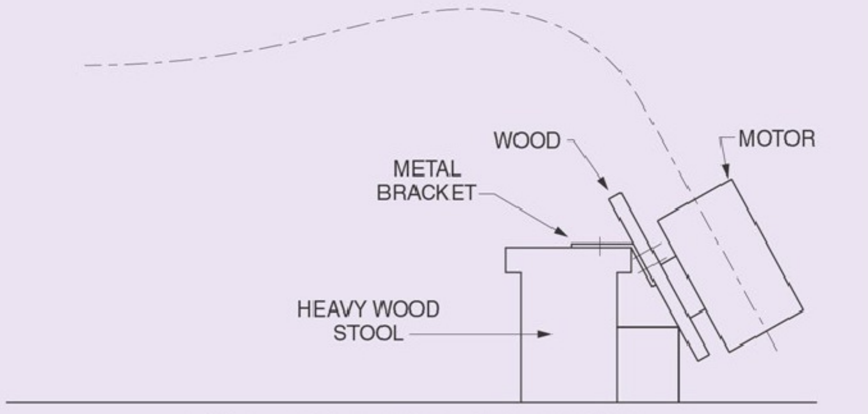


FIG. 2a. SUGGESTED BEST CURVE

Rotating Components

Spindle (Fig 8)

Now for the tricky bit. Try to obtain a suitable length of ¾in. dia. bar in EN8, however mild steel will do, as loads are light. The essential result required is that the chuck should run concentrically on the oilite bushes, and hence the appropriate features on the spindle must be machined concentric. This can be achieved either by working between centres, or by using the chuck if sufficiently accurate, although most three jaw chucks are only within about 0.002in. If your chuck is a bit out, and you are used to it, you may be able to get an acceptable result by inserting a thin packer on one or two jaws. If in doubt use centres.

Whichever method you choose, allow extra length for chuck jaw or carrier locations, and it may be found beneficial to machine to within 0.010in. on dia. and allow the material to relax overnight. Some slight movement may occur. Finish the spindle bearing surface by leaving the ⅜in. portion 0.005in. up. Burnish with emery into a smooth running fit in the bushes with no play.

The Chuck fitted to my "Head" is ⁵⁄₁₆in. capacity, with a ⅜in. UNF internal location thread. To ensure a concentric, parallel, non-wobbly thread, it is essential that this be machined with a single point tool or similar. If you lathe cannot screw cut, you may prefer to use a plain or taper spigotted chuck and change details to suit.

As regards the ⁵⁄₁₆ portion of the spindle, it may be found convenient to leave this a few thou oversize, and finish machine later to achieve a light push fit with the drive sleeve.

Drive Sleeve (Fig 9)

Making this part is pretty straightforward, although once again we need to ensure good accuracy this time to avoid unnecessary vibration. Those intent on building quickly may simply leave the sleeve as plain ¾in. OD. I chose to pretty it up with an all over skim, and weight removal as in the drawing. As my flexi shaft has a ⅜in. x 24 UNF thread, the same has been specified for the drive sleeve. To ensure a parallel thread, the tapping must be done in the lathe. One approach is to grip the tap in the tailstock chuck, and allow the tailstock to move freely, pulled or pushed by the tap. Other techniques may be used depending on the tooling available.

Welding

If you do not possess such equipment, then you need to enlist the assistance of your local fabricator. He will run his electric torch over the slide plate and boss in less than five minutes. The rib on this item can be held in position with a weight bar resting on it. How do you get your welder to cooperate? Easy, give him for his "senior domestic management", a pound of home grown raspberries now and again. Also, remember that his 100ton shears have bits of off cut plate lying around them. To him it's just scrap. To you and me, it's gold.

Operation

I used a 2900rpm ½hp motor on the flexi drive, but a ¼hp will do. On the subject of grind wheels, I have found those having ¼in. dia. shafts to be OK. The motor should be sited so as to achieve a smooth run for the flexi. Finally please note that the device is intended for light work not heavyweight rough grinding.

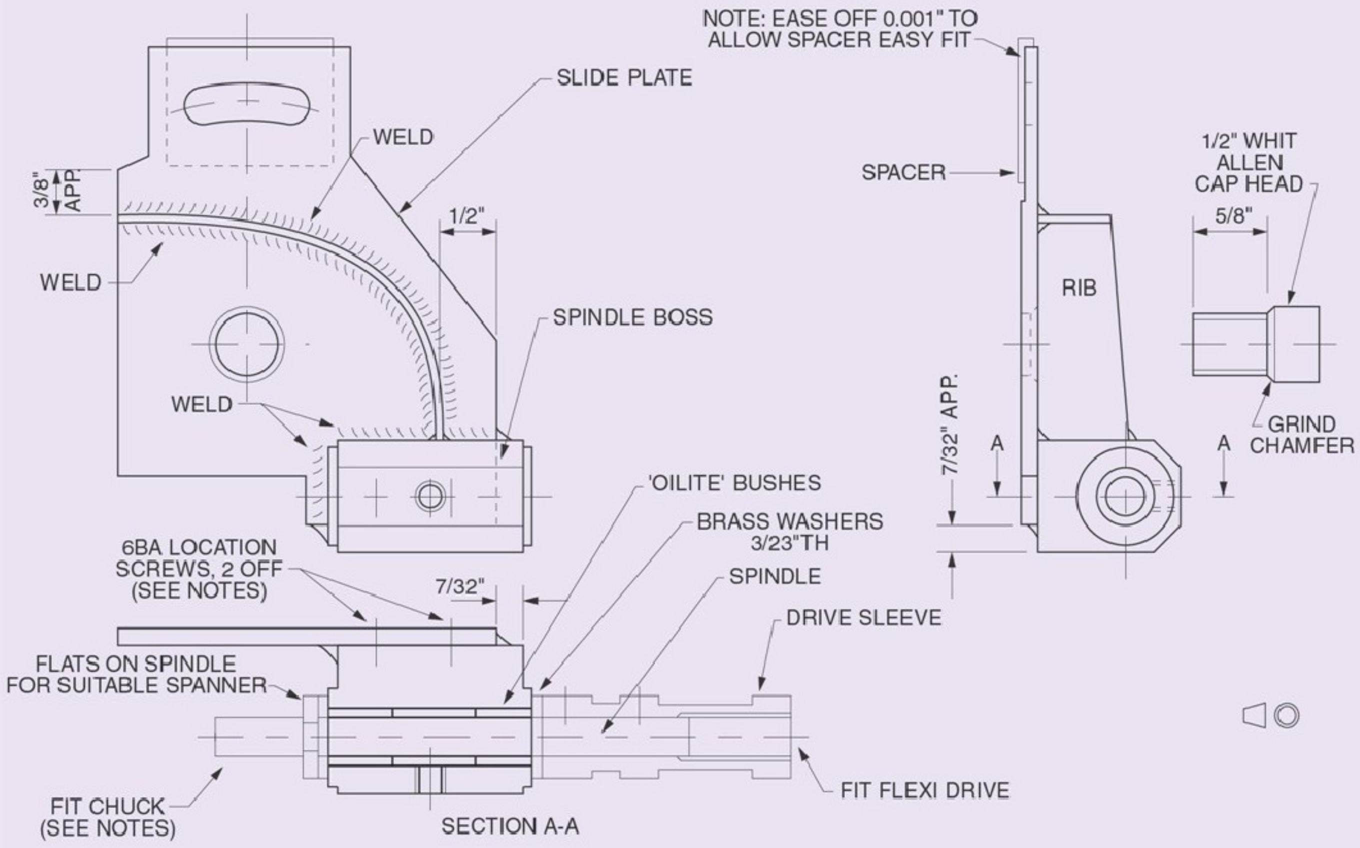


FIG. 3. GENERAL ARRANGEMENT

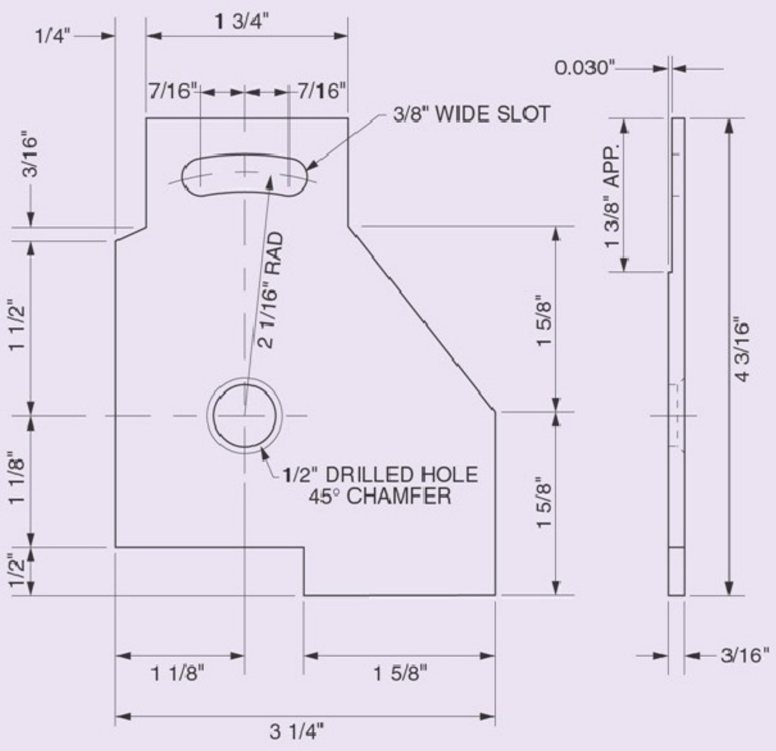


FIG. 4. SLIDE PLATE

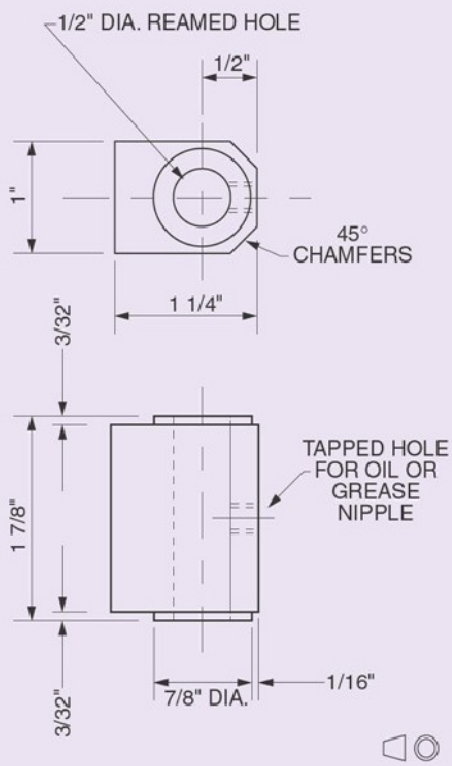


FIG. 5. SPINDLE BOSS

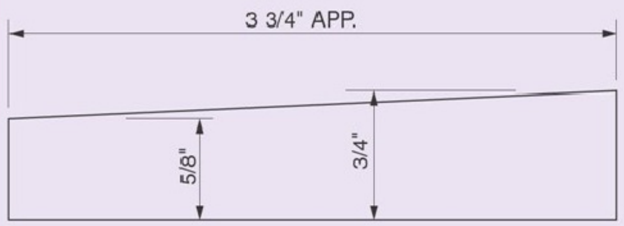


FIG. 6. RIB, 1 OFF
1/16" OR 2mm STEEL PLATE

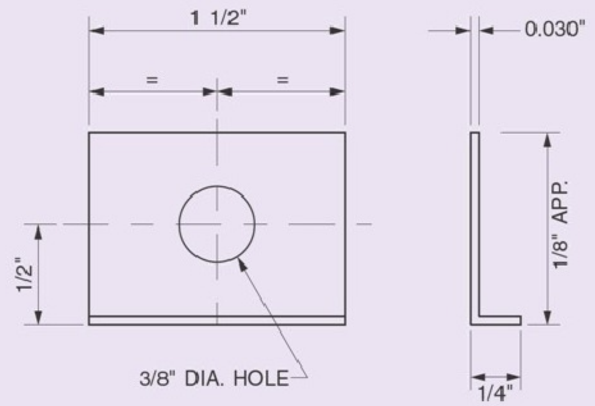


FIG. 7. SPACER

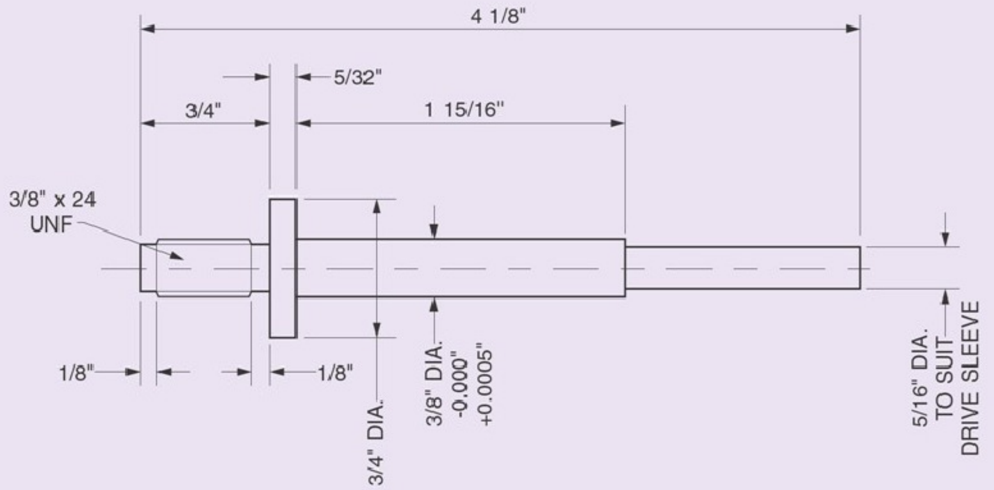


FIG. 8. SPINDLE
(EN8 IF POSSIBLE)

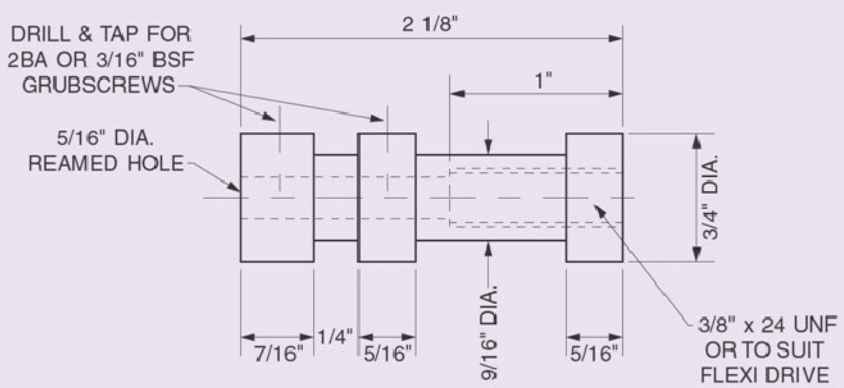
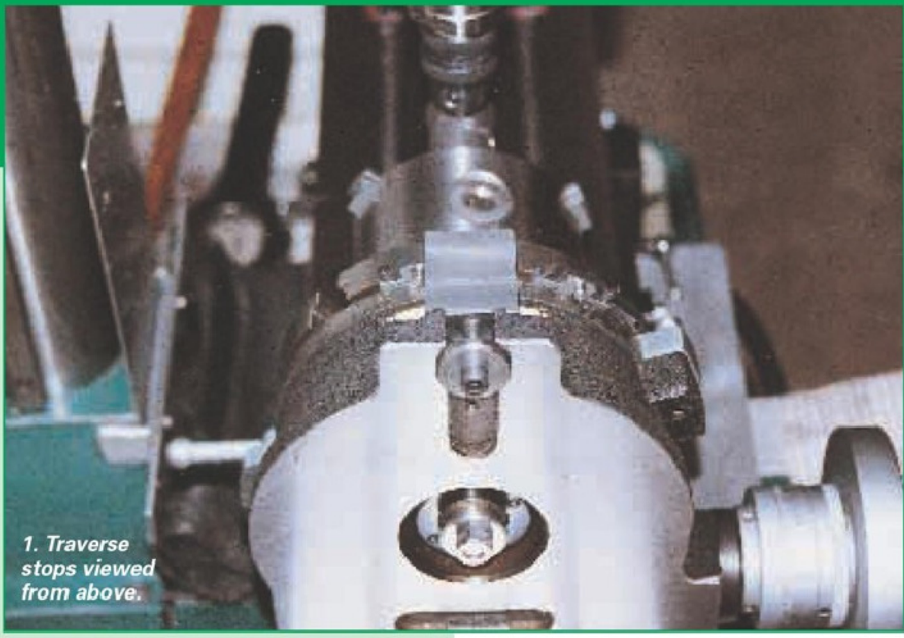


FIG. 9. DRIVE SLEEVE

TRAVERSE STOPS FOR MYFORD (VERTEX) ROTARY TABLE



1. Traverse stops viewed from above.

Shelley Curtis describes accessories to ease the cutting of Two Stroke ports and similar items.

It is said that necessity is the mother of invention - hence my rotary table traverse stops!

Manufacture

The manufacture of these items is quite straightforward and needs little description. Note that tightening the 6BA x 1/4in. cap screws in the partially cut threads serves as a means to expand the feet of the Traverse Stops and secure them in the peripheral slot in the rotary table. The drawings and **photographs 1 and 2** show the assembly of the various components.

The T-slot Plug is for bridging the gap if the positioning of a traverse stop should

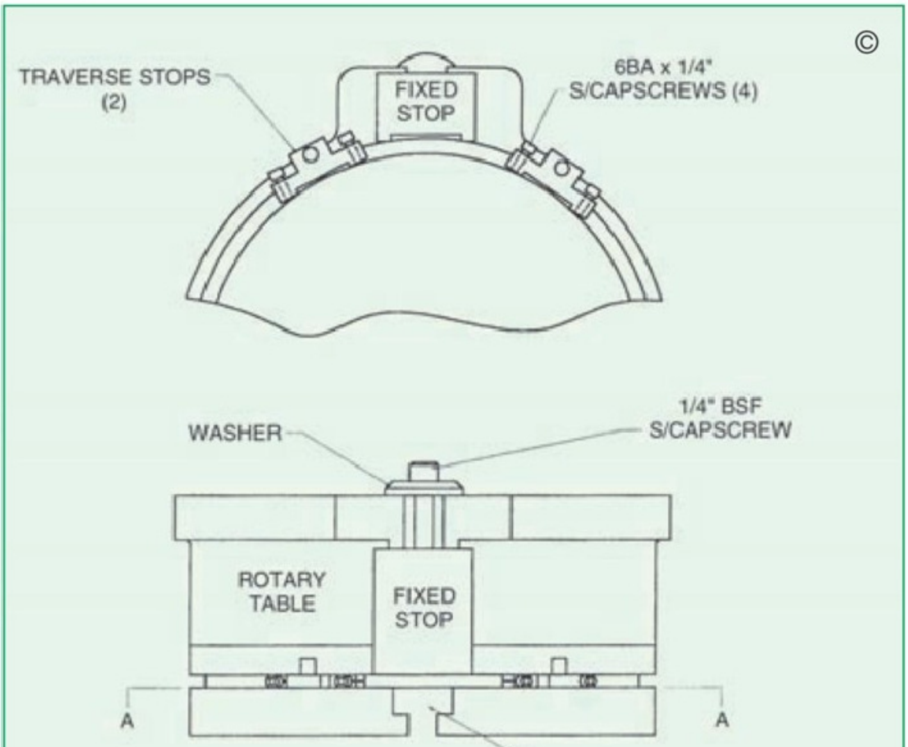
Background

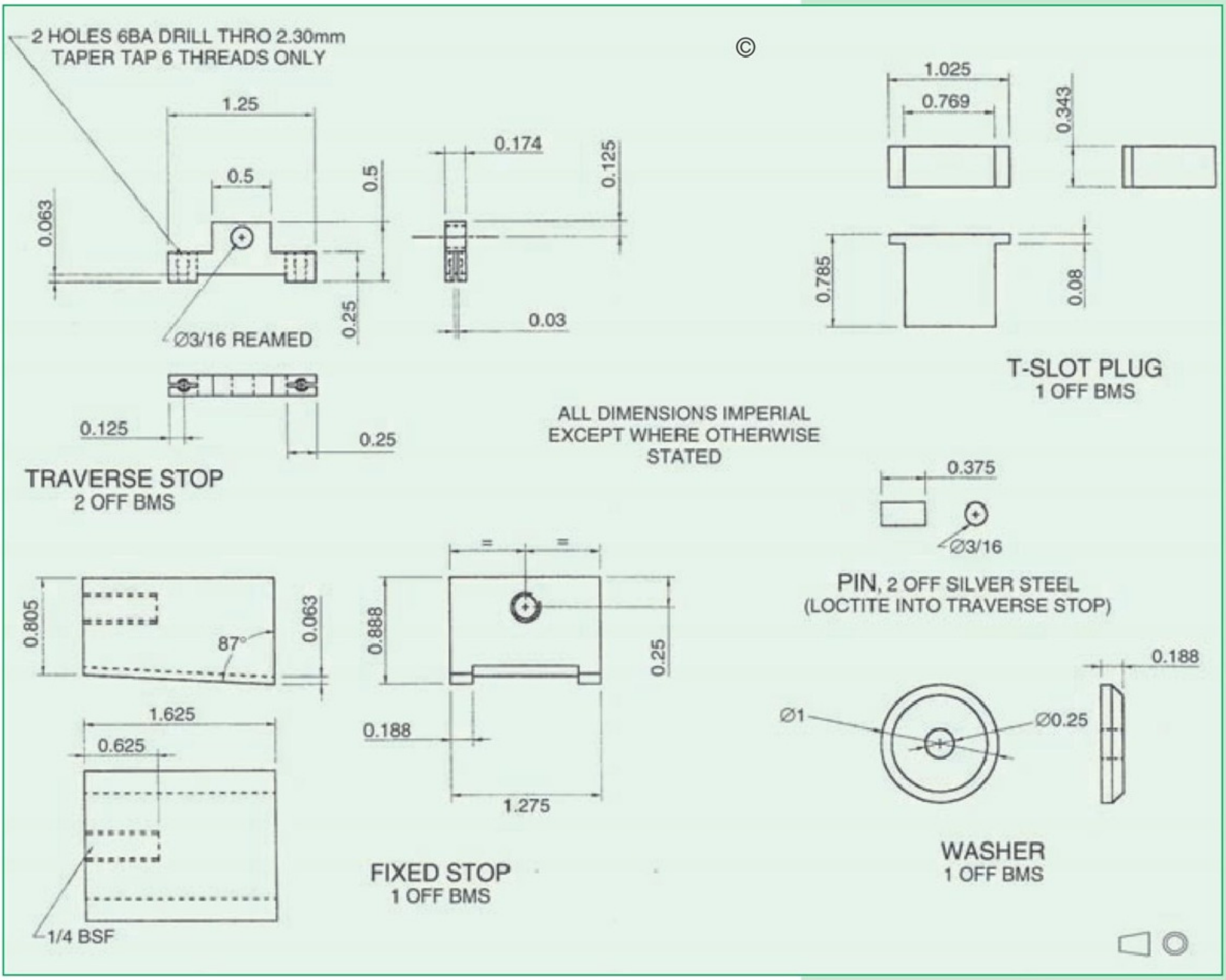
One of my interests is making model IC engines and I find that accurately cutting the transfer and exhaust ports in cylinder liners of 2-stroke engines is one of the more delicate and tricky operations.

If the design embodies a ringed piston then the port's cross section usually has to be subdivided into smaller apertures to avoid the possibility of the ring being trapped. (The ring has to be pinned to avoid rotation, of course, but the risk is still there). Early engine designs had circular ports, which were obviously easy to machine - simply requiring the drilling of holes of the correct diameter. Modern engines, to maximise area and improve efficiency, have ports of square or rectangular outline which present a different challenge.

My method is to mount the cylinder liner on a mandrel (with its diameter reduced in the area where the ports are to be cut) in a chuck on the rotary table. Secure to the milling table with the cylinder aligned with the table X axis. The ports can now be profiled using a small slot drill (1/16" or 3/32"). The vertical dimension of the ports can be defined using the milling table traverse stops. The horizontal dimension is determined by the rotary table. And herein lies the principal hazard..!

However delicate one's touch, it is all to easy to exceed the number of degrees rotation and spoil the job - or snap off the slot drill.





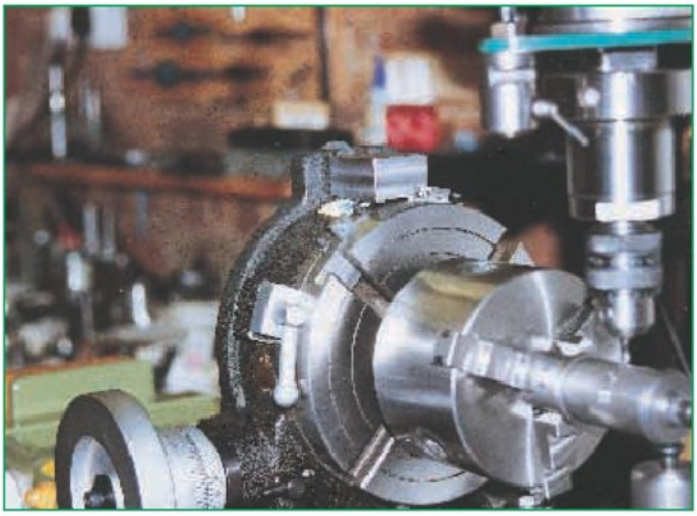
coincide with a T-slot on the rotary table. (Murphy's 1st law! and **Photo 3**)

Operation

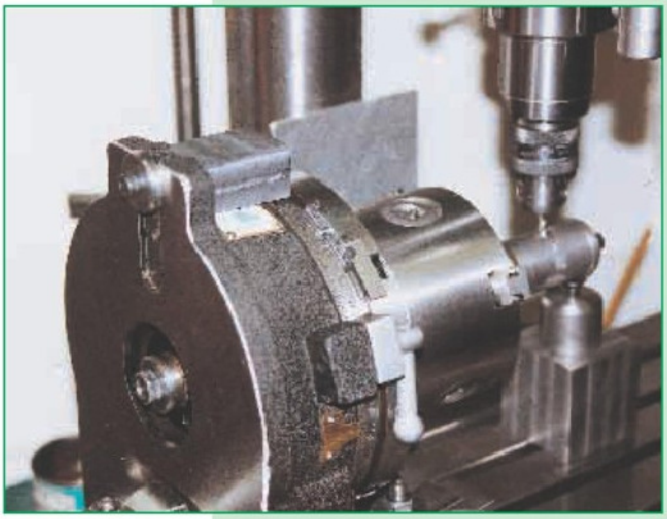
In use, just set up the limits and start by drilling a hole a few thou' less than the slot drill diameter in one corner. (This will avoid the "keyhole" effect which can occur when plunging in with a slot drill). Feed in the slot drill .005" at this point after each "circuit" and repeat until the port is complete. Approach each stop - milling and rotary table gently. Result: a perfect job - and no broken tools.

This system will span an arc of some 70 degrees so could be useful in other operations requiring positive limits.

It can also be used with the rotary table in horizontal position, sitting on two ½" parallels with a clamp seated on the fixed stop.

