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# 1

# INTRODUCTION

The router is undoubtedly the most versatile power tool in the modern workshop. With the tremendous range of cutters, jigs and accessories now available, it is the perfect tool for a wide range of applications, from home improvement projects through to production environments.

Using a few basic techniques and the right choice of cutter, the router offers unrivalled possibilities. It will improve the speed, efficiency and accuracy of any cutting or machining operation, whether with natural timbers, man-made boards and many other materials.

Like any power tool involving cutting at high speed the router needs to be treated with respect. By following the simple common-sense advice in this booklet and in your router manual, your router will give you years of productive use.

Of course, the really hard work is carried out by the router cutters themselves. Naturally, like all cutting tools, router cutters have a finite life. The practices recommended in this booklet have been devised to ensure you maximise the working efficiency and life expectancy of your cutters. Most importantly, you'll obtain the highest standard of finish and accuracy time after time when routing.

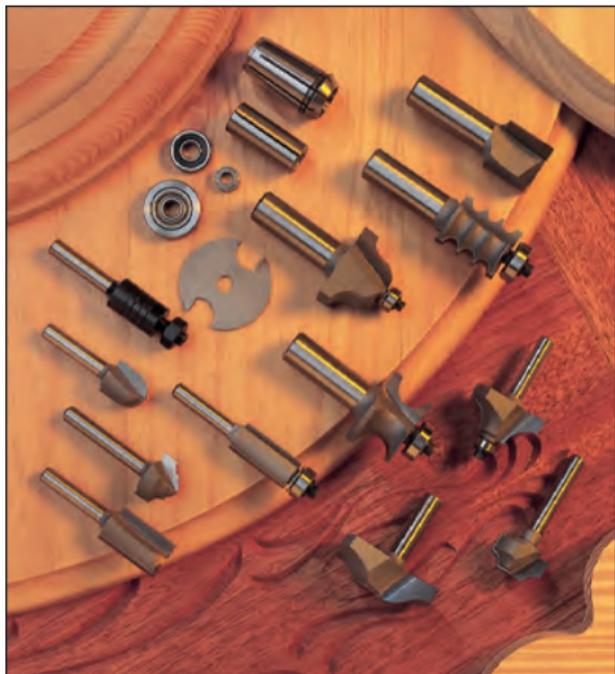
By choosing Trend Professional Range router cutters you will ensure that you are using products made to the highest possible tolerances. Trend Craft Range routing products and our Starter Sets offer an affordable alternative for DIY and home improvement applications.

Full details on all our router cutters and routing products are contained in the latest Trend Routing Catalogue, available free from your local Trend Stockist or by contacting us at the address in this booklet.

We wish you a productive time using your router. Enjoy using it and by taking care of your cutters, they will serve you well!

# 2

# CUTTER SELECTION



Cutters are available in many different flute forms, materials and sizes. Whether choosing one for production applications or for home use, the correct selection of a router cutter to suit a specific application is vital in achieving the best possible efficiency and finish.

The aspects of cutter selection are grouped in the following six sections:

## **2.1 CUTTER FLUTE FORMS**

## **2.2 CUTTER GEOMETRY**

## **2.3 CUTTER MATERIALS**

## **2.4 CUTTER QUALITY**

## **2.5 SHANK DIAMETER**

## **2.6 CUTTER LENGTH**

## 2.1 Cutter Flute Forms

### 2.11 Single fluted cutters

Straight, core box or engraving cutters are often ground with a single flute or cutting edge. With one larger flute produced, less body material is ground away than on other cutter forms. This produces a stronger cutter with better chip clearance characteristics, allowing faster feed rates to be maintained, but generally to the detriment of the finished cut edge.



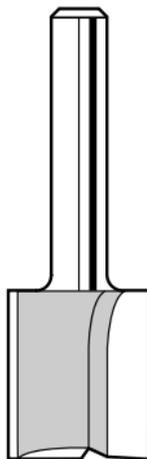
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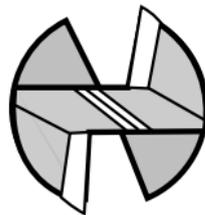
*A single fluted straight cutter in TCT.*

### 2.12 Two fluted cutters

The most common form of router cutter is produced with two cutting edges ground symmetrically opposite each other. Two fluted cutters produce a far better finish, but should be used at a slower feed rate than single fluted ones to allow waste material to clear adequately. For plunge cutting applications, a cutting edge is often ground on the bottom of the cutter. With tungsten carbide tipped cutters over 9.5mm in diameter, a third central tip of tungsten carbide is used to give a plunge cutting facility.