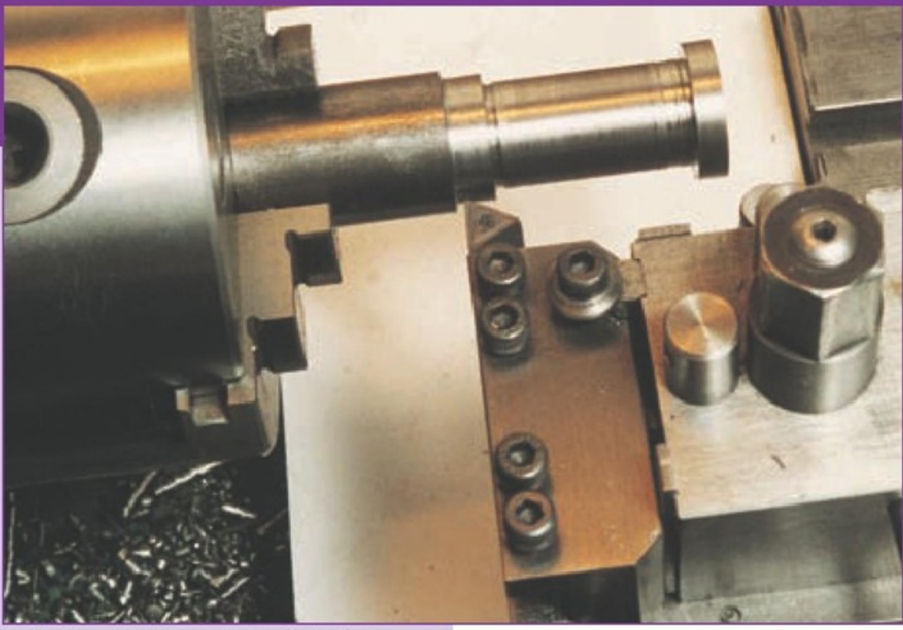


2. Set up in use. Note T-Slot Plug in position.



3. T-Slot Plug clearly visible.

LATHE PROJECTS FOR BEGINNERS (16) A MILLING CUTTER CHUCK



1. *Turning the Morse taper test piece.*

Harold Hall concludes his series by describing an invaluable accessory for the mill.

One of the earliest lessons a novice milling machine operator will learn is that the spiral action of an end mill will, when taking a cut, attempt to draw the cutter from the chuck holding it. The result is that it soon becomes apparent that the drill chuck usually supplied with the average mill drill is quite inadequate. Having purchased my first mill drill some years back for around £600 I soon learnt that this was so but was dismayed to learn that a suitable milling cutter chuck was going to set me back in excess of £100. This seemed quite disproportionate compared to the cost of the machine and I was led to consider making one. This I did and have found the resulting chuck to be more than adequate over the 15 years of use (Ref. 1). I have though found, as I become more involved in the workshop, that I would like to use endmills having a greater shank diameter than the ½in./12 mm. that my original chuck catered for. This series gave me the excuse to make a larger version that would take up to ⅝in./16 mm. as it would provide a substantial project to bring the series to an end. As presented, the design includes collets for holding threaded shank endmills, and holders for cutters having parallel shank with flat. It should be noted that industrial chucks such as the Clarkson Autolock (for threaded shank cutters) feature a hardened centre in the body which engages with the female centre at the rear of the cutter, serving the dual purpose of centralising that end and holding the axial position.

I will as I did for the mill drill spindle in the recent issues, limit my text to a production schedule format, expanding on this only where considered necessary.

Taper and Chuck Body (1)

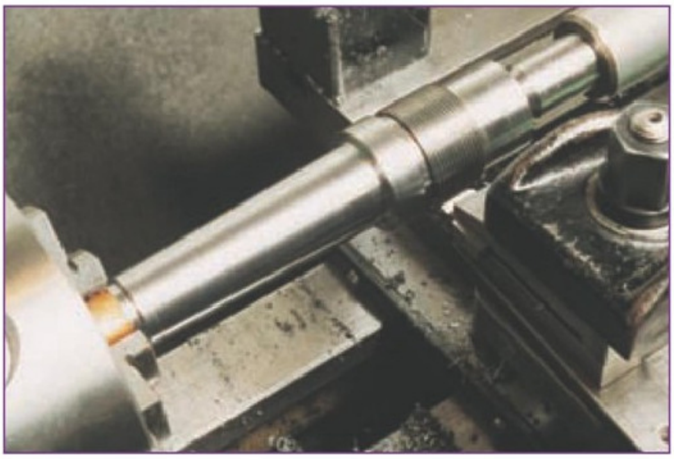
Set the top slide (**Photo 1**) for eventual machining of the taper, using the method described earlier in the series in Issue 75 Page 29. Note that the smallest end is nearest to the chuck. Leave top slide set at this. Some dimensions quoted both on the drawings and in the following text are for a number 3 Morse taper, if you require another taper some dimensions will require changing.

Cut a piece of mild steel bar, 136 mm. long 32mm. diameter. Fit securely in the three jaw. Centre drill end to 6 mm. diameter. Support with tailstock centre. Face end as close to the centre as tool will permit. Finish turn 18 mm. diameter 15 mm. long. Chamfer end. Reduce to 25 mm. over 75 mm. **Photo 2**. Disengage centre. Fit steady at outer end of 25mm diameter. Engage centre. Set steady. Remove centre. Drill and tap to suit draw bar to be used.

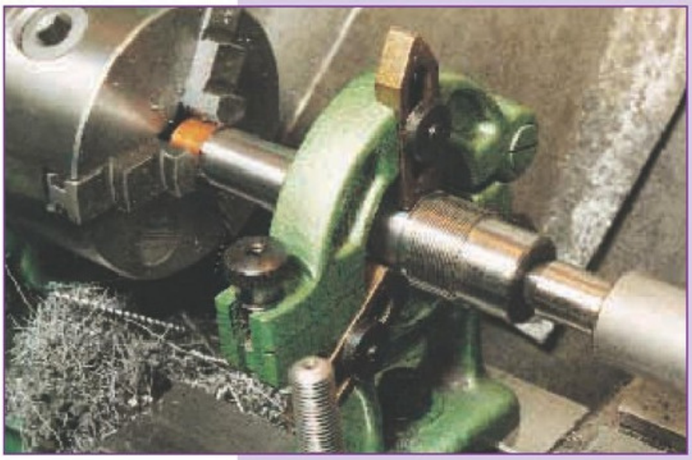
Release one arm of steady. Move steady

2. *Preliminary turning the Morse taper part of collet body.*

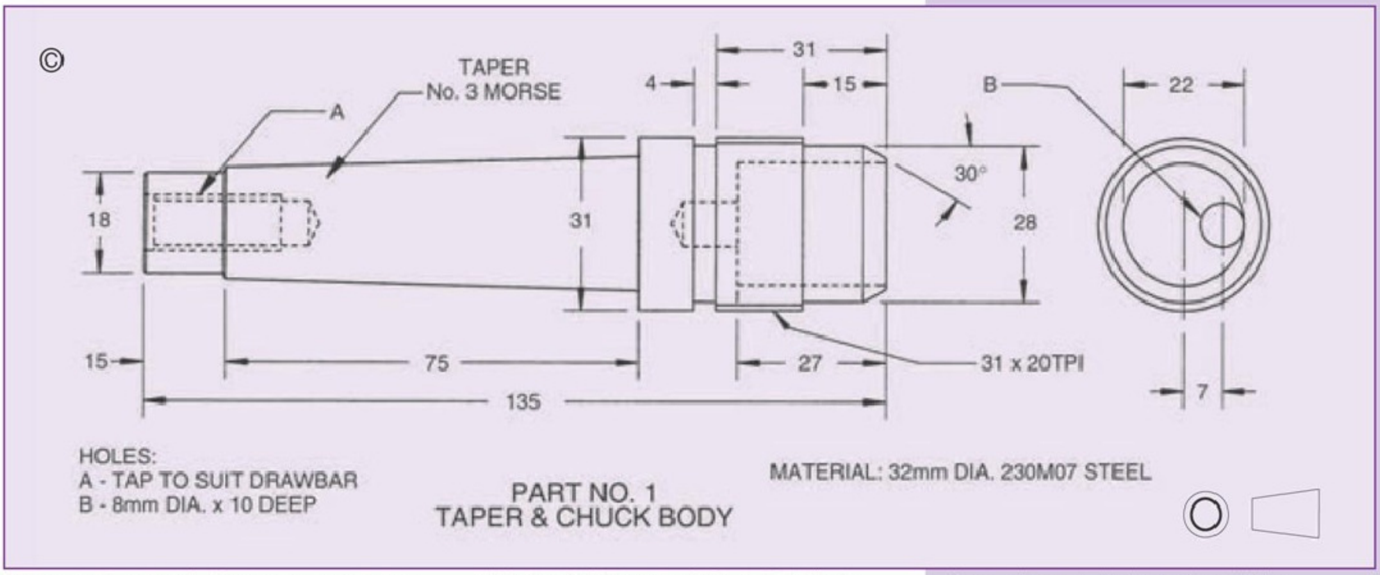
3. *Finishing the Morse taper.*



4. *Cutting the thread on the collet body.*



5. *Setting steady whilst body is supported by the tailstock centre.*



nearer to the chuck. Remove part, reverse and grip part on 18 mm. diameter, suitably protected. Move steady to outer end of 25mm. diameter and reset the one arm. Centre drill outer end to 10mm. diameter.

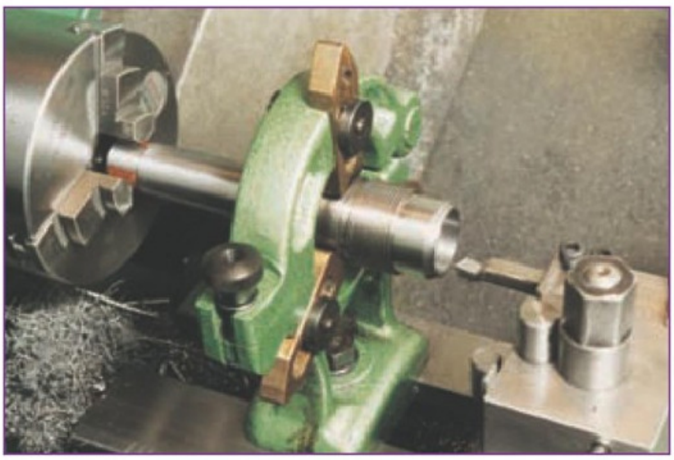
Remove steady. Engage tailstock centre. Rough turn outer diameters. Turn taper, finishing with a round nose finishing tool. Remove and check in the taper in which it is to be fitted, if you set the top slide accurately this should be a formality. Return to the chuck and again support with the tailstock centre. The part must now remain in the chuck until machining is complete. Once more skim over the taper with the finishing tool, **Photo 3**. This is essential to ensure that it is running true again. Finish machine **31** mm. outer diameter. Finish machine the 28 mm. diameter making the 31 mm. diameter 30 mm long. Machine 4 mm. groove.

Machine thread, **Photo 4**. Remove tailstock. Fit steady in position to support the 31 mm. diameter. Re-engage centre. Set steady, **Photo 5**. Remove tailstock centre. Face end to give 15mm. length. Turn small taper. Drill with large size drill 25mm deep. Bore to 22 mm. diameter, 27 mm. deep, **Photo 6**.

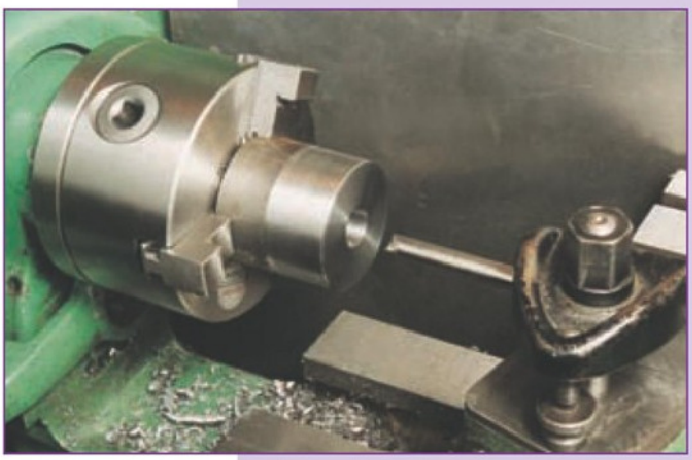
Remove from the lathe and drill the 8mm. diameter hole on the drilling machine.

Collet Closing Ring (2)

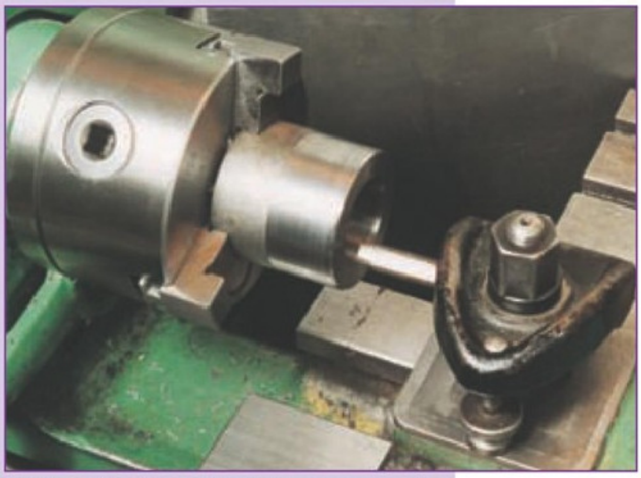
Cut one piece 50 mm. diameter 45mm. long. Fit reverse jaws in the three jaw and fit part. The part must not be removed from the chuck until all boring/threading operations are complete. Face end. Skim outer diameter for appearance sake as far as the chuck jaws will permit. Centre drill. Drill 15 mm. or as large as is available. Bore through 16 mm. diameter, **Photo 7**. Bore 28mm. diameter (close sliding fit on



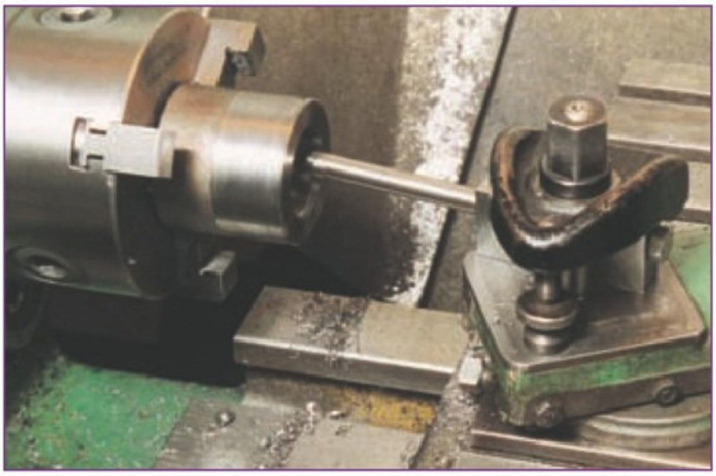
6. *Boring the collet body.*



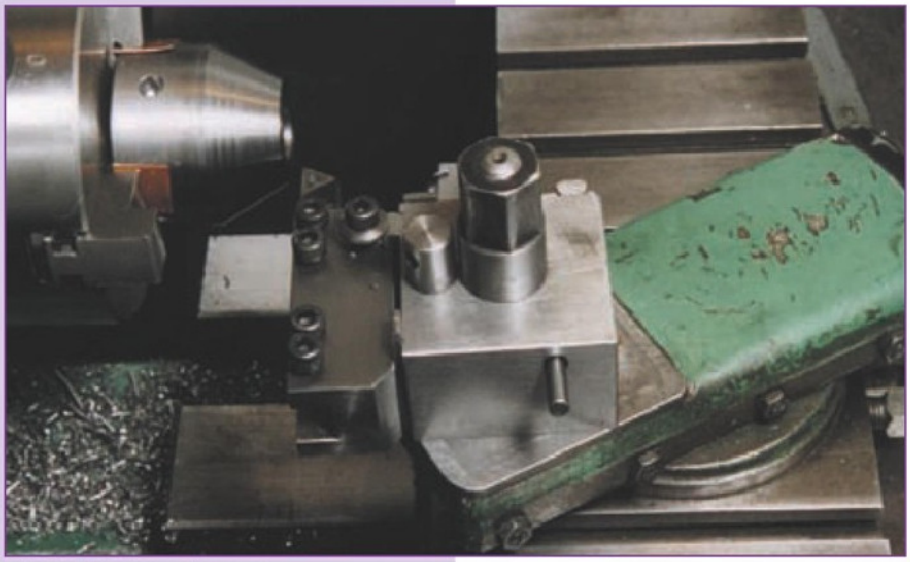
7. *Making the small bore of the collet closing ring.*



8. Threading the collet closing ring.



9. Making the internal taper in the closing ring. Note the boring bar is fitted upside down for machining at the rear of the bore. This enables the top slide setting to be used for both the closing ring and the collets themselves ensuring identical angles.



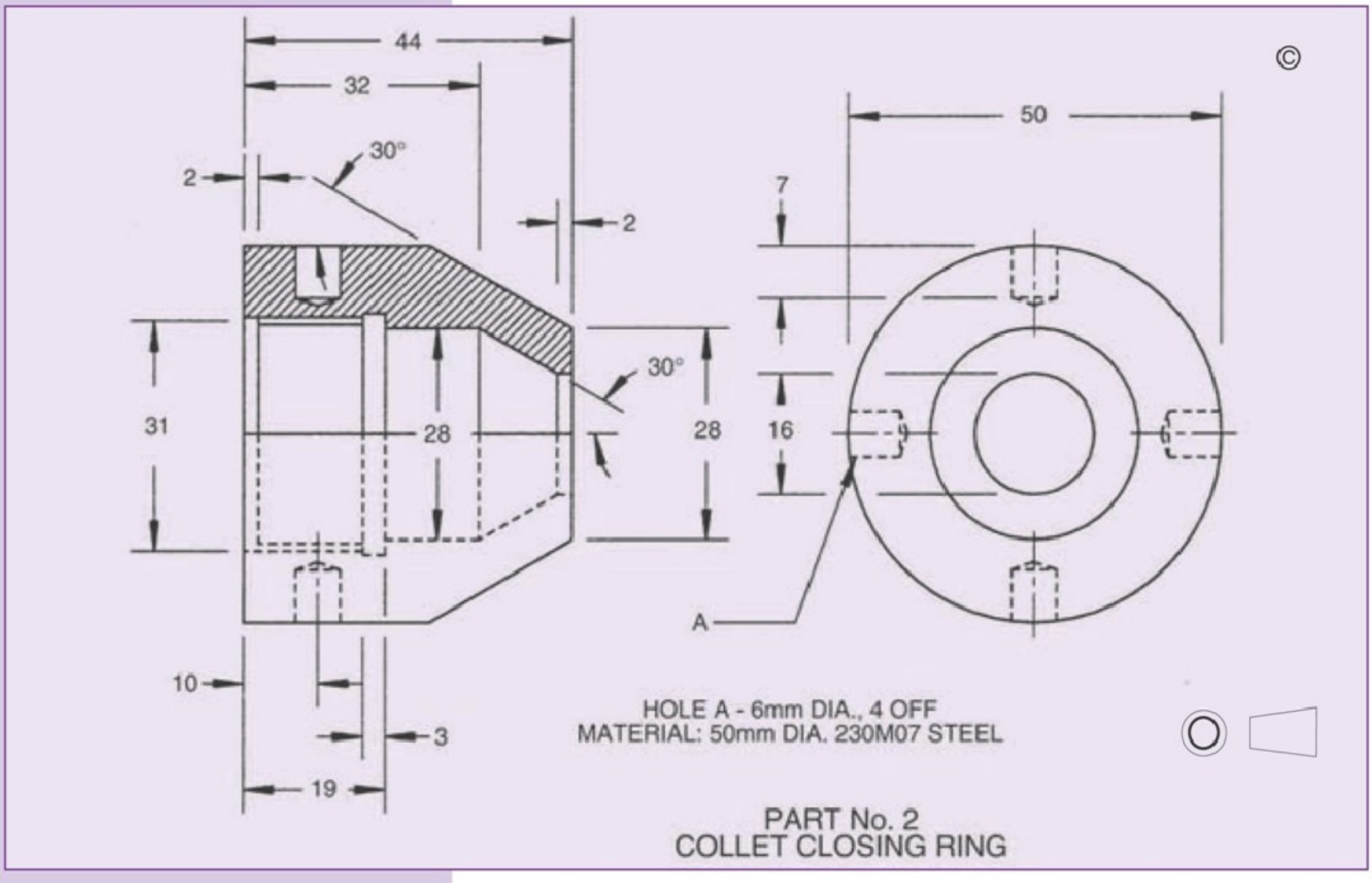
10. Turning the outer taper.

28 mm. diameter on chuck body) 32 mm. deep. Bore 29.5 mm. (assumes 20 TPI Whitworth thread form) 19 mm. deep. Bore 31 mm. diameter 2 mm. deep. Make 3 mm. wide groove. Machine thread, **Photo 8**.

Set top slide to 30 degrees. Fit boring tool, upside down to machine on the back of the bore. Turn the internal taper, **Photo 9**. Make sure transition between 28 mm. diameter and taper maintains the 32 mm. dimension. Leave top slide set at this taper until collets are completed.

Remove part and drill tommy bar holes. Return to the three jaw, suitably protected. Face end to give 44 mm. dimension. Turn outer taper, **Photo 10**.

To be continued in next issue.



TRADE COUNTER

Please note that, unles otherwise stated, Trade Counter items have not necessarily been tested. We give news of products and services which have been brought to our attention and which we consider may be of interest to our readers.

Trycut and Testfoam

Modern high specification industrial CADCAM software allows detailed checking of the final machined component without actually cutting metal. For users of Compucut or other budget CNC systems, an alternative approach is available. Clearly, if an untried program carries errors of the fast feed into the component nature, the consequences can be catastrophic. Equally a minor dimensional discrepancy on a final operation will consign valuable work to the scrap bin.

Two materials available from College Engineering Supply aim to address these concerns. Testfoam is a rigid high density polyurethane foam availble in block form, based on a 6in. by 9in. cross section. It can be machined to an accuracy of 0.1mm with very low machining forces. Thus an unplanned fast feed machining move need not cause cutter breakage.

Typical prices for Testfoam blocks are : 6in.x 9in.x 3in.—£6-50, 6in.x 9in.x 39in. —£58-95 . (excl VAT)

The second material, Trycut, is described as an easy cutting plastic/wax. In this case the material can be put through the various conventional machining processes, eg drilled,reamed, milled, threaded, turned, chamfered, or polished. Compared to the foam material, it will more clearly reflect the accuracy of the process. Compared to most engineering plastics, Trycut is more easily machined and also exhibits a lower melting point. This latter aspect makes it eminently suitable for prototyping jewelery designs, and making masters for lost wax casting of components. Due to the low melting point, the material (and its swarf) is easily domestically remelted, strained, and recast for reuse.

Trycut is available in various sections : square (90mmx 90mm), rectangular (90mmx 40mm) and round (25mm, 35mm, 54mm, and 78mm diameters). Typically, a 500mm length of 25mm dia. bar costs £7-55 (excl VAT)

College Engineering Supply are located at 2, Sandy Lane, Codsall,Wolverhampton, WV8 1EJ, Tel 01902 842 284

Website: www.collegeengineering.co.uk.

MEW Index

The updated computerised index for Model Engineer's Workshop Magazine is now available covering issues from 1 to 80, being supplied on two 3.5in. Floppy disks. This is a DOS program, but works well on a Windows system and requires no knowledge of the workings of DOS.

The index provides viewing with Sort and Search facilities, also Editing, Updating and Printing. However, updates are also made available every six issues for those who do not wish to update the index themselves. Each update covers from issue one. As in previous years, the index will be published in a forthcoming issue of MEW.

Also on the disk is a program for calculating and listing the results of all possible changewheel combinations using the gears available, typically over 10000 for 13 gears.

Cost is £10-00 including UK post, £12-00 for overseas orders. The disks are available from:

CAHW Systems, 23 Fieldway, Berkhamstead, Herts, HP4 2NX

White metal and much else too

Finding suppliers of white metal type materials is not always easy. Milton Keynes Metals is an industrial stockholder of ferrous and non ferrous metals, who issue a separate catalogue dealing with model making and casting supplies. In addition to the expected ranges of steel, brass, stainless and bronze and alumium stock, one also finds a comprehensive range of tooling, and areas devoted to whitemetal casting and associated mould making.

Milton Keynes metals can be contacted at Unit 2, Ridge Hill Farm, Little Horwood Road, Nash, Milton Keynes. Tel 01296 713 631 or website: miltonkeynesmetals@sagehost.co.uk

New Brochure from Warco

Warco have published a new 48 page brochure which includes several new lathes and milling machines together with belt sanders, grinders, sheetmetal machinery, and an expansion to their already extensive selection of tooling accessories.

Their 26 year experience of supplying to model engineers, coupled with their independent quality control procedures, mean that the company benefits from an in depth understanding of model engineering needs, and has established a reputation for quality machinery at competitive prices.

The Brochure is available free of charge from Warco, and the company can be contacted at : Warco House, Fisher Lane, Chiddingfold, Surrey, GU8 4TD

Telephone 01428 682 929

e-mail warco@warco.co.uk

New from Chronos

In time for Harrogate, Chronos announce two new items both of which bring professional accessories down to a size which will interest the amateur. Both come with an introductory offer to readers of MEW.

Touch point Sensor (Optical EdgeFinder)

These excellent tools quickly locate work edges and save time when finding positions on milling machines, jig borers, and other machine tools. They operate by illuminating on contact with a metallic workpiece, a clearly visible red pilot light. The location of end surfaces, inside and outside diameters, can be detected, and as the sensor end is an accurately ground 10mm sphere, the datum position is easily found. Until now, these devices were available with a 20mm diameter body which was often difficult to accommodate in home workshop machinery, however Chronos have secured a quantity with a No 2 MT body suitable for many popular smaller machines. The unit is supplied complete with batteries, test certificate, and instructions.

Catalogue price £49-95 inc vat & carriage – Special offer to readers £42-50 inc.

While stocks last!

Chronos are at : Unit 8 Executive Park, 229/231 Hatfield Rd. St. Albans, Herts. AL1 4TA

Tel 01727 832 793 Fax 01723 848 130

Interchangeable Points Live Centre

Previously available only with a 3 Morse Taper shank, these Live Centre Sets come complete in wooden case with 7 interchangeable points, and extractor. The body is made of SCM4 tool steel, hardened and ground. The set is now available in either No 2 or No 3 Morse, and the centres supplied include one female, and one larger diameter (32mm) suitable for supporting tubes. It would clearly be quite straightforward to make up even larger adapters for even larger tubes. Catalogue price £85-00 inc vat & carriage - special offer to readers £75-00 incl.

READER VISIT

We visit the workshop created by Lee Dove, motorsport enthusiast and Morgan afficionado.

1. The Harrison Lathe. The Transwave Converter can also be seen on the shelf- top left.

2. The race Morgan shown minus engine.

Tucked away between garden and paddock nestles the stable block which Lee has converted into a well lit spacious workshop. On arrival one is immediately struck by the sense of order, cleanliness, and of tools all in assigned places. Over a number of years, Lee's interests have ranged from model aircraft, to horses, (the living, breathing, one horsepower variety), to racing motorcycles to motorsport. In this latter area he currently competes in racing, hillclimbs, and trials. He is also one of those fortunate individuals whose wife and daughter share the same interests. As a result, whereas some of us find difficulty obtaining approval for workshop time, Lee's wife, Dani, is only too happy to pack him off after dinner, if only to ensure that her car is also ready for its next event. Dani hillclimbs a Frogeye Sprite, Lee, Dani, and daughter Alex all have a go with the Troll trials car, and Lee races one Morgan three wheeler, and hillclimbs a second.

Workshop machinery

The Troll project several years ago signalled the need for workshop equipment, and working in a scale of 1 to 1 demands something a little larger than a Unimat. The first major acquisitions were a Harrison centre lathe, (**photo 1**), (ex college so virtually unused) and a pedestal drill. Three phase power is supplied by a Transwave converter, which was considerably less costly than an inverter of similar power capacity. The Transwave is a device which repays the effort in getting to know its foibles. For its operation it relies on motor feedback to generate the third phase, and as a result there are one or two points to note. First there is a minimum motor size for successful working, and so the spindle motor should be running before starting the coolant pump. Second, starting torque limitations encourage the selection of something less than top speed at start up especially if the headstock oil has been cooled to the consistency of molasses. Once the niceties of "driving" the Transwave were mastered, it has proved a cost effective and totally reliable power source.

Having completed the Troll, and having become involved in hillclimbs with the roadgoing Morgan, Lee set out on a more ambitious project, to build a racing version (**photo 2**). For this the starting point comprised little more than a box of chassis lugs and a rack full of steel tubes, aluminium sheet, and seasoned ash. Part way through the construction it became clear that a mill of around Bridgeport size would be a worthwhile addition. The machine acquired (**photo 3**) was being disposed of by a nearby engineering shop, where the owner had both an original Bridgeport, and a Taiwanese copy. He had

3. A view of the hybrid Bridgeport mill.

4. The Spherical Dolly made to form the Morgan upper tail section.

6. The components of the home made Louvre Tool.

5. The Vertical Louvres which necessitated the special tool.

decided to put the Bridgeport head (with R8 spindle) on the Taiwanese base (with unworn slideways), and then dispose of the second machine (Taiwanese head with INT30 spindle, and Bridgeport base), and this machine now graces one corner of Lee's shop. After a good clean up and readjustment, it continues to give excellent service, and is also powered quite happily by the Transwave set.

Special Tools and Equipment

Building the bodywork for the racing three-wheeler necessitated solving a number of problems and acquiring a number of skills. Twenty-two gauge aluminium is not the easiest material to work with, and Lee does admit to a few headaches welding up the various parts. Wire beaded edges meant making up formers and sets, and the double curvature of the upper tail section required a tailor made spherical dolly (**photo 4**). Many of us with some experience of sheetmetal work will be familiar with commercial louvre tools, usually intended for use on a press or pressbrake. The louvres on the Morgan (**photo 5**) were made without access to such equipment. A commercial tool is normally designed to shear and then form as one operation. Lee's solution relied on separating the two parts of the operation. First the material was cut with a fine saw along the louvre split line. Second, the louvre was formed by applying the tool shown in **photo 6**. It is comprised of identical top and bottom plates, and a shaped bar. The workpiece is clamped between the plates (which are aligned with each other, and the saw cut), and the bar forced down through the aperture in the top plate, thus deforming the aluminium. The depth of the louvre can be controlled by the thickness of the bottom plate.

One detail noted on the race car was the finely finished dash board. As the dash is a structural member, it is built as a sandwich construction of aluminium and wood. The visible aluminium surface is decoratively finished in fishscale or engine turned effect. I seem to recall that the best known method to achieve this was by gripping a length of wooden dowel in the drill chuck, and applying grinding paste to the end, however after experimenting, Lee reckons that a cork from a wine bottle gives a better result.

Somewhat surprisingly, the piece of equipment regarded by Lee as "most useful" is not one of the items of machinery or tooling, but the purpose built bench about 18 inches high, strong enough, wide enough, and long enough to carry a complete Morgan. In addition to safely presenting a car at a comfortable working height, the bench also serves a wide variety of more general purposes.

The orderly approach to tool storage can be assessed from **photo 7**. Tools are of course packed up and taken away to race meetings, however on return, each item is returned to its allotted position in the workshop shadow board. In the foreground of the same photo, and featured on the front cover is the JAP vee twin race engine, now overhauled and ready to be refitted for the forthcoming season. It may be of interest that this engine develops around 100hp, propels the Morgan up to about 130mph, and consumes methanol at the rate of one gallon for every three miles.

7. Lee, with vee twin on the car bench, and orderly tool storage behind.

NOTES ON VARIABLE FREQUENCY INVERTERS

Peter Dawes of Orange, New South Wales, Australia, shares his experience.

I recall reading the article by Tony Jeffree which appeared in MEW issue 69, on the Newton Tesla speed control package applied to a Myford lathe. Having used two variable frequency three phase inverters (VFIs) for a number of years, I feel it may be of interest to air my experiences of using these devices. One is on a mill and the other does double duty on a small lathe and on a drill press. They are different brands and the cheaper one is not quite as good as the more expensive one – only to be expected I suppose. But both do their job well.

But there is good news and bad news about these units. First the good news:-

1. They are the answer to an M.E's prayer. I couldn't do without mine, having once used them. I've never had the slightest trouble with either machine, but if I did, I would have to get it fixed or replaced pronto. Shifting belts is just no longer acceptable to me.
2. Secondly they seem to provide smoother torque and running than did the single phase motors, even though I am running one of the three phase systems at somewhat lower power than the original single phase. This is only a feeling, and I cannot prove it.
3. The ability to reverse by push-button is useful on a mill and a lathe, although it is by no means essential. It is the simple continuously variable speed control that is the basic reason for using these devices.
4. Fourthly, and quite important, they have 'soft start', and usually programmable ramp up/down, which avoids massive starting currents.
5. Fifthly, you can use one VFI to power two (or more) machine tools by the simple expedient of adding an industrial three pole three position switch rated at 15A 500VAC or more to the system and switching the output of the VFI from one motor to the other as needed. But don't do it while either motor is moving. This works well as long as the machines are not more than a few metres apart and each is within the power rating of the VFI. I am driving a bench drill and a small lathe with a pair of 1/2HP 3-phase motors that I bought cheaply at a deceased estate sale, and I am running them with a 3/4HP VFI, all off a standard domestic single phase power point. In the home workshop I doubt if you would ever need to run two machines at once.
6. You can change speed in mid cut and without stopping – useful when facing a large disc because you can increase the speed progressively as you approach the centre. Or you may need to slow a cut on account of chatter or for some other reason. But do not try to reverse on the fly to brake your machine unless the manufacturer has approved it. It's risky on account of the inductive spikes that are produced. They can easily damage the electronic circuits. Frankly, I am not game to try it on mine. However I am lead to believe that some of the more modern designs allow for a programmed forward-stop-reverse.

VFIs also have a few aces up their sleeves. They are controlled by microcomputers and so it is relatively easy and cheap to incorporate monitoring of over-voltage, under-voltage, over-current, temperature rise (ie temperature within the controller itself, but if the motor itself has a thermal sensor some controllers can monitor that too).

Now the bad news:-

1. VF inverters are very expensive – certainly in Australia, and unreasonably so considering the amount of circuitry they contain. A TV set has far more electronics in it yet costs half what these devices cost. However, on the positive side, as the technology becomes more popular, the costs are reducing.
2. They are more "fragile", in the sense that they are easily destroyed by large spikes on the power lines. You are well advised to install a good surge and spike suppressor on the line feeding the VFI – just as you would for your computer - and of course it must be rated for the peak power demand, which as a rule-of- thumb is five times the full load running current. Old motors would take these surges in their stride – but not so these and similar electronic devices. Again, latest designs may include more safety features.
3. Perhaps the most serious defect however, is the torque at low frequency.

Many older generation controllers have poor torque at lower frequencies. This is more or less inherent for reasons we cannot go into now, but it can be compensated in later better quality units by extra circuitry that automatically feeds increased current to the coils to compensate - by sensing the load as it were. This is sometimes called 'flux vector feedback' but different makes may have different names for it. It can be so effective that you can actually construct a drive that will provide full load motor torque down to one hertz. Without this special feedback, expect the torque to fall more or less linearly with frequency from the normal 50Hz down to zero. Some devices provide for programming a property called the 'VF curve' (voltage v. frequency) that can modify the slope of this fall to some extent. VF curves may be programmable from 'straight line', to 'convex down' (fan loads), to 'convex up' (for loads such as compressors, but this is not to be confused with the temporary 150% overload capability that is standard on most VFIs for starting high inertia loads). What we want is the maximum possible 'convex up' for maximum continuous low speed torque.

So without flux vector feedback, there is effectively a practical lower limit on frequency of about 15 Hz depending on what minimal torque is acceptable, and thus at these low frequencies you may still have to shift belts or use back gears! But I have found from experience that I have only needed to shift a belt less than 5% of the time- that is when machining a large diameter with a heavy cut.

Another thing that users should be aware of is that torque also falls linearly with frequencies ABOVE 50Hz and this applies to virtually all VFIs. There is a good reason for this too. As speed increases, so torque must fall for POWER to stay constant - as it must. Users should regard the device's specified power output as an absolute maximum and never try to crib a bit extra. Temporary overload of about 150% is often permissible but the key word is 'temporary'. Some VFIs advertise a frequency adjustable to over 300Hz, but it is quite likely that at this frequency the torque will not even be able to turn the machine over. It's basically useless. Don't bank on being able to use much over 100Hz in machine tool driving applications. However on metal cutting machine tools, the upper end of the range is never a problem. It is the lower end where we want higher torque with low speed, and where belts and gears may sometimes be essential. I cannot comment on the properties of the Mitsubishi controller in this respect since I have had no experience of it.

4. These VFIs generate radio frequency interference (RFI) and by law this must be filtered to keep it out of the mains and out of the airwaves. Separate custom made RFI filters can cost as much as the controller itself so make sure you get one that has its filter built in.

Also, the three leads from controller to the motor form a good RF antenna and should be shielded by running them in a grounded metal conduit. If you do not do this you may get interference bars showing up on your TV set or hash in the radio. If anyone in the house has a pacemaker, this shielding becomes vital.

Wiring a motor in Delta

My VFI's output 240volts, and the 3phase motors, being old and 415volt rating, did not provide for delta connection in the terminal box, and so had to be dismantled to find the star point of the windings. To do this remove the end bells to expose the field windings and look for the taped join where the three phase windings are connected together, usually at the end opposite the terminal box. Break the join and attach lengths of flex wire to the three ends. Tape the joins again so they are well insulated and tie them down securely. Then feed the three new extensions back via gaps in the laminations to the box and find somewhere to terminate them. If there are no free terminals just join them with insulated joiners in mid air as it were. For delta you reconnect the three windings in series as follows:

Let S=start and F= finish. Arbitrarily label all the ends from the old star point as "finishes" and all original terminals in the box as "starts". Join F1 to S2 , F2 to S3, and F3 to S1. (The windings are numbered arbitrarily). You now have a closed 'triangular' circuit made up of the three phase coils in series with each other. Check the connections with a multimeter to ensure that there are no opens and no shorts.

The three power output leads from the VF controller are connected one to each vertex of the triangle. It doesn't matter which one goes to which point of the triangle for the moment. We can switch one pair over later if we need to reverse the motor's 'normal' direction. That means that each new junction must have three wires into it.

Most modern motors will have all six leads already returned to the terminal box so that star or delta can be configured at the box as required. Also, it should be borne in mind that modern motors are probably better in some other respects. They will have better quality windings and should run quieter and more efficiently than older ones. As Newton Tesla said, it is possible to select motors that are optimally suited to this type of work. That said, it is unlikely that any reasonable three phase motor will not work perfectly satisfactorily once it has been reconnected in delta configuration. (VFI's are available with 415V output, but these tend to be 415V input, higher power, and more expensive and would use star motor connection.)

Speed control

The changeover switch and more importantly, the "Speed", "On/Off", "F/R" and "Jog" buttons on the hand control unit (available with some VFIs to allow the large main box to be placed out of the way) are mounted on a pedestal somewhere between the two machines so as to be accessible from both. The cables can be routed up inside the column of the pedestal which can consist of nothing more than a piece of water pipe with a flange on its base and top. The control unit proper is usually wired with low current wires but they must be double-insulated or rated for 240 volt in case of a breakdown to the mains. All internal wiring is at or potentially at, mains voltage or higher . Speed is controlled either continuously by a small potentiometer, or fixed speeds can be selected by a rotary switch or by a set of push-buttons.

Potentiometer speed control gives no indication of speed other than the frequency display, so to get around this either mark the face of the dial as Tony described, or use the switched fixed-speeds method. But neither of these make provision for the belt or gear ratio and it's the speed at the machine spindle that matters. The only thing that can provide this is a tachometer on the spindle. I have fitted tachos to mine but I find that simple approximate speed indication suffices in most cases. Very slow and very fast are the only situations where you need more accuracy. You can usually guess what is needed, and in any case you can change it in mid cut if necessary – something you cannot do with belts or with gears.

The changeover switch is not cheap but the system is so convenient it is well worth the investment. A switch will be about 2" square by about 4" long and needs to be mounted in a box on its own or in with the control unit.

About the waveform

One more word of warning! There are 'El cheapo' inverters that produce a pseudo-sine wave output. These waveforms might consist of a few square steps whose net power and voltage may well be the same as a sine wave. But unfortunately they are just not suitable for use with induction motors and certainly not suitable for our purposes. Good quality controllers generate reasonably "true" sine waves whose envelope will have an equivalent harmonic distortion of no more than a few percent. Now this is not a property that is frequently quoted but you can be sure that major brands such as Hitachi, Mitsubishi, Teco and others that are specified for speed control of three phase induction motors will be OK. But ask for the figure if contemplating an unknown brand.

Switching speed and noise

Another property that can be important is switching speed. VFIs synthesize their waveforms by using pulse width modulation (PWM) and switchmode techniques. Low switching speeds, such as one or two kilohertz can become audible and hence annoying. Higher switching speeds such as 5 or 10kHz or more, are quieter, being nearer the limit or outside the range of most human ears, but they are more difficult to manufacture. They require faster semiconductors and not surprisingly, cost more. Many VFIs today seem to use IGBTs - insulated gate bipolar transistors – and operate between about 3kHz and 15kHz. On one of my devices even this frequency can be programmed. IGBTs are preferred because they combine low drive current with fast switching speed, low conduction resistance, high current and high voltage capability.

Cooling

One further question which must be addressed concerns heating. Whilst drilling jobs do not usually last long enough at any speed to cause the motor to overheat, work on lathes and mills can continue for half an hour or more. When the motor is running at low speed its internal fan is useless and if pulling any sort of load, it will soon overheat. The solution for this is a small external constant speed fan. It can be a shaded pole motor of about 60 to 80 watts, but buying one fitted integral with the motor can nearly double the cost, even if you can get it. So mounted below the motor that drives the mill I added a rolled sheet metal housing in which I mounted a small cheap auxiliary fan. The motor is wired to be on permanently whenever power to the controller is turned on. That also warns me to turn off the power to the controller when I have finished work. I can report that while the original Taiwanese single phase motor on the mill ran very hot ALL the time, the new three phase motor never gets above 'warm'. There must be a significant improvement in efficiency if nothing else.

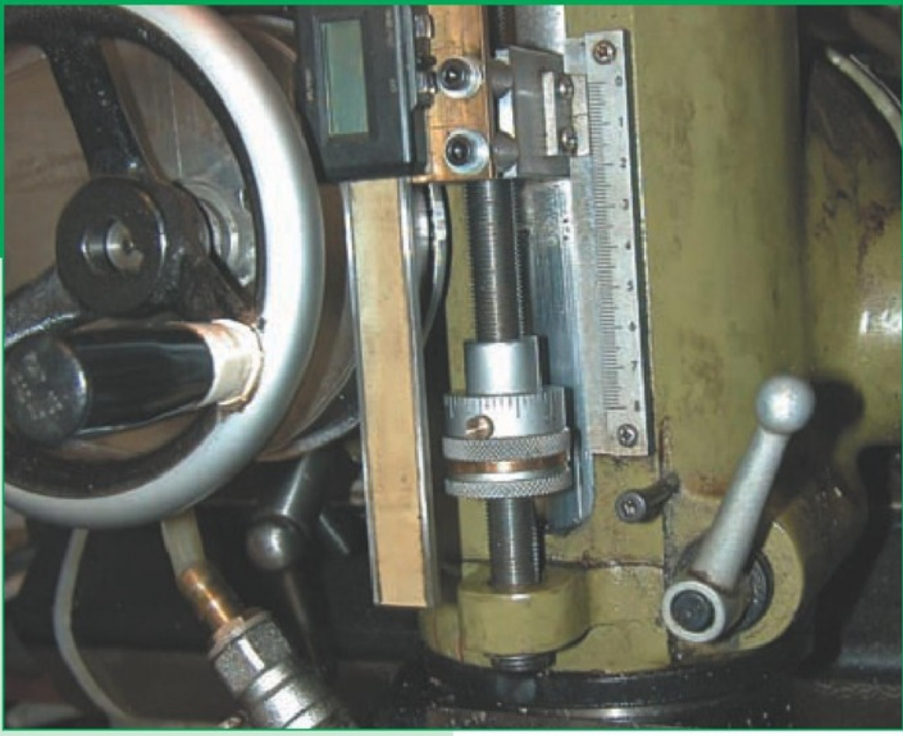
I have not fitted a fan to the motor on the drill/small lathe and there have been no problems with it.

Circuits

Finally, I know of no circuits for VFIs, and that is not for want of trying. This is an area of advancing technology, and manufacturers keep their designs secret - so much so that you will be unlikely to ever see a circuit diagram even for doing repairs. If anyone has one, please let me know, or better, send me a copy! (Email: dawesp@netwit.net.au ; or fax: 061 (02) 6362 9279). Aside from that, they operate with internal lethal voltages, so it is simply not feasible for the amateur to try to make his own, or even service one.

QUICK QUILL STOP

Peter Rawlinson shows how to save time and money with a modification which can be adapted to many Milling Machines



1. The Quick Quill Nut in place on the Mill

Introduction

Some time ago I was looking through a large tool suppliers catalogue and noticed a part that acted as a quick quill stop nut. However the price as I recall was in the order of £ 35-00. and I thought that it was expensive for what it did. I therefore decided to see if I could design and build the unit for myself. Also if it were possible to modify the existing nut on my Mill, then it would effort of engraving the graduations that might be required.

To this end the part was removed from the Mill and was found to be very substantial. The design then proceeded and the outcome was the unit that is depicted in this article. The drawings and photographs relate to my Mill, and the individual may require adjust sizes to suit his own machine. It is very quick to use and saves countless time winding the stop up and down the threaded rod. Ideally of course two are required, to provide locking. I have in the meantime made just one, as can be seen in **photo 1**, but a second can always be manufactured if needed. The locknut could of course be somewhat thinner, as described below.

Manufacture

The existing nut is modified to become the Outer Case. The first operation is to machine out the existing thread, to bore the body out to 22 mm. diameter, and then to offset the part in the chuck and rebore at the offset making sure the orientation is correct to the "Zero" on the graduations. After this it will be necessary to clean off the ridge on each side so that the inner nut can be moved across with a nice sliding fit. This whole operation could be carried out in the Mill using a 22mm. diameter end mill or slot drill, or even a carefully applied Rotabroach type cutter as the manufacturers do say they can be used for cutting half holes etc. The two No. 6. BA. tapped holes for the cover retention can also be finished at this stage. The outer case is shown in **photo 2** and the drawing.

The second step is to make the nut, photo 3 and drawing and I suggest that a piece of Hard Phosphor Bronze is used, to give wear resistance and strength, as much of the thread must be machined away to give the clearance necessary for the sliding action. This can be started off in the lathe and then transferred to the mill but between these two operations I suggest that the drilled and tapped hole for the Knob is completed and any burrs removed from the thread, using a hand tap. After transferring to the mill the offset bore (which I dealt with using a single point tool) is machined. It is also necessary to make sure sufficient thread is removed to allow the rod to slide through. This will necessitate the removal of more than half of the thread. The last operation on the nut is to drill the hole for the spring location. This must be as deep as possible as it is necessary for the spring to compress fully into this recess to give the required clearance for the threads to disengage. To

2. Modified outer case

3. Inner nut showing spring and knob and actuator

4. Lower Cover Plate

achieve this, it may be worth while using a slot drill to win a little extra depth where the spring will contact. It is also worth mentioning that the nut should also be a good fit, measured axially, in the outer case to ensure a backlash free fit. This may be best fitted by hand. Remember however, that if there is slop in the thread then a close fit between nut and case will not help.

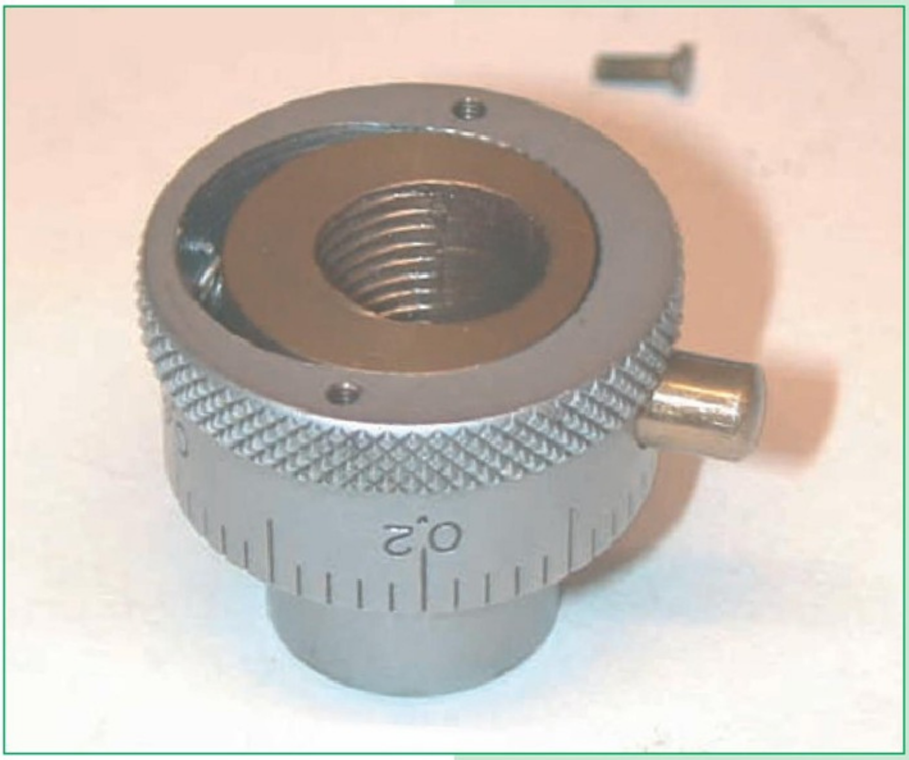
The last part is the lower cover (**Photo 4**) and as this is straight forward, no further detailed guidance is needed.

Assembly (**Photo 5**) is self explanatory, the only comment being that the spring must be a free fit in the location recess, reasonably strong, and must as stated before, compress completely into its housing to allow full clearance.

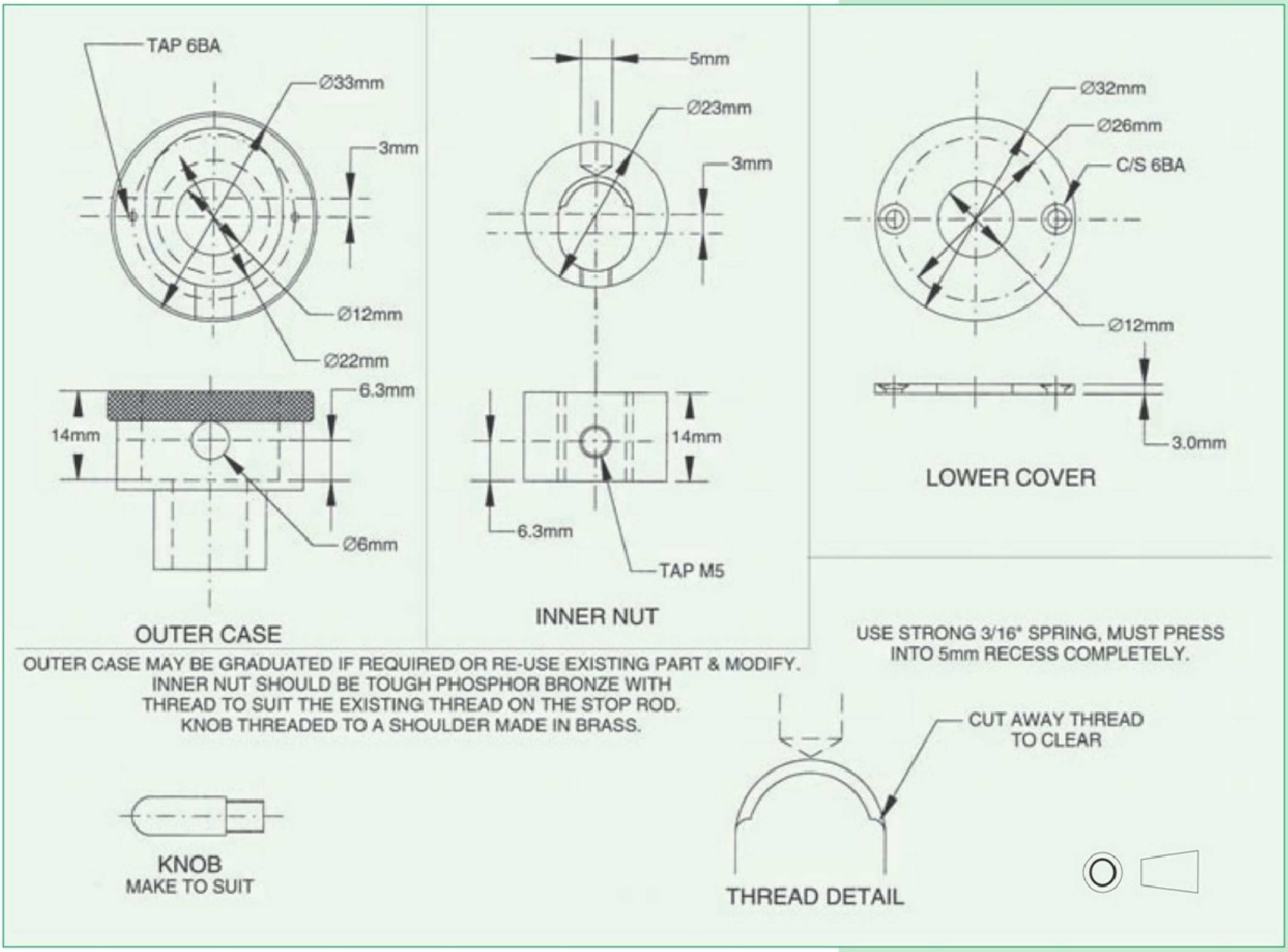
If a second device is required for locking purposes, then the bottom protrusion can be left off and the overall thickness reduced to 11mm. Reduced thickness of 1.5mm each for the outer case and cap plate would leave 8mm for the Nut. I have however found that my existing locknut which is only 5mm. thick spins down the rod very quickly, and therefore have chosen to retain it. I hope the device is of interest and helps to save time for others in the shop as it has for me.

As usual if I can be of help I am happy to do so but phone only please.

Peter Rawlinson. Charing Kent. 01233 712 158.

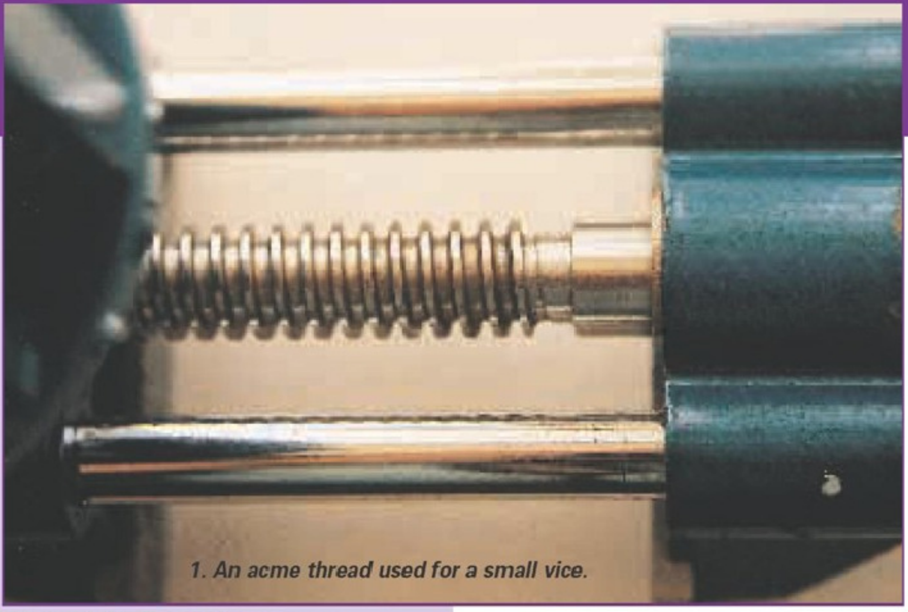


5. Removal of the Lower Cover Plate allows the part assembly to be seen.



SCREW THREADS ARE NOT JUST FOR FASTENING

Bob Loader takes a look at various thread forms, uses, manufacture, and measurement



1. An acme thread used for a small vice.

A useful reference book

A long time ago, when I was in charge of an apprentice workshop, I had access to a technical library with among many other useful books, a copy of 'Machinery's Screw Thread Book'. I used it mostly for reference but also as an object of curiosity and, when I had a minute or two to spare, not very often, I used to ponder some of the threads in it. There were all the standard ones and a lot with most unlikely names and applications, like the Chicago Fire Department hose coupling thread for instance. I couldn't resist looking up the Lowenhertz thread and being a bit miffed when I found that it was an ordinary vee thread.

There were other specials, those for watch and clock makers and the very fine ones for optical work, those which are easy to cross and tend to be very tight to undo.

I should think that about 80 or 90% of threads are used for joining or fastening, of the others there are some which I think of as Workshop Threads which do special jobs. These are the ones used for moving, measuring and clamping. the most important ones being, square, acme and buttress.

Square

This is an old stager and has been around for a long time. Consider an old cider press, the pressure is applied by square threads. **Fig.1.** is a stylised version of what it looks like and the proportions. It is very strong and avoids bursting stresses in the nut, very important when pressing the last knockings out of the apple pulp, or when a large clamp is clamping a piece of woodwork while the glue sets, or when adjusting the pressure on the rollers of an old-fashioned mangle. It was also the screw in the jumper of a water tap and in the valve mechanisms of large valves controlling the flow of steam, oil and other liquids in heavy engineering plant. Coming down in size to our level, the strength properties are excellent for machine vices, large clamps and jacking screws which have to stand heavy pressure, like those used for the vertical movement of machine tables.

Cutting square threads

Not an easy task at the best of times with many pitfalls. The best advice I can offer is to cut the male thread to at least full depth, and use some 60/40 brass for the nut. A carefully ground parting tool will give enough depth for the screw, and a brass nut is more easily machined.

Square threads are a bit more difficult when they are multi-start ones. There is a sum to do which will give the angle to lay the tool over, so that the heel of it doesn't interfere with the slot which it has cut. The formula is,

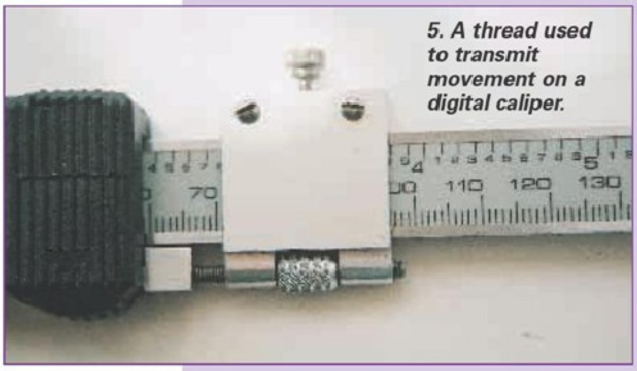
$$\text{Tangent of the helix angle} = \frac{\text{Lead of the thread}}{\text{Average circumference}}$$

The lead of a thread is the pitch

2. The acme screw and nut from a lathe cross slide.

3. A round thread on a light bulb.


4. The accurate thread of a micrometer.


5. A thread used to transmit movement on a digital caliper.

multiplied by the number of starts and the average circumference is the outside diameter minus one thread depth multiplied by pi. So, to take a simple example, for a 1in. diameter square thread of ¼in. pitch, the lead is the same as pitch, so the sum is,

tangent of helix angle

$$= \frac{0.250}{0.750 \times 3.142}$$

$$= \frac{0.250}{2.356}$$

$$= 0.1061$$

The nearest tangent value (in the Zeus chart) to this figure is, 6 degrees and 5 minutes. For cutting purposes 6 degrees will be quite good enough. For multi-start threads all that changes is the top line, for example, for a three-start thread, the formula would be,

$$\text{tan. helix angle} = \frac{0.250 \times 3}{0.750 \times 3.142}$$

$$= \frac{750}{2.356}$$

So, tan. helix angle = 0.3183, the nearest value is l7 degrees and 40 minutes. The angle would probably be all right at 17½ degrees. Those are the bare bones of the business, for more information there are plenty of books which will go through the whole process more comprehensively than I have.

There are some tool holders specially made for cutting threads which need to have an adjustment for the helix angle. The blade is a very deep section, like a parting tool and it can be swivelled to any angle and locked. I have used one and they work a treat, they are though, extremely expensive and probably beyond the scope of most small lathes. An acceptable substitute can be made by using a large round tool bit in a holder which will allow it to swivel and lock at the required angle.

Acme

You don't have to hunt to see an acme thread because they are an essential part of many a machine tool. Larger lathes will have them in leadscrews, cross slide screws and compound slide screws. Smaller machines, like my Unimat, may tend to use standard Vee threads.

Their popularity and usefulness stems from their strength and compared to the square thread, their ease of manufacture. (For applications requiring only modest precision, thread rolling is possible) They can be used to transmit movement and measure at the same time. Add the other virtue that the shape, shown in **Fig 2**, is a modified square shape which will allow a split nut or half nut to open and close on it easily and it is even more useful.

Photos 1 and 2 show acme threads. The first is the thread in a small vice and the second the leadscrew and nut from a lathe cross-slide.

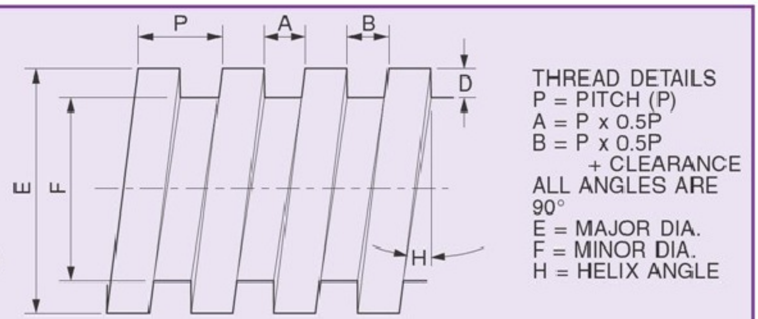


FIG. 1.
SQUARE THREAD
(LEFT HAND)

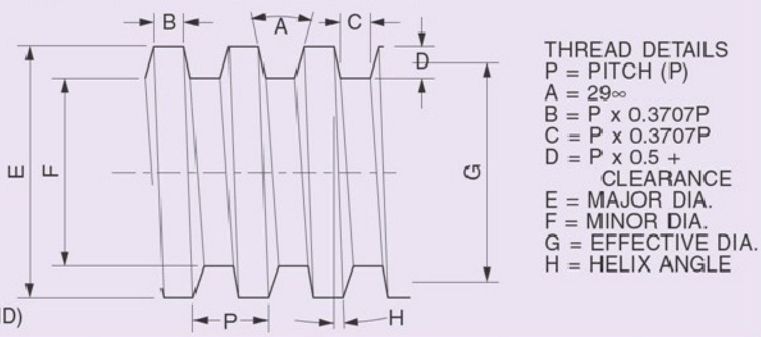


FIG. 2.
ACME THREAD
(RIGHT HAND)

Cutting acme threads

This is interesting but not the sort of task a model engineer will come across often, if at all, which is as well because it is not too easy. The best way I have found to cut the outside thread, is to cut a narrow square thread first which is the width marked C on Fig.2. Once this has been done, the 29 degree tool can be used to finish the profile. A good method is to cut alternate flanks, rather than plunging the tool straight in, if the whole of the tool is in contact, there is a lot of force on it. Cutting the internal thread is not a barrel of laughs and my advice is to use a tap, if one is available.

Part of the business of training first year apprentices was an end of year project, which was the construction of a small shaping machine. It had three acme threads, ranging from ½in. to ⅝in. I was lucky and able to have the taps bought in. An acme tap is a very precise item with a pilot section which cuts a small groove, followed by a conventional tapered length somewhat longer than an ordinary tap. There is just the one tap and it serves as taper and plug. Because of the length, the taps flexed alarmingly when used and apprentices sprouted beads of sweat and twitched when the tap stuck and started again with a click. The material was wrought phosphor bronze, which didn't help and I had told the apprentices how much each tap cost, an average of about £50 each and that was in the mid 60's.

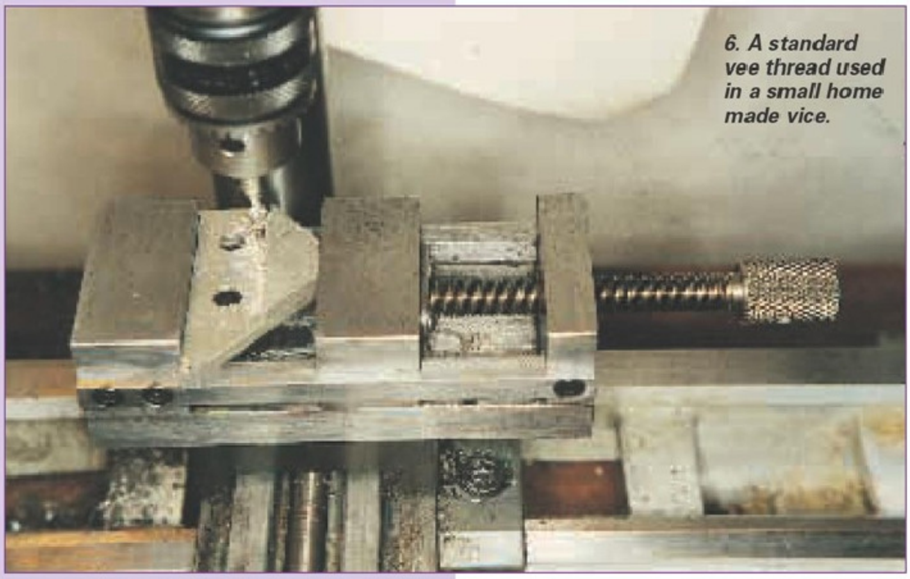
On the principle that you don't keep a dog and do your own barking, I just let them get on with it, standing behind them from time to time - they hated that.

None of the taps was any the worse when the job was finished, they were of a size which gives the machinist a chance, easy to lubricate and keep fairly clear of chips.

The smallest acme thread I have seen is the one used in some height gauges of the Chesterman type. It is used to finely adjust the scriber, for coarse adjustment, the thread can be released, another example of the thread shape being easy to engage and disengage. I always used to wonder if a vee thread would have done as well and cut down the price of the instrument.

Buttress

This is a peculiar shape, shown in profile in **Fig.5**. It is just the job when there has to be a lot of pressure resisted in one direction; so it is ideal for larger bench vices. Because of its shape it will also



6. A standard vee thread used in a small home made vice.

release very easily for quick adjustment by depressing a trigger on the side of the vice handle. To sum up, it combines the clamping and non-slip function of a square thread with a quick release. As for cutting one, I pass, never having had to do it. So I offer no guidance.

Round or Button

This is one I have cut. Many years ago, when I was an apprentice, I had to make a bulb holder for the dynamo front light of my bicycle. In those days, unlike now, it was easy to get stopped for riding without lights.

Cutting the thread was easy, once the tool had been ground and the number of threads per inch counted. The thread is used mainly in light bulbs of various sizes, like the one in photo 3. The thread profile is shown in Fig 4. and it is easy to see why an alternative name for it is, 'knuckle' thread.

Vee Threads for measuring and moving

For small measuring tools such as micrometers, vee threads are ideal. They are easy to produce, wear well and can have adjustment components in the design. **Photo 4**. shows the beginning of the thread of my 0- 1in. micrometer, a fine one of 40 t.p.i. This thread in conjunction with the 25 divisions on the thimble gives one thou per division. A thread of 20 t.p.i. could be used, but the increased number (50) of divisions would imply smaller divisions or a larger thimble. For metric micrometers the thread used is ½mm. pitch and the 50 divisions lead to 0.01mm per division. Metric micrometers frequently have somewhat larger thimbles than the traditional Moore and Wright imperial version.

Micrometer threads are very accurately made and are hardened and ground. They can be adjusted for wear but my experience with my 0-1in. is that, since I first had it in 1947, and in spite of frequent use, it has not shown any need for adjustment.

Small vee threads can be used to transmit movement and for clamping. **Photo 5**. is of a modification I made for my digital caliper, the knurled nut is used to move the caliper for fine adjustment, better, in my view, than the original thumb wheel provided.

For clamping, the small vice in **photo 6**. uses a fairly fine thread and the parallel clamp in **photo 7**. an even finer one: the finer the thread, the higher the clamping force, in relation to the torque applied.

Cutting vee threads

When possible, use the standard taps and dies, the makers have got the business taped and it makes things easy. There are exceptions, like when a non-standard threaded part is lost or goes walkabout. It has happened to me several times, once when the tension nut of one of my fishing reels fell into the Severn. It was a non-standard one so I had to make a tap to cut it. It is easy enough on most lathes but these days with my Unimat 3. a bit different, needing a few extra bits and pieces. **Photo 8**. shows the machine set up for cutting a thread. It is a hand operated job and once the gears and clasp nut are set they have to stay set until the thread is cut to full depth. The two idlers make sure that the 60 tooth gear will reach the 30 tooth tufnol one on the lead screw and that the rotation is in the right direction. Larger lathes will have threadcutting dials and reversing mechanisms to take care of these points. For information on the actual ways and means of screw cutting, check with Harold Hall's excellent series on lathe work for beginners.

Measuring threads

The accurate measuring of threads is an interesting process and **Fig. 3**. shows two methods of checking vee threads.

Thread micrometer

This is by far the easiest but potentially most expensive way. The thread micrometer is similar to an ordinary one but the anvil and spindle are shaped to the thread angle, features 4. and 5. on Fig 3. These instruments are available in ranges, for the various thread angles, and for various pitch ranges. The feature they measure is the effective diameter, which is the diameter where the width of the vee is equal to the width of the gap, see Fig. 3. The figure for the effective diameter is in most thread tables and is sometimes called the pitch diameter. It is also possible to purchase "Thread triangles" which attach to a standard micrometer, and may be used in conjunction with measurement conversion tables supplied with them.

3 wire method

When a thread micrometer is not available other ways can be used and one of them uses 3 wires as shown in Fig 3. The wires can be looked up in tables in the more sophisticated references. They are called, 'best sized wires'. If there isn't a reference book handy, the sizes can be calculated by using a formula which is specific to a thread form. For example, best wire size for 60degree threads is given by D = 0.57735 x pitch, where D is the wire diameter. When I have had to use the method, I used the shanks of number drills, they seemed to have the best range of sizes. The shanks had to be clean and un-scarred and the only difficulty was holding the three wires and the micrometer at the same time, a job really needing three hands. My solution was to

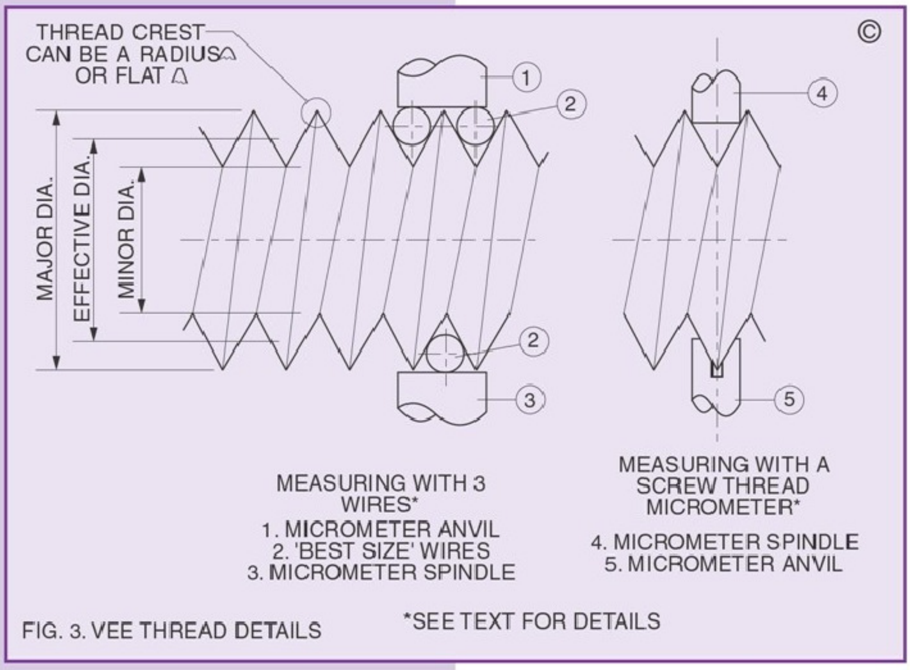


FIG. 3. VEE THREAD DETAILS

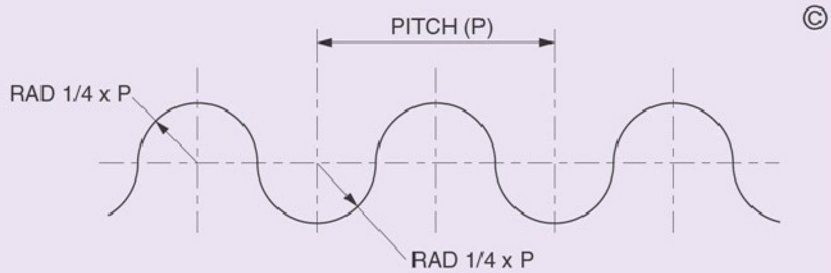


FIG. 4. ROUND THREAD

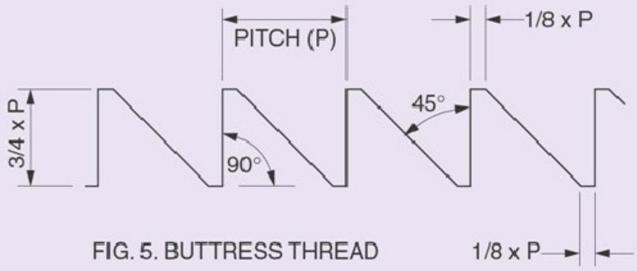


FIG. 5. BUTTRESS THREAD

use some plasticene to hold the bottom wire, leaving two hands fairly free. It is an interesting method but not one used every-day. If you are serious about thread precision, then a set of 16 sizes (48) wires covering pitches from 3 to 48 threads per inch can be purchased for around eighteen pounds, very much less than the cost of a thread micrometer. Details of the formulae to determine best wire size, and to calculate actual thread sizes from measurements may be found in publications such as "Machinery's Handbook"

Optical comparator

By the side of the section where I learned about turning, there were two very useful gadgets, an optical dividing head and a small optical comparator. The dividing head was something I used a lot when I had graduated to the instrument benches, a couple of years on, but the comparator was used a lot by most of the turning section. There were overlays of the common thread profiles which could be clipped to the screen so that the projected magnified outline of the tool being checked showed any variation from the true profile. The tool was then ground or stoned till it fitted. When I was an apprentice it was called the, 'shadowgraph', and there was a more sophisticated one in the inspection department which filled us with dread when we knew that our work was to be viewed on it.

Multi-start threads

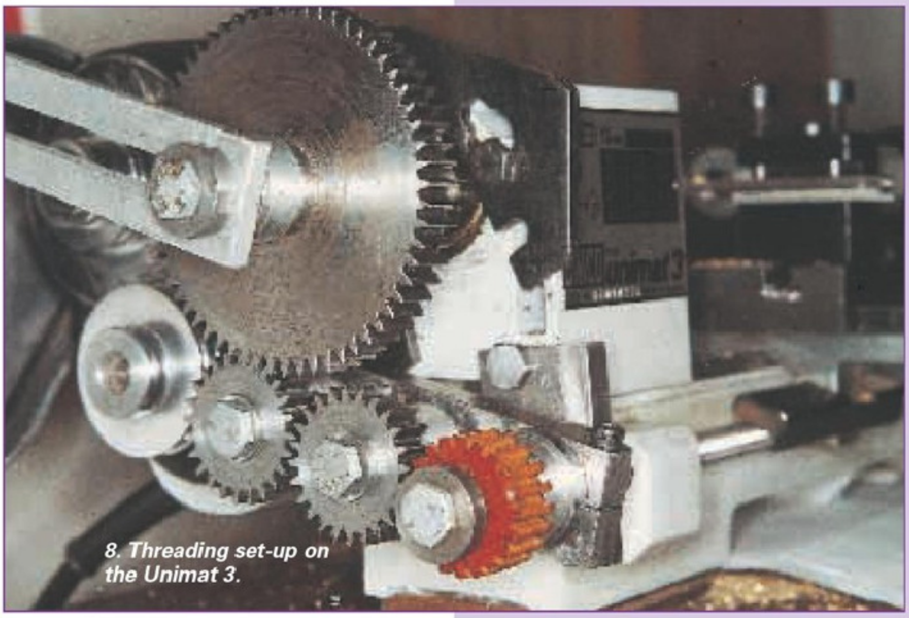
These are used when a thread must have a large axial movement for a small rotational one. Some machine lead screws are multi-start, so that the operator doesn't have to stand winding for a long time to position the table or slide. When considering these it is useful to forget about the thread pitch and think about lead instead. The lead of a thread is the distance the nut will move for one turn of the thread: for a single-start one, lead and pitch are the same; for a multi-start, lead is the pitch multiplied by the number of starts. If you refer back to the information on cutting square threads and the formula for finding the angle to set the tool over at, you will see that the angle changes a lot when the thread is a multi-.start.

An everyday example of multi-start threads is the screw caps on milk bottles. Have a look at a Marks and Spencer one and you will find a 1/16in. pitch thread with 7 starts. Sainsburys do it differently with a 3/16in. pitch thread with 2 starts. In each case it means that the cap can be done up and undone quickly and conveniently.

Other household items to look at which use the less common threads are, fizzy lemonade bottles and some toothpaste tubes. The lemonade bottle tops frequently have an acme thread, or its very close relative, only single-start this time, and usually segmented to allow moulding. The toothpaste tubes, those with a screw cap and a small flip-up piece as well, have a small buttress thread on the main cap. I expect this helps to reduce the bursting load on the cap when they are filled.

So threads, apart from their engineering uses, also find their way into kitchen and bathroom containers as well.

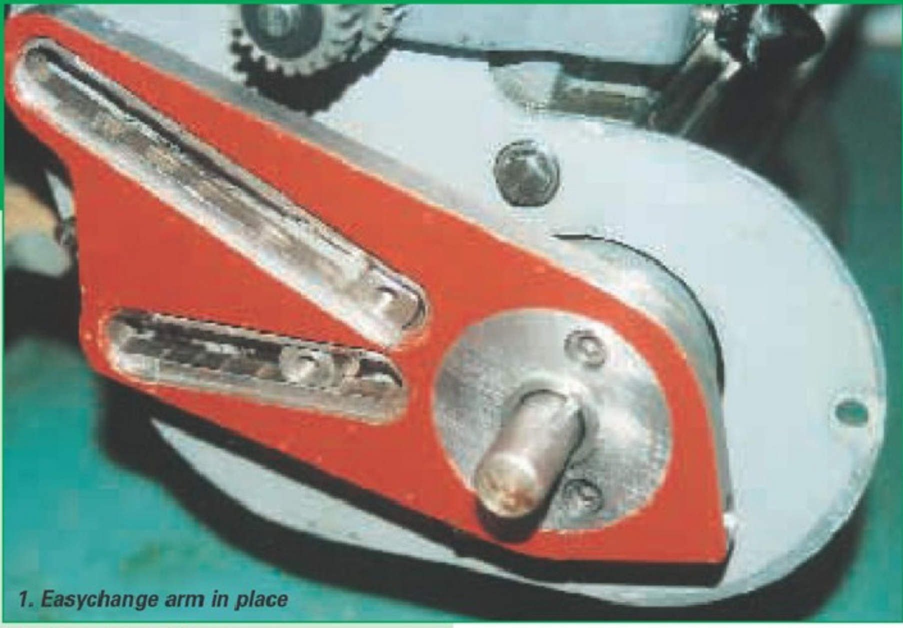
7. Fine threads in the parallel clamp have a good locking effect.



8. Threading set-up on the Unimat 3.

EASYCHANGE BANJO

A modified Quadrant Arm for the Myford, Paul Boothby offers a redesign to bring music to the ears of change-wheel swappers.



1. Easychange arm in place

Introduction

I find there is nothing more irksome in the home workshop than setting up change-wheels on a lathe. It is a fiddly job at the best of times. An improvement to the situation is to use that most useful chart in the MEW Data Book (Reference 1), where one need never reset the studs when cutting standard pitches- i.e., always assuming one has the necessary gears!

The "Easychange" has been designed specifically to minimize those frustrations arising from adjusting those studs on the quadrant arm. The device may not overcome all the problems associated with physical constraints, but it will certainly remove much of the effort of gear changing, by allowing not only the adjustments of the studs and the quadrant arm, but also the fitting of the change wheels to be performed with speed and ease using only a single hexagon wrench. *No adjustments are made to the right of the quadrant arm.* With practice, all adjustments and setting up can be achieved with one hand.

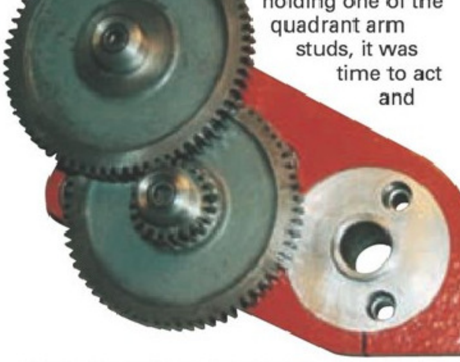
No apologies are offered for the choice of units shown in the drawings:

Since the Myford Lathe is Imperial, all measurements made on the lathe or with a Vernier caliper are in decimal inches, and those made with a rule are fractional. We are now well into the 21st Century, and we find metal stock is metric- hence the steel used is 12 mm rather than ½in. As BA threads are also effectively metric, drills used are metric where applicable.

2. The various components of the redesigned assembly

Background and Description

The above "frustrations" had been building up in the workshop for some time, and having a lathe without a screw-cutting gearbox did not help matters. When the thread stripped in a tapped hole holding one of the quadrant arm studs, it was time to act and sort things out one way or another. First the hole was retapped (5/16in. BSF in place of OBA) ready to accept a 5/16in. capscrew. Whilst the change wheel side of the lathe was stripped down, some thought was then given to improving the support of the change wheels, and the result was this project.



3. The Easychange fitted with changewheels

The slots in the "Easychange" are geometrically similar to those in the original Myford quadrant arm, but are slightly longer so that more change wheel combinations can be assembled. The lengths of the slots shown are the absolute maximum that can be used so that the change-wheel cover can still be fitted over the quadrant arm. The arm can be made with even longer slots, but it will not be possible to replace the cover. For any not willing to "risk it", the lengths of the slots may be reduced to those on the original arm supplied with the lathe (3.5in. and 2in. between centres, **Fig. 1**). For convenient reference, the outline of the Myford Changewheel cover is shown in **Fig 2**.

The studs have been redesigned, allowing their positioning and holding of the gears to be performed with one operation from the left of the quadrant arm. No access is needed between the arm and the head stock casting. The change-wheel studs are held in their slots by retaining cap strips mounted on the arm. The studs holding the original (Myford) quadrant arm to the lathe have been replaced by cap screws, which now support a boss. The Easychange quadrant arm has a banjo that clamps on to the boss using a capscrew that is easily accessible from the front of the lathe. The screw is located so that the arm cannot be removed from the boss unless the screw is first fully withdrawn from the arm. The components can be seen in **Photo 2**, and the assembly in **Photos 3 & 4**.

1. Construction:

The Easychange can be made entirely on a Myford ML7 lathe fitted with a long cross slide. The long cross-slide has the advantage over the standard length model, by being able to traverse 8 inches: the rear edge can be moved from 1 inch in front of the lathe axis to 7 inches behind. Accessories required include the following:

1.1 A vertical slide.

1.2 A length of PGMS (precision ground mild steel) bar. This should be faced


4. Easychange right hand side showing capstrips

off and accurately centred at each end. Its size can be anything from say, 0.5in. to 1in. diameter and from 6in. to 12in. long. Its purpose is to facilitate setting up.

1.3 A dividing head capable of supporting a lathe chuck (such as the George Thomas design) will be useful when drilling the holes in the boss.

1.4 An angle plate. This should be not less than 4in. long and have one side no wider than 1.875in. These requirements are to allow the job to be bolted to the two front tee slots of the boring table and to not interfere with drilling/milling operations. A hole 0.5 to 0.75 in. deep is required to be drilled/tapped OBA in the edge of the plate, about 1in. from one end. This will allow the milling of the edges and curve of the banjo in section 4. The width of the angle also allows the support of the work just below the lathe centre line.

1.5 A stout fishplate. This will be used for providing support when milling the slots in the quadrant arm. This can be made from 1in. x 0.25in. strip with several holes tapped OBA about 0.5in. apart along its length.

1.6 An elephant foot second support will be needed when milling the edges of the arm.

Various OBA cap screws: for clamping purposes, do not use screws that have rolled threads: they have undersized shanks, and these will allow work to become displaced when altering the cutting orientation during milling the outer curves of the banjo.

The machining processes are described in some detail to suit the less experienced reader equipped with just lathe and drill. Experts with heavier milling facilities will no doubt choose alternative methods.

5. The Easychange fitted to the lathe and ready for action

2. Quadrant Arm (fig. 4)- Preparation:

2.1 Cut the arm from 12 mm mild steel plate, allowing at least an inch excess material beyond the end of the longer slot (**Fig 3**.) Details of the part are in **Fig 4**.

2.2 Remove all rust and scale by sandblasting. If the material has been flame-cut, now is the time to grind the edges of the plate to remove all

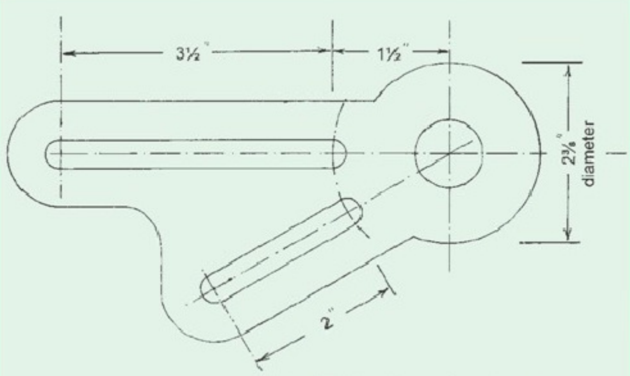


Fig. 1 Myford quadrant arm

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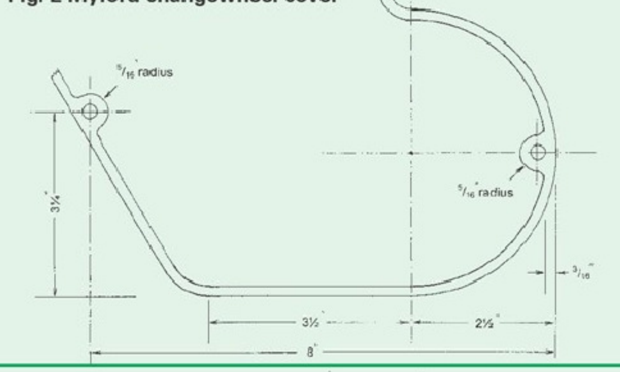
Fig. 2 Myford changewheel cover



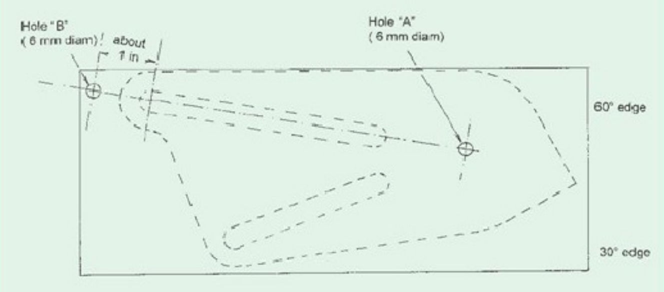


Fig. 3 Raw material
8⅛in x 3⅞inc x 12 mm mild steel

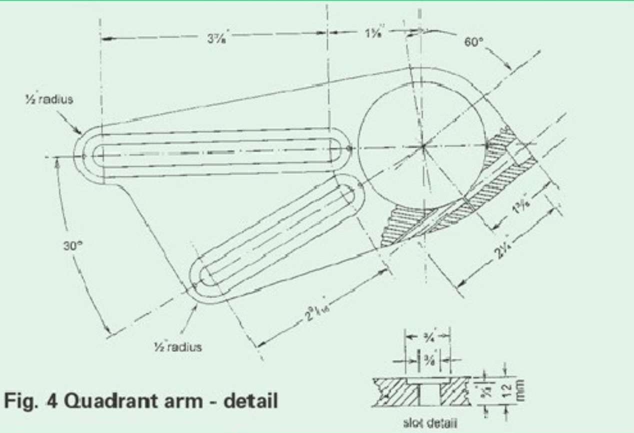


Fig. 4 Quadrant arm - detail

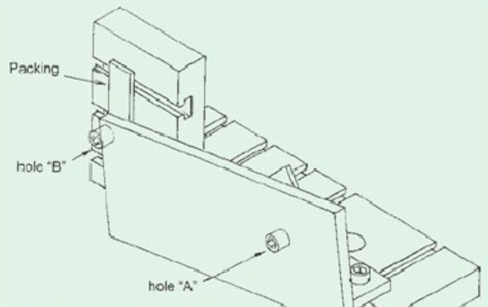
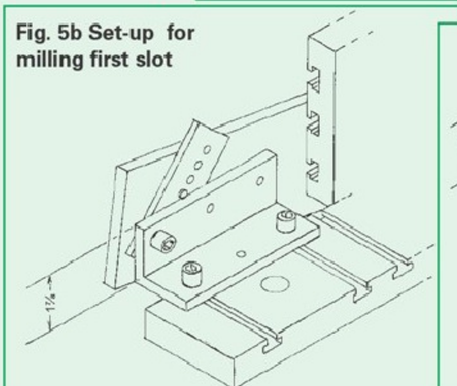


Fig. 5a Set-up for milling first slot

Fig. 5b Set-up for milling first slot



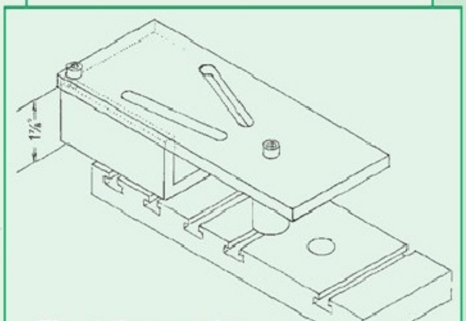


Fig. 6 Set-up for milling long edge

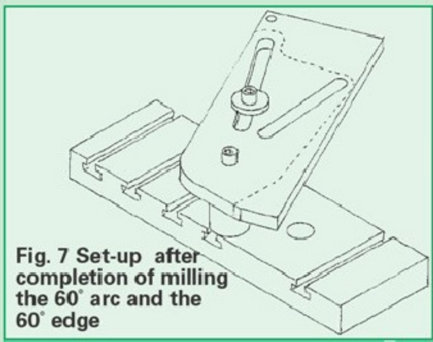


Fig. 7 Set-up after completion of milling the 60° arc and the 60° edge

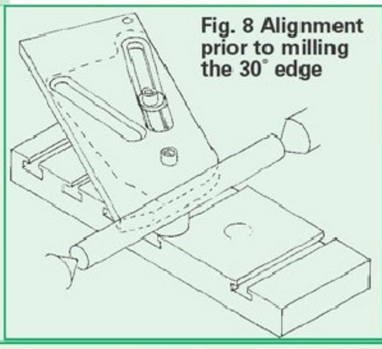


Fig. 8 Alignment prior to milling the 30° edge

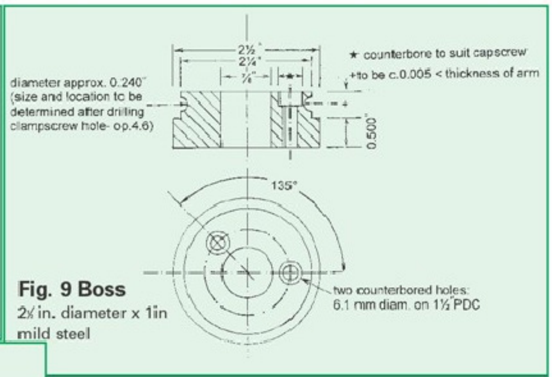


Fig. 9 Boss
2¼in. diameter x 1in mild steel

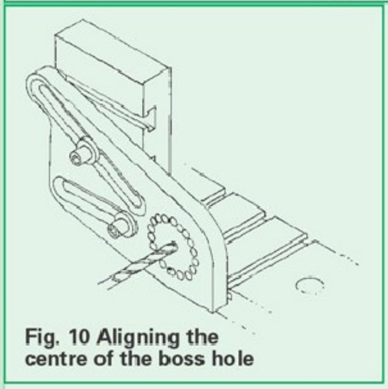


Fig. 10 Aligning the centre of the boss hole

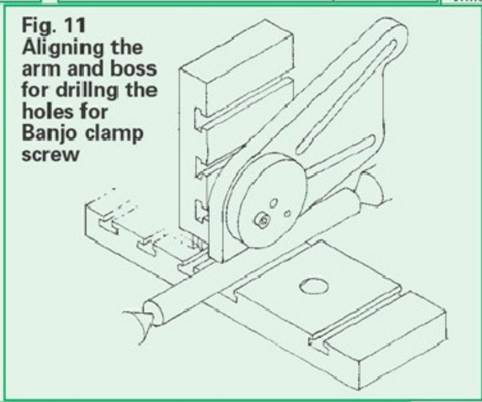


Fig. 11 Aligning the arm and boss for drilling the holes for Banjo clamp screw

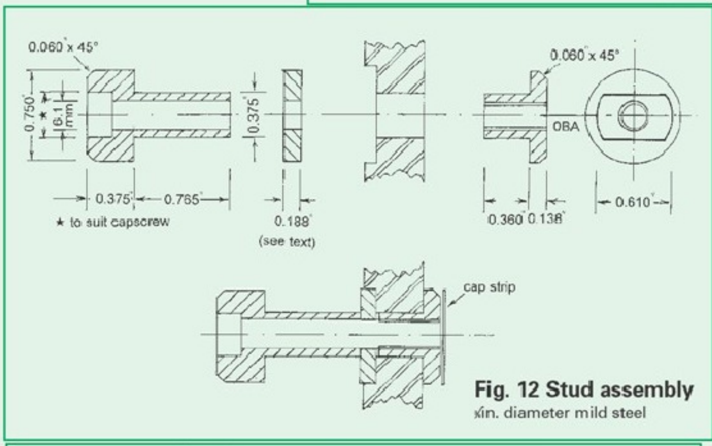


Fig. 12 Stud assembly
⅜in. diameter mild steel

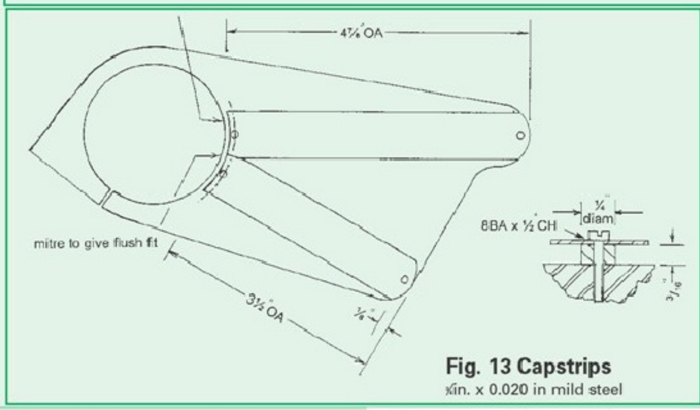


Fig. 13 Capstrips
⅜in. x 0.020 in mild steel

hardened surfaces, slag and oxide. These materials can rapidly blunt tools.

2.3 File all edges free from rags and burrs.

2.4 Mark out according to the drawings, and drill the 6 mm diameter pilot for the boss hole, and the temporary support hole ("A" and "B" respectively in figure 3). These holes will just allow the future milling of the long (upper) edge to be performed in a single operation -providing a long cross-slide is used.

3. Quadrant Arm- Milling the Slots:

3.1 (Refer to **figs 5a and 5b**). Fit the vertical slide in the rearmost two slots of the cross slide and set the face perpendicular to the lathe axis. Mount the angle plate on the front-most slots of the cross slide. Loosely bolt the fishplate to the angle plate. Mount the work on the vertical slide using hole "B", with some eighth inch packing for separation. Bolt the work to the fishplate using hole "A". Align the slot centreline parallel with the surface of the boring table and at the centre height of the lathe. Ensure that the plate is perpendicular to the lathe axis. Tighten all bolts and lock the vertical slide.

3.2 Drill a series of 0.25in. holes along the centreline of the longer slot to facilitate future milling.

3.3 Open the holes out to 0.312in.

Note when drilling holes in the lathe, push the work against the drill using the tailstock to push a piece of wood against the work piece or vertical slide.

3.4 Mill the slot with a 0.375in. end mill, taking only light cuts. Lock the carriage while milling.

Note that strong lateral forces will be exerted on the work piece while milling - hence the fitting of the fishplate. Regardless of which way the slide is traversed, one side of the slot will be climb-milled. Climb milling may give a better finish to the work, but it calls for careful working with the minimum of backlash in the cross slide. Some of the adverse forces will be nullified by forces from the cutting of the opposite side of the slot.

3.5 Using a 0.75in. dia. end mill, cut the shoulders on the slot, taking only shallow cuts.

3.6 Remove the bolt from hole "B" and slacken the one in hole "A". Swing the work clockwise through about 30 degrees, and align the centreline of the slot to be milled parallel to the boring table and at lathe centre height. Clamp the work to the vertical slide, using the newly cut slot, again using the packing between the work and the slide.

3.7 Repeat operations 3.2 to 3.5 on the shorter slot. Remove the vertical slide.

4. Quadrant Arm- Milling the Edges:

4.1 Referring to Fig 6, using suitable packing mount the work on the cross slide so that it is at the centre height of the lathe and the finished edge is perpendicular to the axis of the lathe. Use an elephant foot type mounting fitted to the slot behind the tool-post hole to support hole "A". This will ensure that the full length of the work (but not much more) and also the curvature of the banjo (60deg.) can be milled.

4.2 Mill the full length of the longer side down to the final size. Due to the limits of the cross-slide, it will not be possible to mill much beyond the centreline of hole "A".

4.3 Remount the work as in operation 4.1 with the edge square to the lathe axis, leaving the clamps just finger-tight.

4.4 Advance the cross-slide up to the milled edge and lock the carriage. Move the cross-slide about 0.5in. towards the operator. Rotate the work piece clockwise about hole "A" through about 5 degrees and clamp securely.

4.5 Mill excess metal from beyond hole "A", tangentially to the banjo outer radius.

4.6 Repeat operations 4.4 and 4.5 until an angle of 60 degrees has been traversed.

4.7 Continue milling to complete the "60 degree edge", as shown in **Fig 7**.

4.8 Remove the work from the lathe and clean up the ragged edges.

4.9 Remount the work on the angle plate, but this time "upside down", in order to mill the opposite side. Leave the work loose.

4.10 Move the cross-slide out (towards the operator) and mount the PGMS bar between centres. Advance the slide, and when the "60 degree edge" just touches the bar, securely clamp the work piece, as shown in **Fig 8**. This will ensure an edge will be milled perpendicular to the "60 deg. Edge".

4.11 Mill the "30 deg. edge" to size.

4.12 Mill the curved section of the side in a similar fashion to that in operations 4.4 and 4.5 and complete milling the second long side.

4.13 Remove the work and clean up all ragged edges.

4.14 Remount the work using the slots and mill the remaining side.

4.15 Remove all excess metal, including that around hole "B".

4.16 Mill the radii around the ends of the slots in a similar manner as used on the banjo (operations 4.4-4.5) and complete milling the remaining side towards the end of the longer slot.

4.17 Chain drill around the boss hole. Cut through all but two of the pillars, which should be more or less diametrically opposite each other.

4.18 Remove all supports from the cross slide. Fit the vertical slide in the rear slots of the cross slide, setting it perpendicular to the lathe axis.

4.19 Mount the work on the vertical slide with the chain-drilled holes clear of the slide.

4.20 Fit the drill used to drill hole "A" in the chuck and locate the drill in that hole, as shown in figure 10. Tighten the bolts holding the work, and lock the cross slide and the vertical slide.

4.21 Break away the remaining pillars around the boss hole, and with a suitable boring tool, bore out the hole to 2¼" diameter.

Work on the arm is now complete except for the drilling of the hole for the banjo clamp screw and the cutting the banjo slot. These operations will be completed after making the boss.

5. Boss (Fig 9):

Note: Use a three-jaw chuck and ensure that when drilling the mounting holes, the drill clears a chuck jaw on exit each time. These holes are 135 degrees apart, and if the initial orientation of the first hole is not chosen carefully, there will be a danger of drilling the second hole through the boss and into a chuck jaw (see operation 5.5).

5.1 Turn the shoulder on the boss to be a good fit in the quadrant arm. To simplify the later operation 5.5, the shoulder should be about 0.005-0.010 in. narrower than the thickness of the quadrant arm. Although the width of the shoulder is not critical, the width of the remainder (0.500 inch) is critical, and will govern the success or failure of the project. See paragraph 6.2.

5.2 Fit the dividing head to the cross slide and mount the 3-jaw chuck complete with job on to it. Take care that a 6.1 mm (OBA clearance) drill will clear the jaws at both locations prior to drilling the two mounting holes.

5.3 Drill and counterbore the two mounting holes in the boss. When counterboring, open up each hole in several stages to avoid excessive force being applied to the head.

5.4 Fit the vertical slide with the face parallel to the lathe axis using the PGMS bar as a guide.

5.5 Bolt the boss and the quadrant arm to the lower slot of the vertical slide, so that the boss holds the arm against the slide. Adjust the arm so that the "60 deg. side" is parallel to the top face of the boring table, using the PGMS bar as a guide, as shown in figure 11. Clamp the arm to the slide using a second tee nut and a bolt located in a convenient slot (*not shown in figure 11*).

5.6 Position the vertical slide so that the centreline of the drill will tangentially penetrate the boss hole in the arm. Drill, counterbore and tap the hole according to that shown in figure 4.

Note: The position of the clamping screw is such that the maximum diameter of the boss can be achieved which in turn will allow the maximum clearance for the counterbores of the boss mounting cap screws. Because the quadrant arm clampscrew penetrates the boss, the screw acts as a retainer for the arm If nuts and studs are used instead of cap screws, the quadrant arm clamping cap screw will almost certainly foul the nuts as the arm is rotated on the boss. Larger diameter counterbores will be required to accept a socket for nut tightening, and these will penetrate the clamping screw groove.

5.7 Disassemble the parts and cut the slot through the banjo. Note that the banjo may expand or contract slightly as internal stresses are relieved.

5.8 Cut the semicircular groove in the boss using the part-hole drilled in operation 5.6 as a guide.

5.9 Press out the original sleeve in the Myford quadrant arm.

5.10 Drill and bore the centre hole in the boss. The sleeve should be a good fit in the boss. Insert the sleeve/spacer into the boss, so that the shouldered end fits into the leadscrew bearing block.

6. Stud Assembly (2 off, figure 12):

Each assembly consists of a tee nut, spacer, sleeve, and a OBA cap screw. Fabrication is straightforward, with no hidden snags. In order for the assemblies to function correctly, the following points need to be addressed:

6.1 A small gap is required between the tee nuts and the spacers, so that the spacer and tee nut can lock up when the cap screw is tightened.

6.2 The length of the sleeve should be slightly longer than the keyed sleeves that hold the change wheels, so that the keyed sleeves can rotate freely after the cap screw is tightened.

6.3 Both the spacers and the tee nuts need to slide freely along the length of the slots

6.4 The thickness of the spacers is important. Not only do they need to be thicker than the depth of the shoulders of the slots to prevent the changewheels touching the arm, but they also need to be sufficiently thick to prevent the changewheels jamming the leadscrew changewheel. Their actual thickness depends upon several factors, including the thickness of the arm, the finished dimensions of the boss and the slots. As a guide, the spacers need to be about 0.17 to 0.20 inch thick. On the author's lathe, 0.188 inch was found to be satisfactory. Therefore the spacers are best made last of all, and in the meantime a series of washers should be used to check the actual thickness of spacer required.

7. Stud Retaining Cap Strips (Fig. 13).

These strips are made from three quarter inch wide steel banding- the sort used on packing cases. The material is tougher than mild steel, but is soft enough to allow cutting with snips. Cut the material to size and drill the mounting holes. Drill and tap the 8BA holes for mounting the strips in the quadrant arm. At the boss end of each strip, a mitre will be required so that the strips do not overlap each other. Before final assembly, slightly bend the strips so that they lightly grip the tee nuts to prevent them sliding along the slots under gravity. This is a minor refinement, and is only to remove any inconvenience of a nut sliding behind a changewheel already mounted on the arm.

8. Completion:

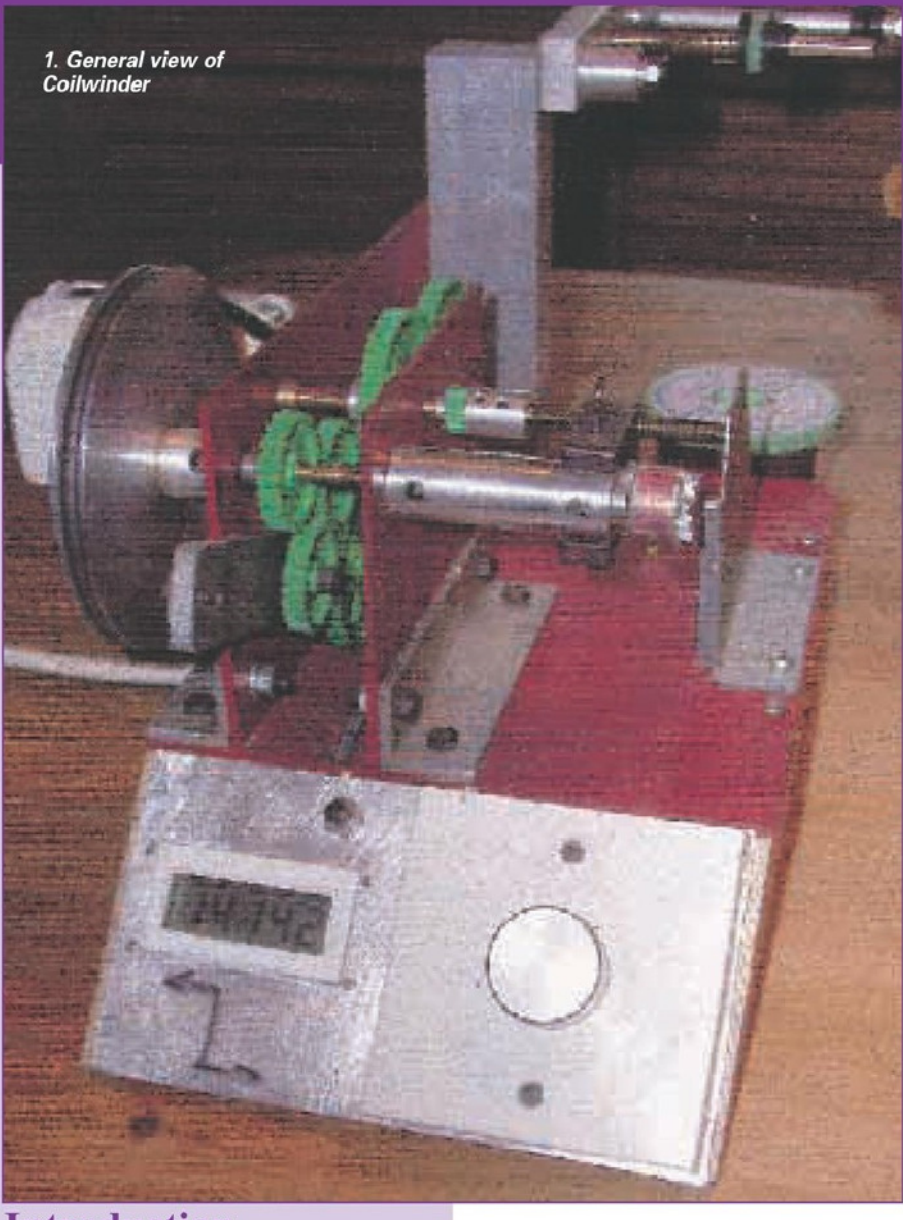
Having assembled the studs and cap strips, all that remains to do is to make final checks for clearances and then make the two spacers to replace the series of washers on the studs. The assembled setup with changewheels can be seen in **Photo 5**.

Reference

1. Model Engineers Workshop Data Book, page C34. (Published with Model Engineer's Workshop No. 38, November 1996)

SECRETS OF SUCCESSFUL COIL WINDING

Brian Perkins describes his coil winding machine, and shares his experience of producing miniature magneto coils.



1. General view of Coilwinder

Introduction

Following Geoff Sheppard's visit to my workshop last year several people have expressed an interest in my experiences with winding coils for the Aquila magnetos and the construction of the coil winder which I produced for handling the secondary windings.

Initial Trials (and Tribulations)

When I first received the reel of 50 g. wire (.001in. dia.) for the secondaries I was not at all sure whether it would be possible to use it successfully, I found that I had to shake it about in the light just to find the end.

I had a few trial runs without a great deal of success, largely caused by the fact that the surface of the wire had a few dings in it which appeared to be causing weak spots. I ended up with about four ends all of which seemed to be coming from beneath the surface of the reel so I returned it to the supplier and asked if they could run off an amount to clean off the top layers they were unsuccessful in this so supplied me with a new reel of 49swg (.0011in. dia.). Even with this 20% improvement in strength I was still struggling with drawing the wire off the reel even though I had it mounted on a swinging arm and everything was fitted with ball bearings.

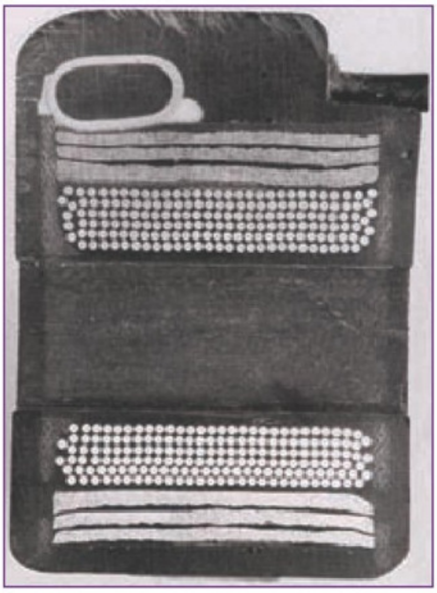
Theories on Primary Wire Size

To put off the evil day I decided to experiment with primary wire sizes. Initially, from what I had read I had tried to increase the voltage being generated but after a while I realised that this did not seem right. To increase the voltage requires a higher resistance primary wire and a greater number of turns which makes it impossible to achieve the turns ratio required between primary and secondary in my limited size coils. The battery voltage required in a coil ignition system is purely to create magnetic flux in the core but with the very powerful neodymium permanent magnet core being used in the magneto what appeared to be needed was a low resistance path to the capacitor for the flow of electrons released by the breakdown of flux. This theory was reinforced by a visit to Bill Linfield who showed me two magneto coils which he had sectioned, one a Minimag (**Photo 2**) and the other a Wipac (**Photo 3**) . It was clear from both of these that the primary winding was of very low resistance which in turn allowed for a high turns ratio.

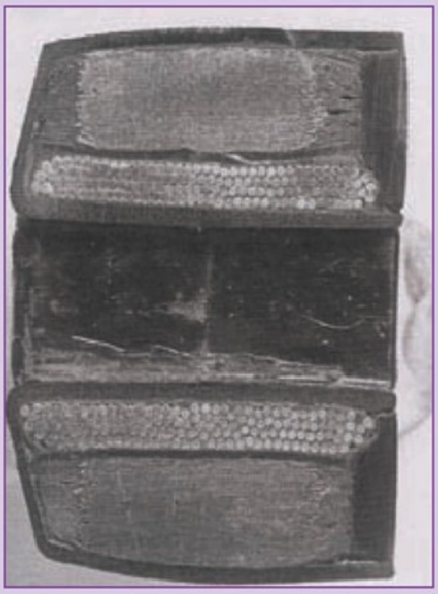
So I wound a series of primaries using wire sizes from .19mm to .45mm with both six and eight layers in preparation for winding secondaries using the 49g wire, getting as many turns of this as possible in the remaining space. The primary windings were put on by hand, were wound cheek to cheek and every effort made to keep them as flat and close wound as possible so that there was the flattest possible surface on which to wind the secondary.

Solving the Secondary

Now that I HAD to wind secondaries it was obviously time to look for help so out with the Yellow Pages in an effort to find someone who handles this size of wire. After talking to several people I was fortunate enough to find a company in Cheltenham and had an extremely helpful meeting with one of the owners, Chris Knight, who allowed me to visit his works to see how they did it. The two most important things to come out of this visit were his suggestion about forming a 'rope' at the start and finish of the winding and seeing the method used on his machines for feeding the wire. The 'rope' is formed by winding 15-20 turns around two hooks held about 2in. apart, one hook is fixed and the other attached to a handle so that the resulting loop can be spun. The end of this rope can then be tinned and it becomes considerably easier to thread it through the end plates of the bobbin and to attach it to the contact button at the end of the winding. This tinning makes the wire very brittle so that it is important to tin no more than is necessary. I learned this lesson the hard way (is there any other?) when a coil that I had finished winding turned out to have a broken wire at the very start where it passed through the bobbin face.



2. The sectioned Minimag coil with its moulded in capacitor.



3. The sectioned Wipac coil showing the low resistance primary.

Coilwinder Considerations

Having read the article by the late Reg Woods in an early edition of SIC and studied the design of Bob Shores 'Sidewinder' in his book, I took what I thought to be the best features from each of them and proceeded to look around for some suitable bits and pieces.

The requirements were for a drive motor to rotate the coil former which needed to be geared in some way to a lead screw to control the winding pitch, this lead screw also needed to be reversible to allow alternate layers to be wound in opposite directions. It is also helpful to have a neutral position so that the vee-guide can be lined up to it's starting position.

I found a useful pack of plastic gears (£6.99) in the local model shop which had four of each of 10, 30 and 50 teeth of 1 module pitch and with a bit of juggling I managed to arrange them as shown on the drawing to drive a 20 tpi lead screw (a ¼, whit. brass screw from the oddments box) which gave a feed of .0012in. per rev. The gearing is 30/30 to 50/30 to 50/10 to 50/10 to 50/50 giving an overall reduction

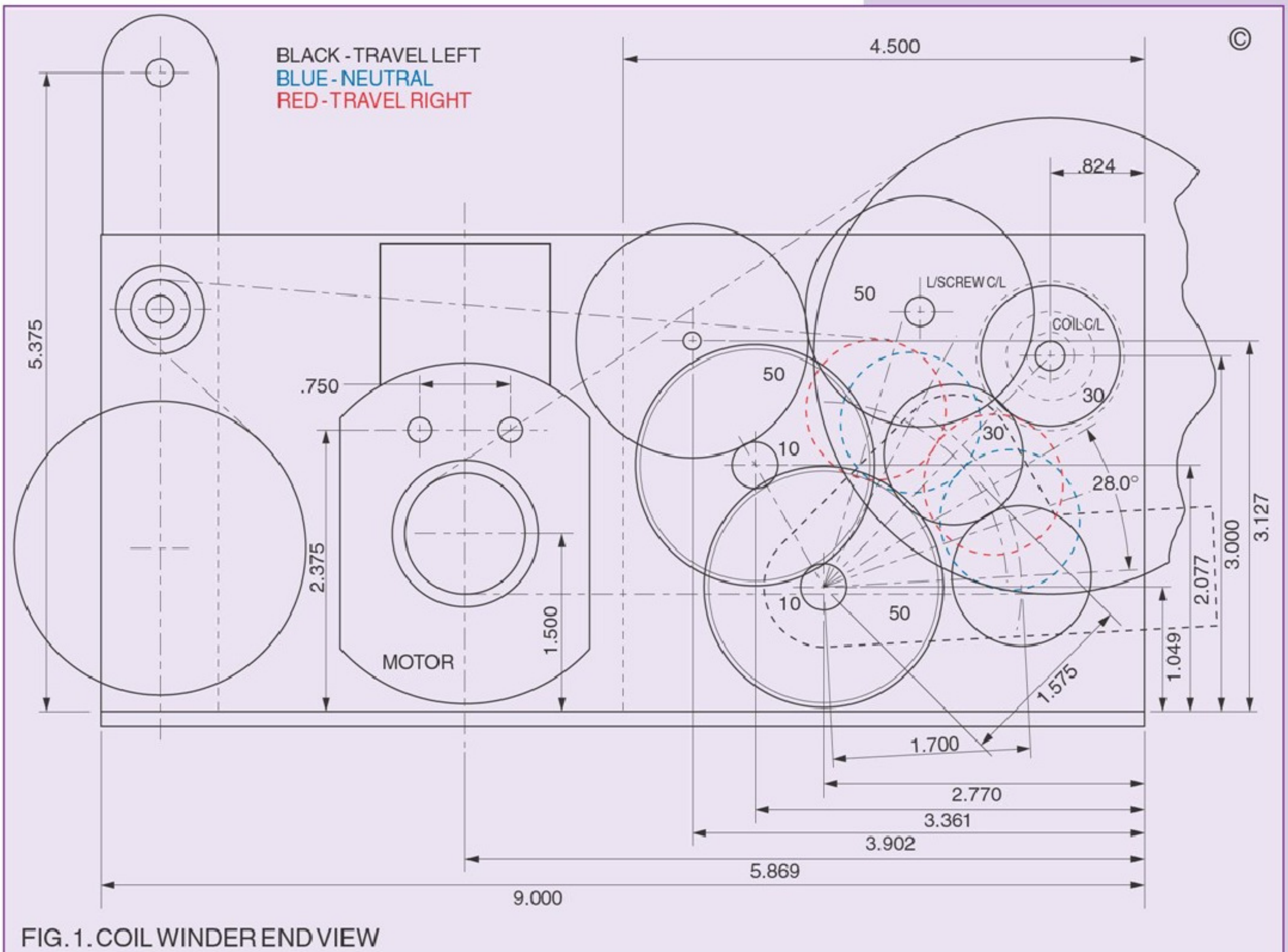
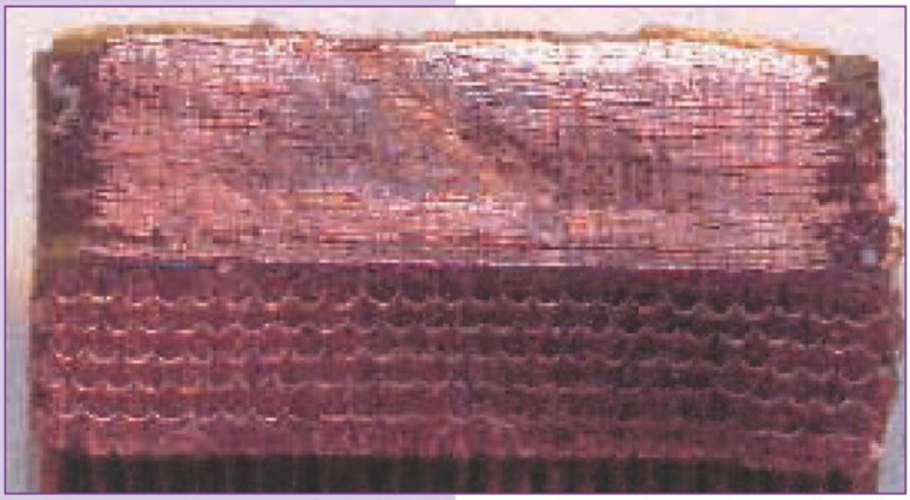


FIG. 1. COIL WINDER END VIEW



4. One of my early coils where it can be seen that the winding has slipped out of the side

of 0.024:1. A visit to a sewing machine repair shop produced a second hand motor for £5 and speed control was arranged with a domestic dimmer switch which is a lot easier to control than the normal sewing machine foot controller. A visit to Maplins provided a digital counter, a micro switch and a reset push button.

With all the bits to hand I prepared a layout drawing of the complete unit, which is shown as **Figs 1 & 2**. For my own purposes, a great deal of detail was not required, and as a result, the drawings remained in the form given which convey the salient aspects of construction. I then had three pieces of 3mm plate sheared by my friendly sheet metal company and proceeded to drill the necessary holes for the gear centres and the alum. angle corner joints. The tumbler reverse lever was cut from a piece of ¼in. aluminium plate and fitted with a simple ball detent to lock it in forwards reverse and neutral. Drive pulleys were machined from aluminium to give a reduction in speed and the belt was a suitable ¼in. dia. 0-ring. The motor was originally mounted within the unit but on connecting it to the power supply I found it was running in the wrong direction and it was easier to modify the mounting than to discover how to reverse the motor.

The lead screw nut was mounted in a forked tufnol block, the fork being arranged to run on the bobbin carrier. Also mounted on this tufnol block was the vee shaped guide roller for the wire. I later found that this guide roller was better locked, and the wire simply allowed to slide over it, as any slight snatch in it's rotation could cause a problem with the wind.

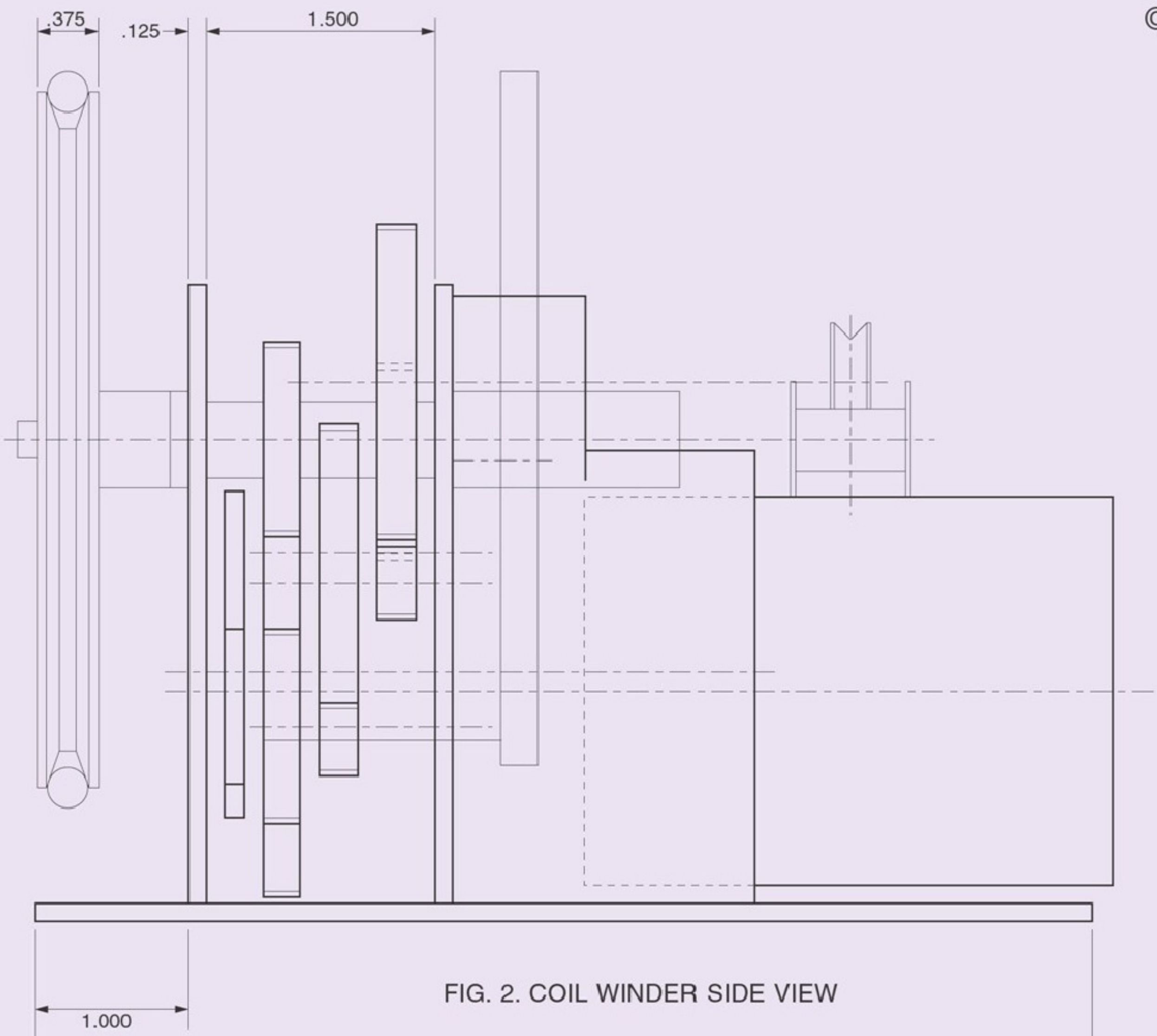


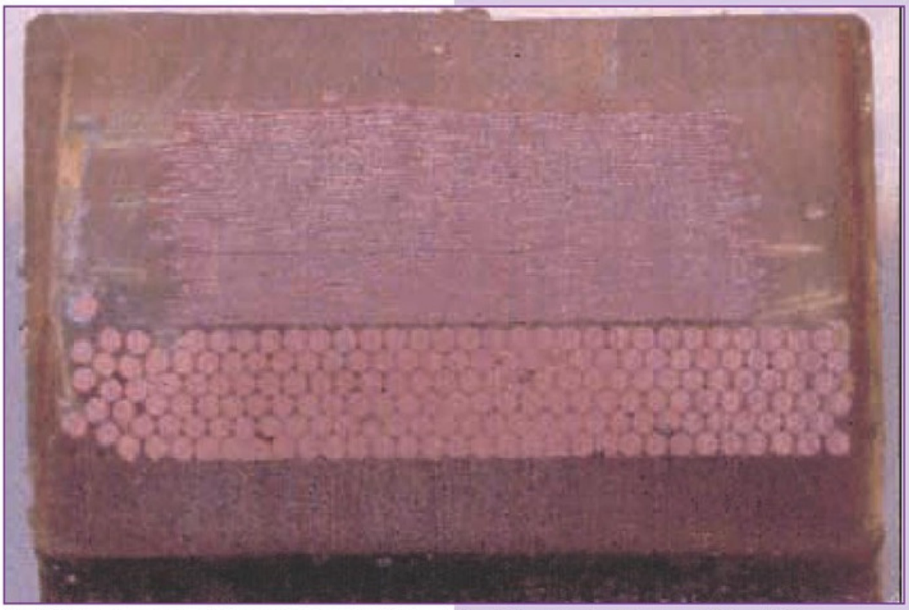
FIG. 2. COIL WINDER SIDE VIEW

Operation and Tension Control

The coil of wire was initially mounted on the swinging arm as shown on the drawing but, even though everything was mounted on ball bearings, the wire was not strong enough to take the starting loads unless acceleration was controlled very accurately which I found difficult to do consistently. Many different feed arrangements were tried but the eventual solution was to run the wire freely off the end of the reel, over a guide bar and through a pair of spring loaded, foam lined discs to control the tension.

Even with this setup I was still having problems getting a consistent wind and wire breakages were still a frustrating problem. Eventually I did what I should have done in the beginning and calculated the breaking strength of the wire, this appeared to be 15 grams so I made up a number of 3 gram weights and a 4 gram platform as shown in MEW issue 77 page 45, and proceeded to load a sample of the wire, it broke on application of the fourth weight so that the breaking load was somewhere between 13 and 16 grams. I then made up a simple, calibrated, spring balance which allowed me to set the tension of the wire as it was fed on to the bobbin.

Using this balance I have found that if the tension is set to 5 grams I get a slack wind and lose several thousand turns, set it at 12 grams and almost certainly the wire will break at some point in the wind, usually at about 12000 turns which is very frustrating as it takes about two hours to get to that point. I find that if I set it at 8-10 grams I can achieve a nice tight wind and can get 18000 turns on to my coil which is 0.26in. id. x 0.75in. od. x 0.48in. long whilst allowing for 0.040in. epoxy impregnation on the sides and outside diameter. To achieve the gap at the sides of the winding I restrict the number of turns per layer to 280 although there is a theoretical capacity of 350 turns. Both Barry Hares and Hans Mulder say that they feed the wire on to their coils by hand, all I can say is that they must have much more sensitive fingers than I have.



5. A later attempt, still on a Tufnol bobbin but with a greater degree of insulation.

Interleaving and Insulation Aspects

The interleaving has, again, been the subject of a number of experiments, I initially tried 0.0005in. polyester film but, because this is completely transparent it is difficult to see the layers forming and very easy to lose the wire down the side which inevitably leads to a short between the layers. I actually had one coil that would give me a shock through the side of the bobbin rather than at the HT contact. The next attempt was 0.0015in. acid free white tissue which worked well, but made it difficult to get a large enough number of turns without leaving the outer layer of epoxy too thin. These coils worked satisfactorily for a while but eventually would short out through the epoxy. Currently I am using 0.0005in. condenser tissue cut into strips approx 5-10 thou. narrower than the gap between end plates. If the strip is too wide it is difficult to get it to lay flat which makes it impossible to get the maximum number of layers, if it is too narrow there is more chance of losing the wire down the side.

On the subject of interleaving it has been suggested that interleaving between each layer is not necessary and looking at the photographs of the sectioned coils it does appear that the commercial coils do not bother but I think this can only be due to the heavier wire and correspondingly heavier insulation that they use. I have been given a figure of 70 volts/micron of insulation so that the .028mm wire that I am using with an insulation thickness of 1.27 microns has an insulation rating of 88.9 volts. As the inter layer voltage at the ends of each pair of layers is in the order of 300 volts it can be seen that, in the case of the lighter wires, interleaving is essential.

Before the coils can be tested they have to be resin impregnated and I had decided to use epoxy resin so another series of very messy experiments started, from dunking the complete coil in a pot of resin and wiping off the surplus (very messy and wasteful of resin) to the final solution of enclosing the coil in a split delrin mould (quite clean and economical). Of course every time one of these experiments fails you are faced with having to make another coil from scratch. To avoid having to remake the laminations every time as well I had decided to make the core as two T-section units meeting in the centre of a turned tufnol bobbin but I later found that, even though I had ground the two faces and they were clamped together, there was a considerable fall off in performance (something to do with eddy currents apparently).

So yet another four sets of core laminations were made and the coil is now wound directly on to the core which is ground to .26in. dia, covered with 2 layers of tissue and fitted with .015in. thick epoxy/glass end plates. This arrangement appears to give a 30% improvement in performance, I have found that if the coil does fail for any reason after impregnation it is possible to cut it off and to salvage the laminations.

I produced the epoxy/glass sheet by laying up 3 layers of .002in. glass cloth (left over from my wing skinning days) between two sheets of glass. I have done this in the past using polyester resin with no problems but, of course, epoxy resin does not self release from glass so I now have, as they say on Blue Peter, one set of glass plates and laminate produced earlier, as an example of what NOT to do.

I have deliberately erased from my mind any thoughts of how many failed coils I have wound but the amount of wire on the reel has noticeably declined, however I have finally arrived at a coil that produces a good spark on flicking the magneto over by hand and appears to have proved the point about the necessity for a low resistance primary. The present design of coil (**Photo 6**) has a primary winding of 125 turns of .375mm dia. wire (5 layers, resistance .5 ohms) and a secondary of 18900 turns (67.5 layers) resistance 215ohms), giving a turns ratio of 150:1.

6. My present design of coil with a one piece core and epoxy end plates.

A WINCH OUT OF SCRAP MATERIAL

1. General view of winch with hook, control unit, and push buttons.

Necessity is the mother of invention. Victor Elsendoorn encountered a lifting problem, and came up with a neat solution.

Introduction

Some time ago I came across an excellent engraving machine (Deckel FG1) for a very reasonable price. I couldn't control myself so I bought the machine. While transporting the machine to my home I wrestled with the question of where to install it. There was still some space left in the middle of the garage but to position it there would be an over indulgence. Let's be realistic: it is nice to have an engraver but the frequency with which one uses such a machine does not justify this prominent centre stage position. So I decided that the right place should up in the attic. The question then of course was; how do you lift a 200 kg machine 3.5 m above the ground? After some thinking and doing some browsing on the web I came to the conclusion that I could build my own winch out of scrap material. Before I started some calculations would be needed.

Kilograms, Watts, and all That

The first thing I needed to know was the power necessary to lift a weight of 200 kg. I found a motor with worm reduction bringing the speed of 1360 rpm down by a factor 36 to 37.8 rpm. The power of the motor is 250 Watts. I intended to use a winding drum for the cable made from a length of pipe 60mm diameter. This became my starting point for the calculation. The circumference of the pipe being 60x3.14=188.4 mm leads to a lifting speed of 188.4x37.8= 7100 mm/min which equals 0.12 m/sec.

Lifting a weight of 200 kg, which equals approximately 2000N, with a speed of 0.12 m/sec needs a power of 2000x0.12 = 240 Watt. This was very close to the input power of the motor, with no margin to cover efficiency losses. By passing the cable around a pulley at the hook, the lift speed reduces by a factor two, thus creating more than enough margin to make the arrangement feasible.

The total height between floor and rooftop is 6 metres so I bought a 12 m long steel cable with a diameter of 4 mm (rated at 1500 kg). Winding a 12 metre cable on a pipe with a diameter of 60 mm means 12x1000/60x3.14=63 rotations, and assuming two layers suggests a pipe length of about 31x4=124mm.

Constructional Notes

The advantage of making use of a motor with a high ratio worm reduction is that the mechanism is inherently self locking and therefore brakes automatically. There is only one way to move the output shaft and that is from the input side. The load cannot "backdrive" the motor. This particular motor with gearbox was found in a scrap yard and in its previous life was intended to drive a conveyer belt.

Building the winch is a fairly straightforward job. The photos give a general indication of how it was done. Some remarks on the drum ends may be useful. The ends of the pipe were closed by welding in two blanks of 10 mm thick steel. On one side an M16 thread was cut to screw the pipe on to the gearbox output shaft. This side was made first. The other side is supported by a short shaft which runs in a hole in the second blank. I turned this hole with the tube screwed on the output shaft. Another approach would be to use a threaded arbor or work with a steady. The required result is that the drum runs true. (See **photos 2 & 3**). For a winch

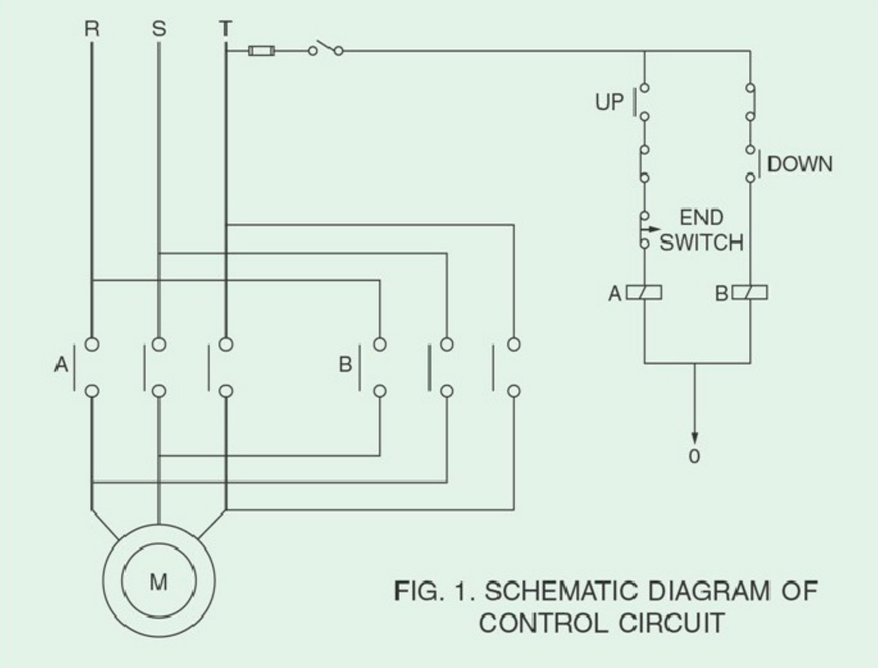
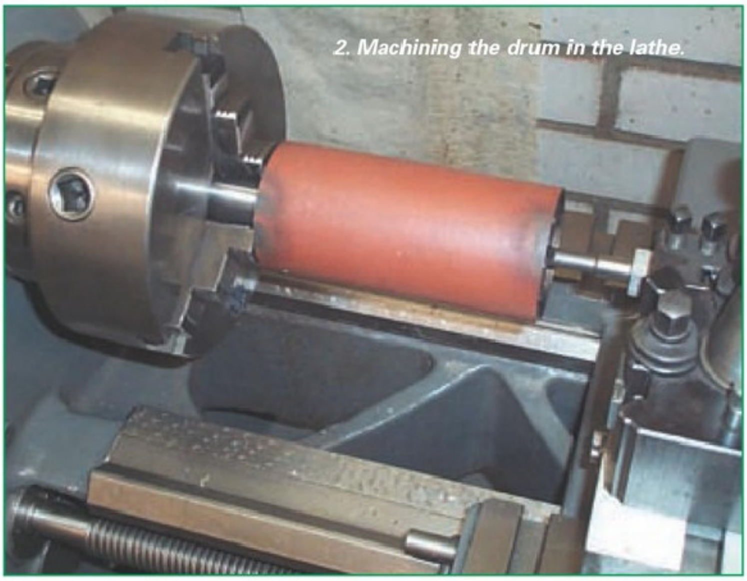
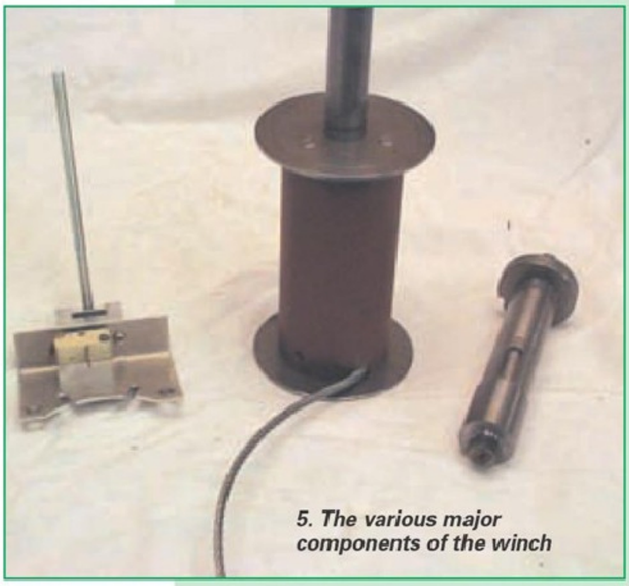
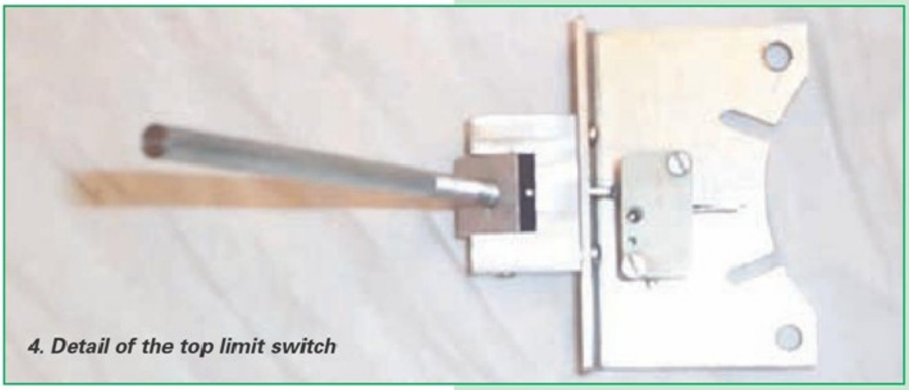


FIG. 1. SCHEMATIC DIAGRAM OF CONTROL CIRCUIT


2. Machining the drum in the lathe.


5. The various major components of the winch


3.Close up of partly assembled frum.


4. Detail of the top limit switch

intended for regular hard work, a suitable bearing bush would be a sensible modification. Larger diameter flanges were then made in thinner material, each one being retained by screws.

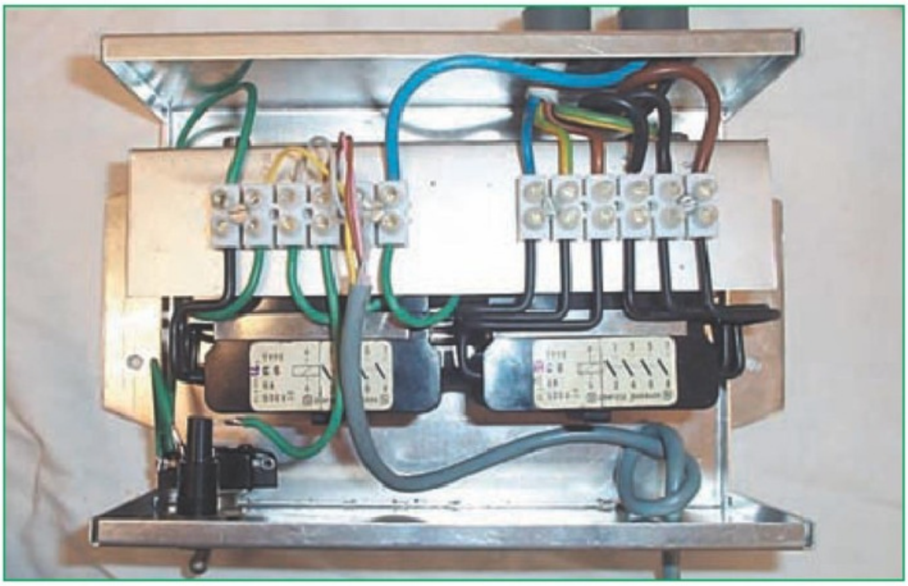
Make sure that the shaft turns clockwise while lifting. This will ensure that the assembly is self tightening in operation, and render a grub screw unnecessary.

To protect the winch from lifting too high an "end stop" was introduced. (See **photo 4**). The stop is built using an aluminum frame with an arm that is raised by the pulley as it approaches top limit. The arm trips a micro switch that switches off the motor.

The major components of the winch can be seen in **Photo 5**.

The control unit

Switching the three phase motor direction is relatively easy. But thinking a bit further I came to the conclusion that a push button remote control was really required. The schematic diagram of the control circuit is given in **Fig 1**. Two relays are used. One relay controls the lifting and the other controls lowering the load. As you can see in the diagram one button blocks the other. This gives an interlock which prevents activation of both relays at the same time and prevents short circuits in the power line. The working of the end stop is easy to see in the diagram. One other point worthy of mention is the introduction of a fuse in the feed to the remote control. This is because this cable is relatively vulnerable. Should an accident happen, a fuse helps to prevent dangerous short circuits in the power supply. **Photo 6** shows the interior of the control box.


6. The interior of the control unit

Cautionary Notes!

1. DIY lifting gear made for domestic use is very much a personal matter, with the safety of the end result totally in the hands of the constructor. If in doubt, don't. In addition remember that anything intended for commercial application immediately becomes subject to various regulatory controls.

2. Don't position yourself under a heavy load while lifting. The calculations might be correct, the welding very professional, the construction well thought through but accidents can happen, and it is always better to destroy a highly prized machine than to reconstruct your head!

3. Mechanical engineers may be familiar with the theory of "Suddenly Applied Loads", where the winch loading reaches double the apparent load being lifted.

ELECTRONICS IN THE MODEL ENGINEER'S WORKSHOP (4)

In response to requests, Mike Feather takes a break from power control topics to give guidance on D. C. Power Supplies

Introduction

The majority of electronic circuitry requires the provision of a steady d.c voltage if it is to operate correctly. Batteries of one form or another can be used and are of course a necessity in the case of portable equipment. A mains derived power supply is usually more convenient than batteries in the home or workshop as it can ensure a steady voltage without frequent replacement of expensive batteries. This article takes a look at some of the theory behind power supply design and concludes with constructional details for a workshop power supply.

The basic requirements of a power supply

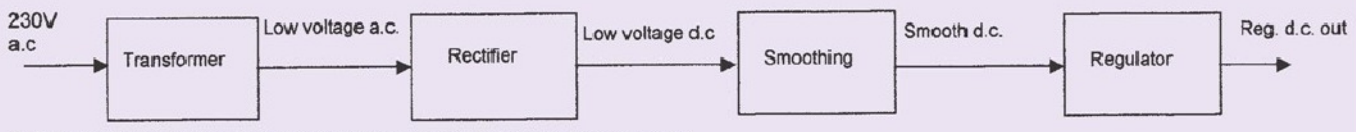
In the U.K. domestic environment, the incoming power is supplied at around 240V, 50Hz a.c. A typical requirement for a small d.c. motor control circuit might be 12V d.c. so the power supply must perform a number of processes in order to achieve this conversion. There are two ways of going about the task, linear and switch mode. The linear approach is shown in the block diagram of **Fig. 1**

The transformer performs the voltage stepping down operation and produces low voltage a.c. The rectifier – usually consisting of two or four diodes – converts the a.c. into low voltage d.c. It might be thought that we now have what is wanted and that no further processes are required. Most circuitry however requires the provision of a steady or 'smooth' d.c. power supply for satisfactory operation and, as is shown **Fig. 2**, the d.c. output from the rectifier is far from that.

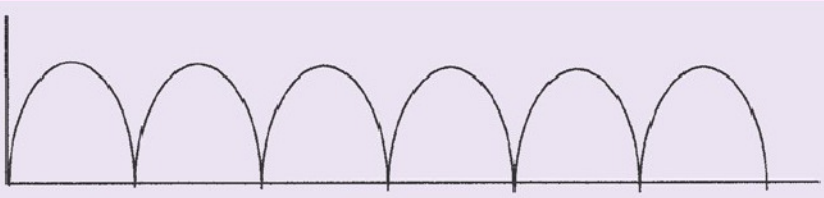
It consists of a series of half wave bursts of voltage, rising to the peak value of the a.c. input to the rectifier. So, although unidirectional and therefore strictly d.c., the varying nature of the supply would cause havoc with most circuitry. If used to drive an audio amplifier for instance, it would give rise to a very loud 100Hz buzz in the loudspeaker.

Fortunately the problem may be largely overcome by the addition of a capacitor as the next stage of the power supply. The basic property of a capacitor is to store charge and the connection of a suitably large one to the rectifier output will cause the capacitor to be repeatedly charged up during the half cycle power bursts. It can then supply power to the load circuit during those periods when the rectifier output voltage is falling back to zero. The end result is that the capacitor smooths out the voltage bursts, so providing the load with a much steadier d.c. voltage. (It is often called a reservoir capacitor in this application; a well chosen term). **Fig. 3** shows the waveform of the smoothed low voltage d.c. at the capacitor output.

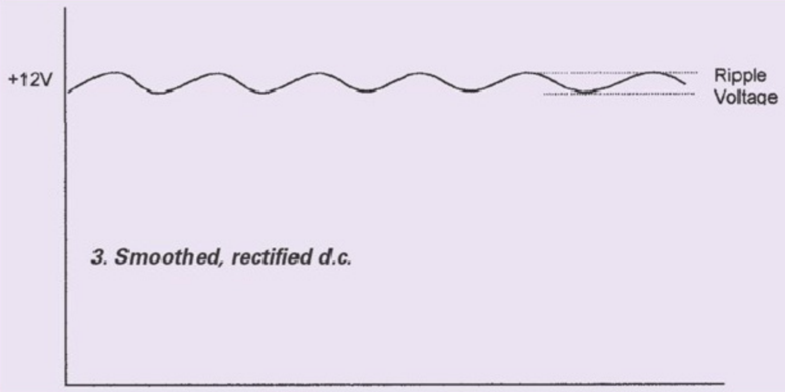
Figs.4 and 5 show the two basic circuit arrangements for single rail (+Vs and 0V) power supplies.



1. Block diagram showing the components of a linear power supply



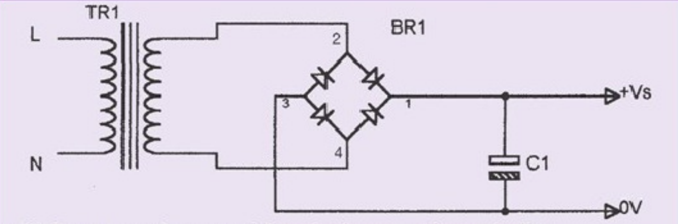
2. Full wave rectified unsmoothed d.c.



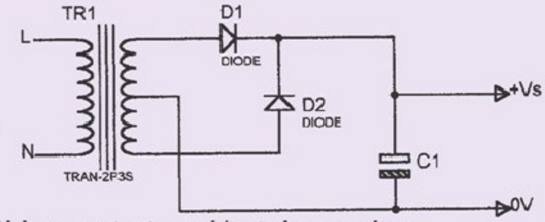
3. Smoothed, rectified d.c.

In Fig. 4, a transformer with a single secondary winding is used. Rectifier diodes D1 – D4 can be individual devices and the 1N5401 type would be appropriate for currents of up to about 3A. A more convenient alternative would be to use a bridge rectifier which contains four diodes in one package. A suitable type would be KBPC102, which can also handle currents of up to 3A. It is shown in in **Fig. 6,** together with its pin assignments.

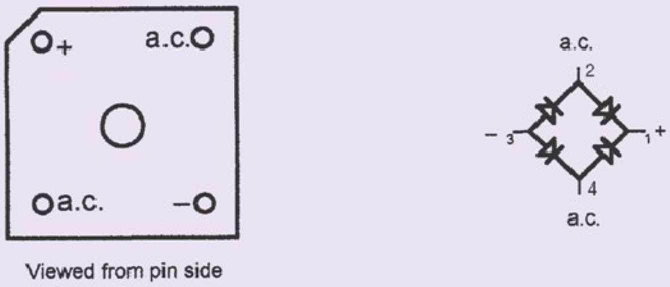
The alternative arrangement of **Fig. 5** employs a transformer with either a centre-tapped secondary winding or two identical secondary coils which can be joined to provide the centre – tap. This circuit requires only two rectifier diodes. Note that with both circuits, the output voltage rises to the peak value of the a.c. voltage across the transformer secondary so that if we employ the circuit of Fig. 4 and use a transformer with a 12V secondary, the output will rise to 1.41 x 12 = 16.9V. The smoothing capacitor will try to maintain the output voltage at this level and must therefore be rated at a working



4. Using a transformer with a single secondary winding



5. Using a centre tapped (or twin secondary winding transformer)



6. KBPC102 Bridge Rectifier (this arrangement is typical of many diode bridges)

voltage of a least this value. It will normally need to be a large value capacitor and, as such, it will be an electrolytic type.. These are polarised devices and must be connected into the circuit the 'right way round'. Capacitors of this type are relatively bulky components and carry clear markings of their value (in uF), working voltage and polarity. A 4700uF, 35 volts working type will be adequate for many power supply requirements.

In the case of the circuit of Fig. 5, a 24V centre-tapped or twin 12V secondary winding transformer would provide the same 16.9V d.c. output and the capacitor specification would be the same. Which circuit to use tends to depend upon what type of transformer is to hand, but twin secondary types are very common and the circuit offers the minjor advantage of only needing two diodes.

Note that for increased current output, the two windings of a twin secondary transformer can be wired in parallel and employed in the circuit of Fig. 4. Some care is needed in connecting together twin winding transformers. Details are shown in Figs. 7A and 7B.

Many transformers have two primary windings in order to allow for operation from 120V mains supplies. The two coils should be wired in series for 240V operation.

To calculate the required power rating of a transformer for a power supply, you should work out the maximum anticipated power requirement of the load and select a transformer with a rating which is comfortably higher. So, for instance, a 50W d.c. motor and associated control circuitry should be supplied by a 100W rated transformer.

The final stage in the power supply involves setting and stabilising the output voltage at the the value required, a process known as regulation. Two or three different types of voltage regulator are available and the choice of which to use depends on the current requirement and whether the output voltage is to be fixed or adjustable. Voltage regulation is usually necessary since an increase in the current drawn from the power will cause an undesirable drop in the output voltage.

Fixed voltage regulators

Zener Diodes

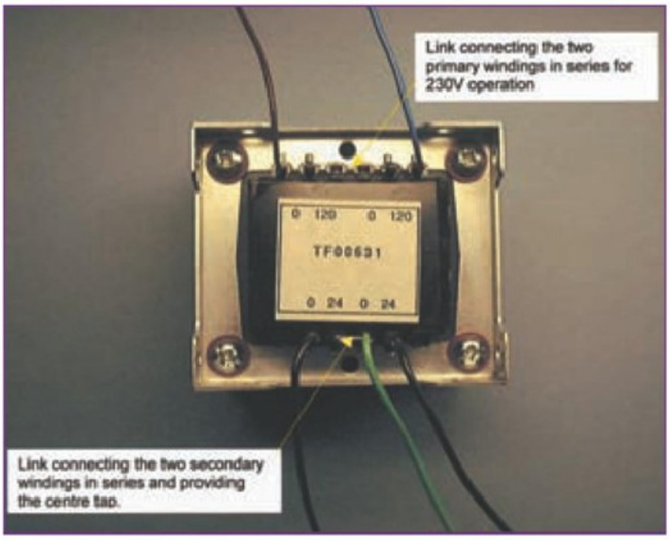
Zener diodes, sometimes called reference diodes, are capable supplying a stable voltage to a varying load for small current requirements – up to about 20mA or so. They are available in a range of regulation (output) voltages, from 1.2V up to 24V and power ratings of 400mW upwards.

Fig.8 shows the basic arrangement of a zener diode voltage regulator circuit.

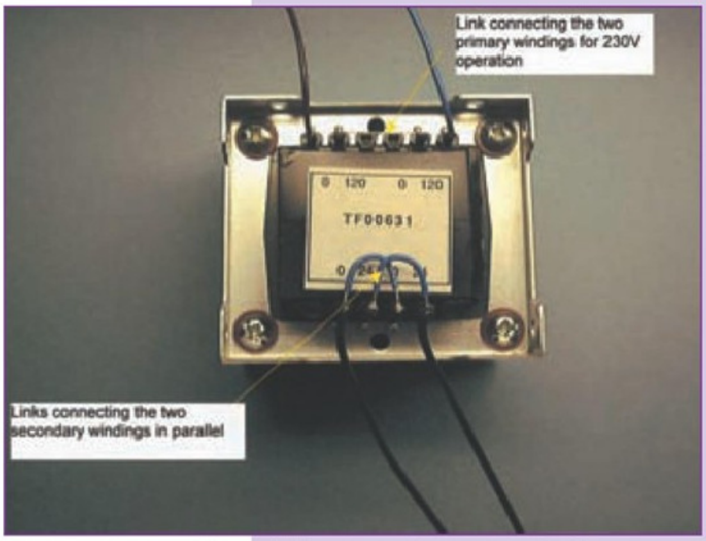
The value of the series resistor R can be calculated using the formula:

R (in K) = Vin – Vout/Iload(mA)+5

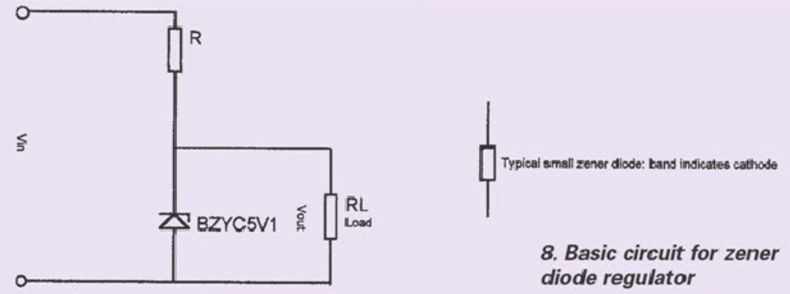
So, for instance to develop a 5.1V regulated voltage for a load which required a current of 10mA from a 9V unregulated supply, we would select a 5V1 zener diode. The series resistor would be :



7a. Wiring a twin secondary transformer to give a centre tapped secondary winding



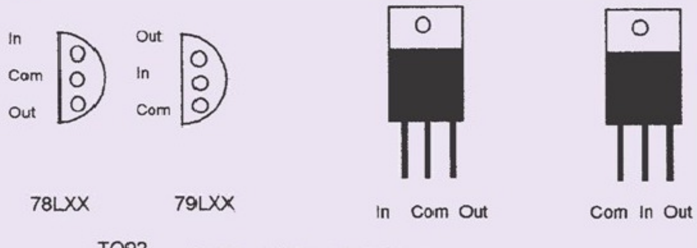
7b. Transformer with parallel connected secondary windings



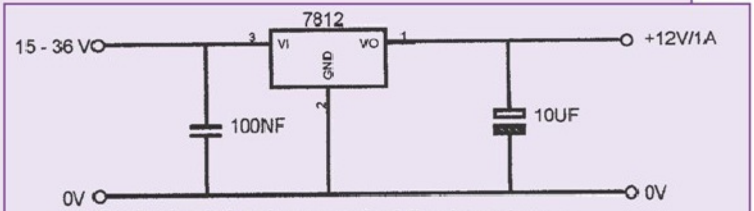
8. Basic circuit for zener diode regulator

Type	Output Voltage V	Output Current A	Package Type
7805	+5	1	TO220
7812	+12	1	TO220
7815	+15	1	TO220
78L05	+5	0.1	TO92
78L12	+12	0.1	TO92
78L15	+15	0.1	TO92
78S05	+5	2	TO220
78S12	+12	2	TO220
78S15	+15	2	TO220

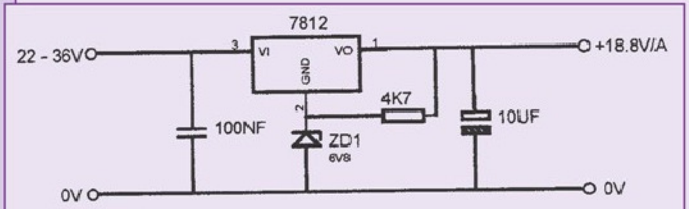
9. Three Terminal Fixed Regulator Data



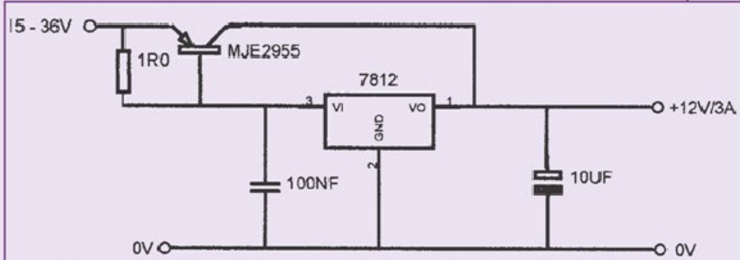
10. Fixed Three Terminal Regulators, package details



11. Basic circuit for three terminal fixed regulators



12. Increasing the output voltage from a three terminal regulator



13. Increasing the output current from a three terminal regulator

R = (9 – 5.1)/(10+5) K = 4.9/15 K = 0.327 K

A 330R resistor would be chosen. The power in the resistor would be VI = 4.9 x 0.015 = 0.074 W, so a standard 1/4W type would be perfectly adequate. The power in the zener diode is VI = 5.1 x 0.005 = 0.026W. The smallest zener diode of 400mW rating will cope easily.

Fixed voltage three terminal regulators

These are basically integrated circuits containing a zener diode and additional circuitry to increase the current handling capacity and further improve the voltage regulation.. They are available with a variety of output voltage and current ratings and the commonly available types are summarised in the table of **Fig. 9**.

Some are available as negative regulators, in which case the prefix digits are 79.

Fig. 10 shows the package and pin out arrangements for the TO92 and TO220 types. Note that the larger types may need to be provided with a small heat sink.

Regulators of this type are very easy to use and **Fig. 11** shows a typical circuit in which a 7812 device is used to provide a stable 12V d.c. output for currents of up to 1A.

Both capacitors are important and the 0.1uF should be wired close to the regulator's pins. This circuit can simply be added to either of the circuits of Figs. 4 and 5 to give a complete 12V/1A regulated power supply.

The output voltage of a fixed regulator can be increased by connecting a zener diode between the common connection and the zero volt line. This is shown in **Fig. 12**.

Another possibility is to boost the current output by adding a bypass transistor and this arrangement is shown in **Fig. 13**. This circuit will provide an output current of up to 3A at a steady 12V. The MJE2955 transistor will need to be provided with a heat sink.

Variable voltage three terminal regulators

Variable voltage regulators allow the output voltage to be varied over a wide range by means of a simple low power variable resistor and a few external components. Commonly available devices and their principal characteristics are summarised in the table of **Fig. 14**. Any of the regulator types can be used in the basic application circuit, which is shown in **Fig. 15**.

As shown, this arrangement will provide an output voltage which is variable over the range +1.25 to +30V at either 1.5A or 5A, depending upon the device used. As in the case of the fixed regulator circuits, the 0.1uF capacitor should be soldered close to the pins of the regulator chip.

Switch Mode Power Supplies

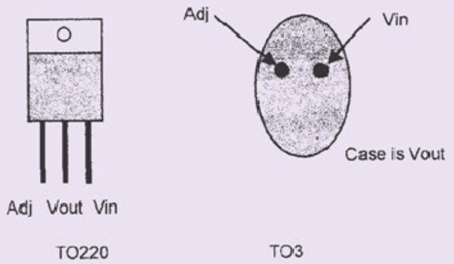
Although straightforward in their design and therefore relatively easy to construct, linear power supplies are not particularly efficient in terms of power conversion and an overall figure of around 45% is typical. They can be rather bulky because of the weight of the transformer, the need for a large value smoothing capacitor and possibly heat sinks.

An alternative approach to power supply design uses the switch mode technique and this outlined in **Fig. 16**. In this arrangement, the a.c. input is rectified by diode bridge 1 and smoothed by capacitor C1. the d.c. is switched by a transistor at a rate of about 20kHz and drives the primary winding of the isolating transformer T1. The output from the secondary of T1 is rectified by diode bridge 2 and smoothed by C2. At 20kHz, the transformer can achieve very high efficiency in a much smaller and lighter package than its 50Hz counterpart. Likewise, the smoothing effect of C2 is much enhanced at this high frequency and a relatively low value capacitor can be used. Switch mode power supplies are very efficient (in the order of 80%) but they do generate significant amounts of RFI and care is required in their design if this problem is to be overcome.

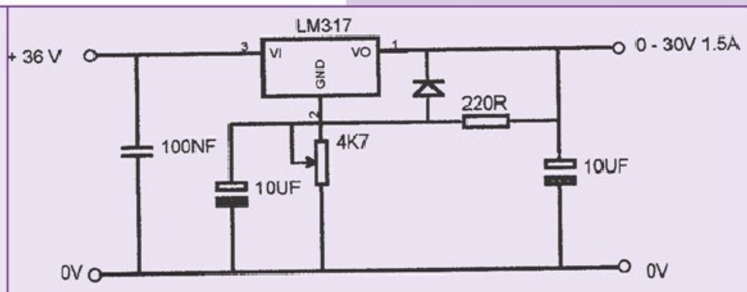
Project: A Versatile Bench Power Supply

A robust general purpose power supply is arguably one of the most useful items of equipment to be found in the engineers' workshop. The remainder of this article describes the construction of such a unit and it employs several of the basic circuits discussed in the earlier theory. For ease of

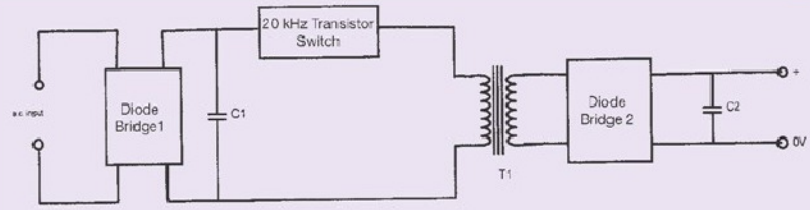
Type	Output Voltage Range V	Max. Output Current A	Package Type
LM317T	+1.2-37	1.5	TO220
LM317K	+1.2-37	1.5	TO3
LM338T	+1.2-37	5.0	TO220
LM338K	+1.2-37	5.0	TO3



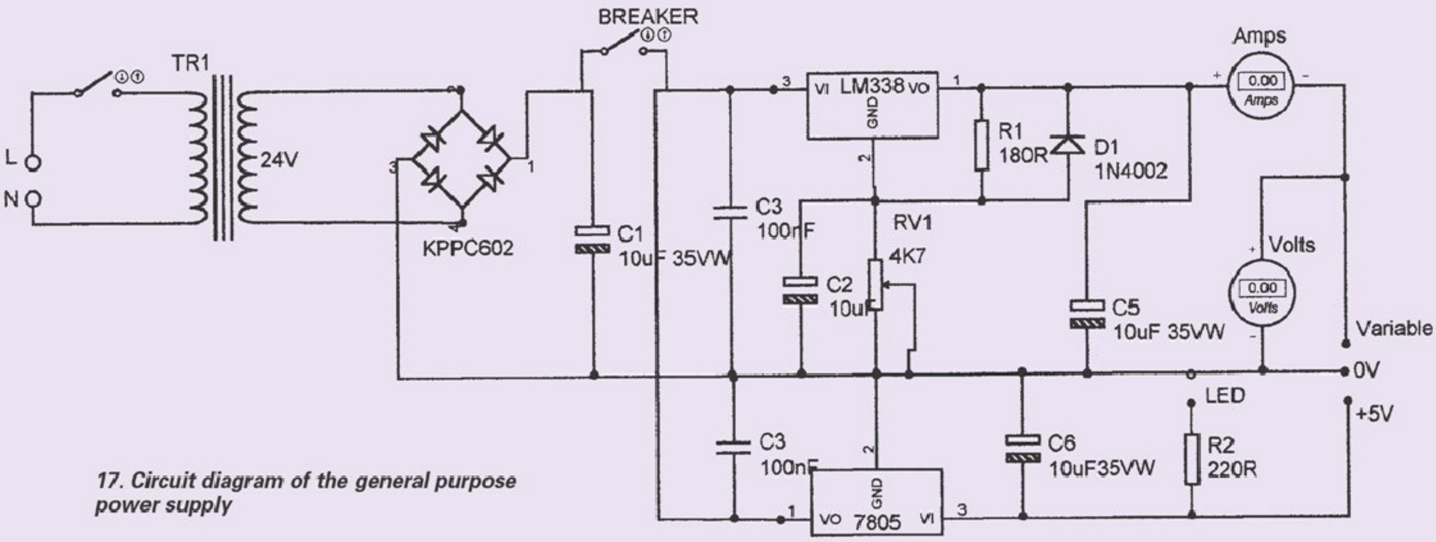
14. Three terminal regulators



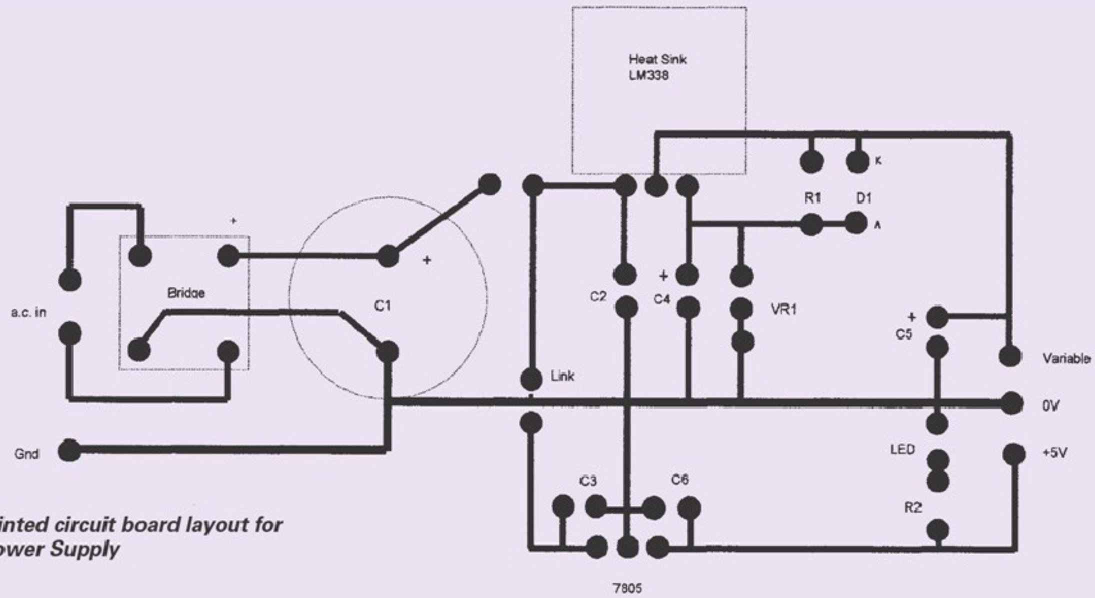
15. Basic circuit for Variable Regulator



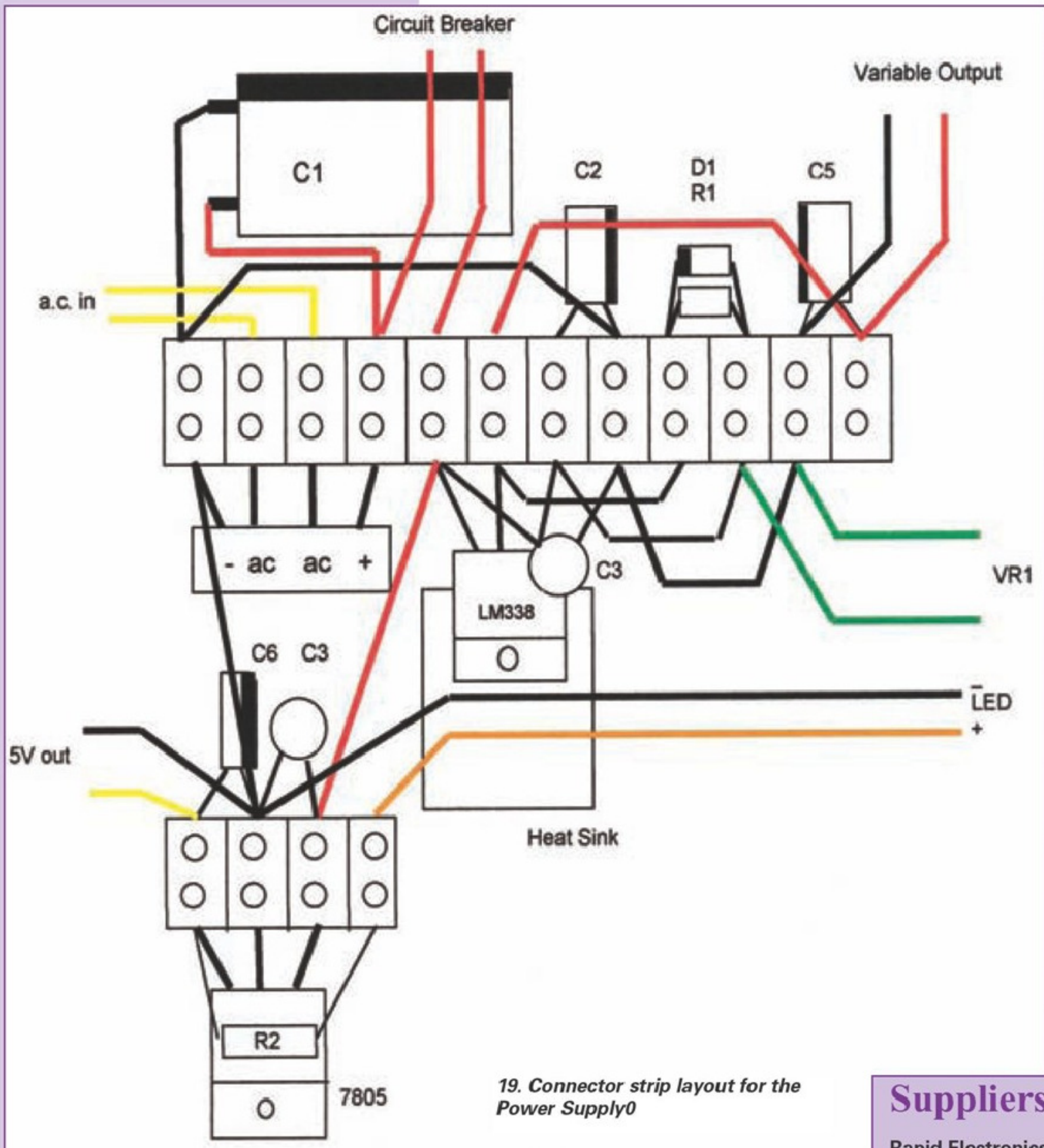
16. Outline of switch mode power supply



17. Circuit diagram of the general purpose power supply



18. Printed circuit board layout for the Power Supply



19. Connector strip layout for the Power Supply0

construction and availability of components, the linear approach is followed.

The power supply is capable of providing a variable output voltage of +1.2v to +25V at currents of up to 5A and a fixed +5V, 1A maximum output for logic circuitry. Current and voltage meters are included for monitoring the variable output and the circuit includes simple overload protection in the form of a thermal breaker. The complete circuit of the power supply is shown in **Fig. 17**.

Fig. 18 shows a possible printed circuit board layout (copper side). Note that due to the relatively high currents involved in the circuit, the copper tracks should be drawn as wide as possible. The overall design is quite simple and would provide a good starting point for those tackling their first printed circuit board. A completed pcb is shown in **Fig. 20**.

Some constructors may wish to avoid the pcb approach, in which case the majority of the circuit can be built using two lengths of 5A terminal strip mounted on a piece of aluminium. This arrangement is shown in **Fig. 19**, with a built up circuit shown in **Fig. 21**.

All of the components are fairly standard and can obtained from the regular suppliers. The meters add to the overall cost significantly and they can be omitted if desired. They are however very useful in practice.

The whole unit must be built into a robust enclosure of appropriate size and the usual precautions must be followed with insulation, mains and earth wiring.

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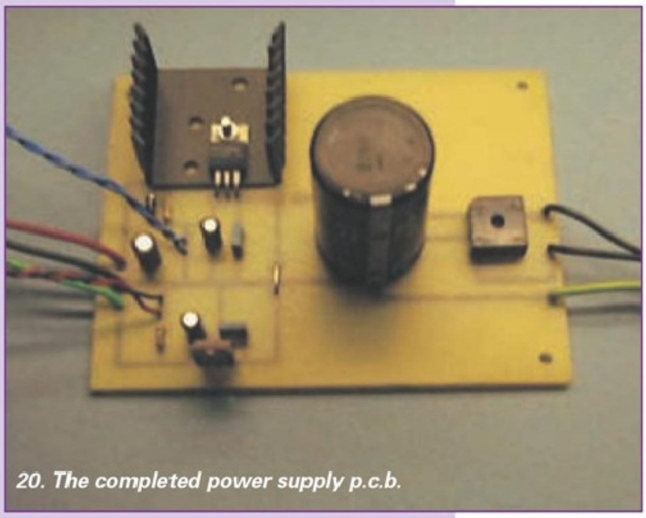
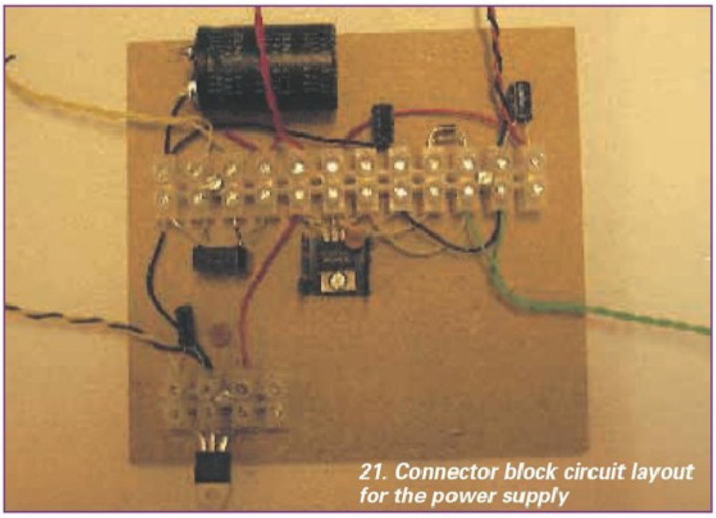


20. The completed power supply p.c.b.



21. Connector block circuit layout for the power supply

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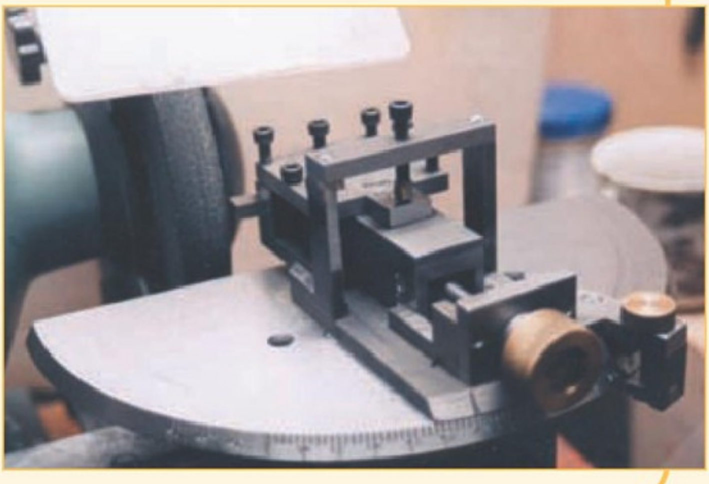
IN OUR NEXT ISSUE

Coming up in Issue No. 83 will be

A GRINDING FIXTURE

Ted Wale presents a device to aid sharpening lathe tools to different angles for different materials.



MUSINGS ON STAINLESS

Trevor Marlow discusses the varieties and idiosyncrasies of this frequently misunderstood family of metals.

ANOTHER FINGER PLATE

A useful aid to small parts workholding is described by Philip Amos .

Issue on sale 21st June 2002

(Contents may be changed)

The alternative designs for rolls

From Philip T Bellamy, Brutten, Switzerland.

Re Plate Rolls and End Rolls

Peter Rawlinson has presumably adopted the the design of rolls used in his workplace. Unfortunately with this type of design, it is not possible to roll a true circle as there are always flats left at the two ends. The design by Martin Evans had the same shortcoming.

When rolling the barrel for a loco boiler or the like, which should be a true circle, then the design by the late George Thomas is to be recommended. In this, there are a pair of pinch rollers, one above the other and a third roll which determines the radius being rolled. I have built one set to the drawings, and another almost double the size. The rolls themselves were made from precision ground steel, polished to avoid marking the soft materials being rolled.

Peter Rawlinson replies

Pinch Rolls partially overcome the problem of the flat, however a flat is still present at one end of the workpiece, and to get over this, the material must be reversed, preferably at each pass.

For industrial applications, full circles are seldom required. When these are needed, it is then necessary, either to have a removable top roll, or to have a removable end bearing arrangement, to allow clearance for extraction of the barrel.

The small flat left by pyramid rolls is normally formed to a curve either by use of a press brake (giving a series of light line folds) or by hand beating. In some circumstances, particularly bar rolling, an additional material allowance is made, and the flat cut off.

Perhaps Phillip Bellamy might be persuaded to prepare an article on his rolls for a future issue.

More information on the The L298 chip

From Tony Jeffree, Sale, Cheshire

I read with interest the article on DC motor control in issue 80 of MEW; in particular, the project based on the L298 to provide a variable speed motor controller looked to be very useful. I have used these devices to drive stepper motors, but have not tried driving conventional DC motors with them. However, there are a couple of small points that are worth mentioning in this connection.

Firstly, the article indicates that running both halves of the L298 device in parallel can increase the current handling capacity. While this is true, the SGS Thompson datasheet for the L298 specifies the max DC current as 3 amps in this configuration, i.e., 1.5 times the max DC current for each half of the driver when used individually, not twice the current as might be inferred from the article. So, while a useful increase in current can be obtained by this method, it is not quite as high as it would appear at first sight.

Secondly, there is no current limiting built into the circuit as described, so if you were to attempt to drive a higher current motor, there would be a danger of overloading and damaging the L298; hence, the motor used should not be one that will draw more than 2 amps from a 24 volt supply. In the stepper drive configurations that I have played with, I have used the L297 stepper controller chip in conjunction with the L298; the L297 has a comparator that can sense the motor current, via a small resistor in series with the motor winding, and use this to turn off the motor when the motor current reaches the desired max value, turning the motor drive back on when the current falls to below the setpoint. Potentially, the circuit described could be modified to have a similar effect, by adding a comparator and gating the output of the oscillator with the output of the current comparator, thus limiting the maximum motor current regardless of the spec of the motor that was being driven. An alternative approach that might be worth trying would be to use the L297 in place of the 555 timer-based oscillator, and to control the motor speed by adjusting the current setpoint into the L297.

If anyone is interested in delving deeper into the L297/L298 specs, you can download them in PDF format from the SGS Thompson website at: http://www.st.com

Comments on Exhibition Categories.

From Christopher Smith, Taunton, Somerset

Re. M. E. Exhibition Tools and Workshop Appliances Section

I would be more inclined to reveal my inadequacies in a loan section dedicated to novel workshop devices, without the pressure of competing.

If we must be competitive, how about a category such as "Most Ingenious Workshop Device", to be judged regardless of finish? The prize might be a suitably distressed trophy.

From Ted Wale, Nova Scotia, Canada

I like very much the suggestion that a class be set up at the annual show for Tools and Workshop Applications where the judging is on the produced item and the effectiveness of the tool in doing this, where show-stopping finish is not even considered. If there were such a class I would immediately enter several items that I have made for my shop, each to fulfill a particular need in making an end product and not to produce a shiny new tool that one hardly dare use. In addition I suspect that the items entered would be simpler and smaller than the present contenders for the Challenge Cup in that they would be made for a totally different purpose- To MAKE something rather than to BE something. By their very nature they could easily be sent to the Exhibition from afar, in my case 3000 miles. In our active New Zealander's cases 12000 miles. What a source of entries to tap. If this were to be a competition rather than loan section then it would, no doubt, cause some head scratching for the judging team, especially when judging for interclass and overall awards as the requirements would be totally different between classes and especially from previous practice.

I suspect that a large number of our fraternity would be very supportive as soon as they could really believe that function and not finish was the essence of the judging and that smallness and simplicity were an asset and not a liability.

Electromagnetic Effects and old gramophone motors

From Peter Spenlove-Spenlove, Wigstone, Leicestershire

Having enjoyed Tony Claridge's series on electro-magnetic devices, I noted his eddy current brake experiments described on page 50 (Figure 1) in the October 2001 (Issue 77) copy of Model Engineer's Workshop. Fig. 1 reminded me of two practical applications of this braking effect.

In the factory, during WWII, a couple of gramophone players were used to play 78 rpm "Music While You Work" records. When the auto-changer wore out, these players were scrapped. Being curious, I salvaged the two motors,(see photos) one of which still has its rotor disc of nickel plated copper. This disc was fixed on to the actual turntable spindle; i.e. direct drive. The disc was driven by 230 volt wound laminated core coils with associated capacitors and copper shading on some poles. The disc rotated in the air gap between wound poles. There is no mechanical contact, but as some records were still meant to be played at 80 or even 84 rpm, a means of controlling the speed was needed. Although lost and therefore not shown in the photographs, a strong horseshoe magnet was fitted to embrace part of the disc between its poles. A control lever could move the magnet so that more or less of the magnetic flux could pass through the disc, just as Tony

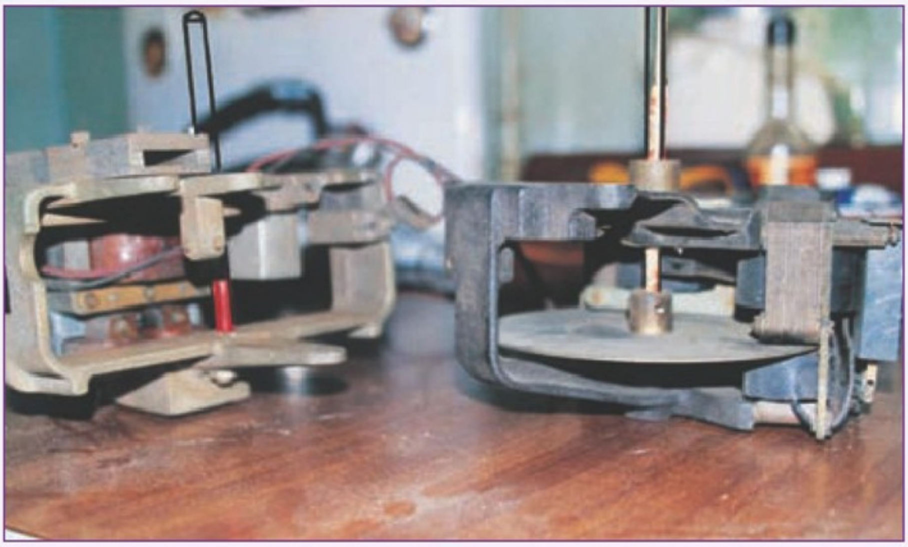
Claridge states with his "Fig. 1" experiment. Because there was no mechanical contact, there was no noise and no wear. These direct drive motors are massive and weigh just over 10 pounds in the condition photographed. With the magnet and the heavy C.I. platter, this could be doubled! It was replaced by the newly invented "Dansette" record player which almost every family seemed to have.

The other practical application was the family car speedometer. The accompanying sketch shows and explains the elements within a speedometer. It looks as Tony's "Fig. 1" but now the magnet is moved around his disc. This, if fast enough, will wind his weighted string back up on to the cotton reel!

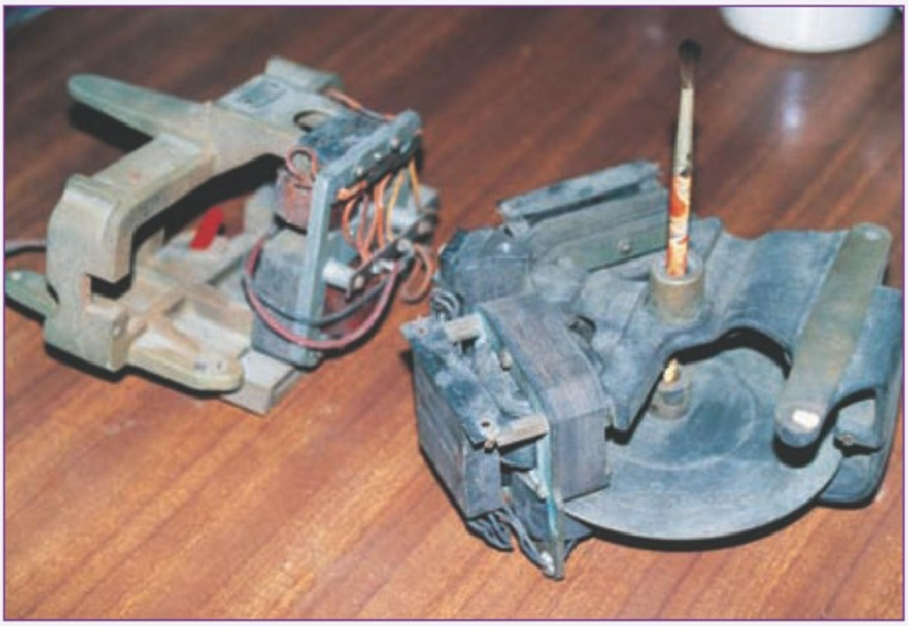
In industry it is often necessary to transfer delicate wires, foils and tissue from stock drums or reels without damage such as stretching or breakage. Delicate copper wire might be wound into small coils for electronic equipment. The tension must be even and absolutely reliable for mass production. The inertia of a supply spool is massive. Any snatch due to bearing friction variation, speed change of wound coil former, stops to change formers etc. or variability of performance of friction brakes could be disastrous. Thanks to modern electronics it is possible to monitor the tension and instantly send a control current to an electromagnetic torque or braking system which is not mechanically connected to the winding equipment, but magnetically only. There is no stick-slip friction and no 'cogging' at slow speeds. Readers who study Tony Claridge's "Fig. 1" principle will, I hope, be able to envisage how it can be employed in all sorts of industrial processes.

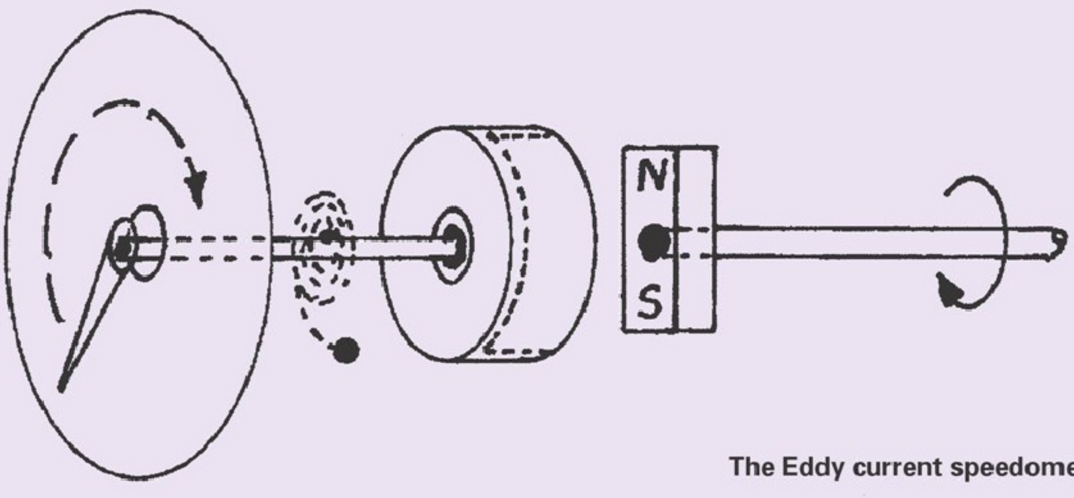
Returning to the subject of the car speedometer, the road wheel speed is transmitted by (usually) a flexible shaft to rotate a bar magnet which is magnetised as shown, whether it be bar or disc shaped. Within the instrument body, this magnet is positioned to rotate within a light pressed sheet aluminium (or copper) cup. There is no contact other than windage. The cup is riveted to a spindle which extends though a calibrated dial to a pointer. A clock type hairspring holds th assembly at zero speed. As soon as the magnet starts to rotate, eddy currents in the cup react 'proportionate' to the speed, causing the pointer to rotate against the hairspring and indicate the vehicle's road speed. With instrument quality bearings and a dust proof enclosure, this type of speedometer proved ideal for mass production. Being simple and rugged it was in common use.

The sketch shows the basic elements, but with the magnet withdrawn from the cup to simplify the sketch.



Two pre-war gram motors. Spindle to platter missing. Direct drive. Disc on one missing. Disc driven by mains laminated electro magnets, one of which includes a 1 mfd condenser in its circuit. RPM 78. One (with no disc now) has a slide with permanent magnet to reduce speed.





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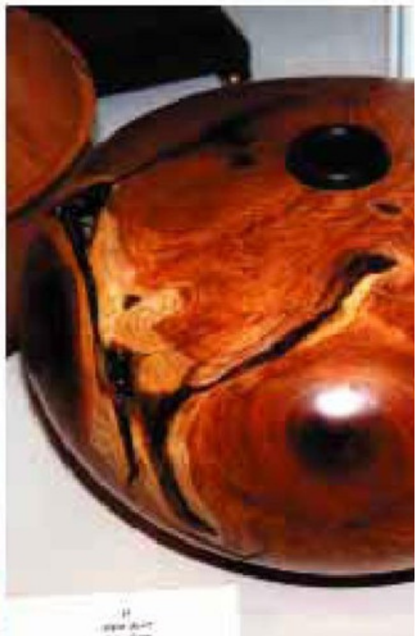

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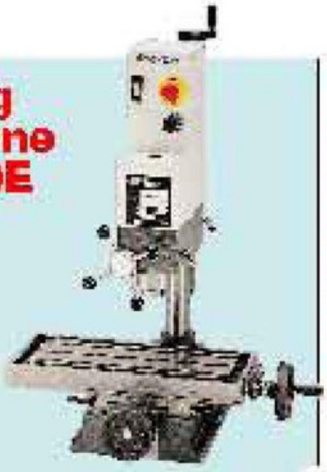

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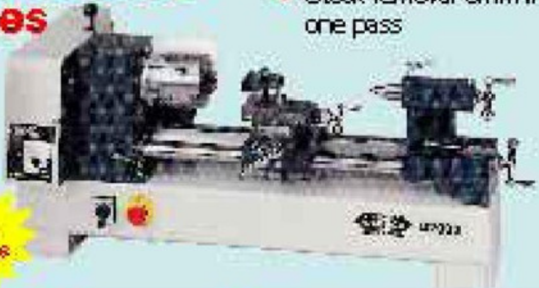

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