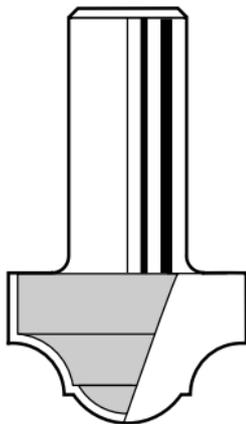
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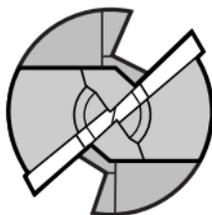
*A two fluted straight cutter in TCT.*

## 2.13 Shaped cutters

Shaped cutters are usually two fluted and are used for decorative moulding or jointing applications. By changing the depth or width of the cut, or by altering the table fence or side fence position, different profiles can be produced using the same cutter. With bearing guided versions, the fitting of an alternative larger diameter ball-bearing guide, will often produce a different shape. Typical standard profiles include bevel, radius, dovetail, rounding-over and rebate cutters.



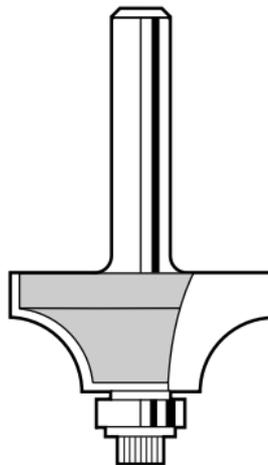
*Ref. 18/52*



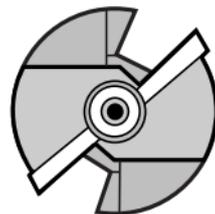
*A classic panelling  
cutter in TCT.*

## 2.14 Bearing guided cutters

Straight cutters are also available as self-guiding cutters, and are designed to follow the edge of the workpiece or a template fitted above or below it. Self guided cutters are used for trimming, moulding or rebating. To achieve this, a ball-bearing guide is fitted, or a solid pin is brazed into the nose of the cutter. See also pages 26 and 37 for further information.



*Ref. 46/93*

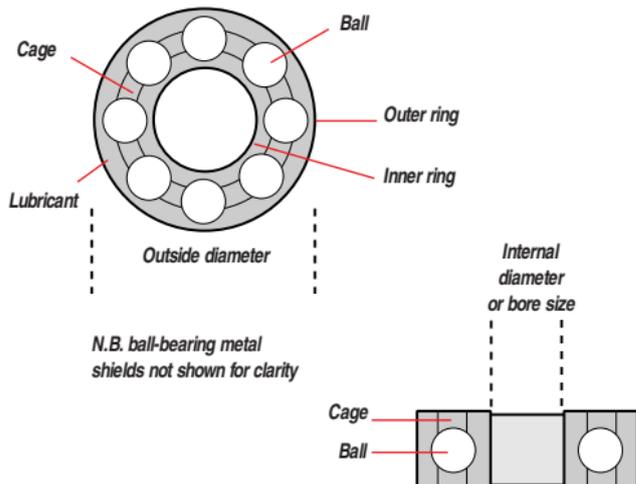


*Bearing guided ovolo cutter  
supplied with an alternative  
bearing to give a rounding over  
mould.*

## 2.15 Ball-bearing guides

Ball-bearing guides can be fitted either to the cutter shank, above the cutting edges or on a spigot machined on the end or nose of the cutter. As the ball-bearing diameter predetermines the width of the cut from the board edge, by changing the ball-bearing guide for one of a different diameter, the width or depth of the cut can be altered.

Ball-bearing guided cutters have the advantage of reducing the setting-up time, as the maximum width of the cut (e.g. rebate) or depth of cut (e.g. grooved edge) is fixed by the ball-bearing diameter. The ball-bearing guide or pin is run against the edge of the work, with guide or template mounted above or below it.



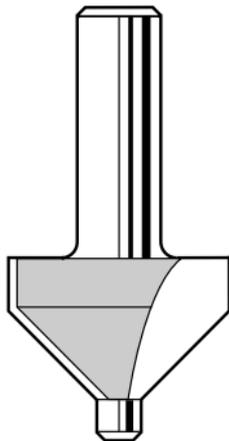
This allows the cutter to follow a curved edge and avoids the need to use a side fence or parallel guide for straight edge work. The precision afforded by ball-bearing or pin guided cutters, is often critical when using interlocking or matched profile scribing cutters.

Ball-bearing guided cutters have an advantage over solid pin guided cutters, in that they produce less friction between the ball-bearing outer edge and the timber, which reduces the risk of burning the edge of the workpiece. Ball-bearing guides are generally held in place by either a socket headed screw or hexagonal nut. In most cases a small washer is fitted and should always be refitted when changing or refitting guide bearings. Ball-bearing guides for use on router cutters have shields fitted that reduce the amount of dust and dirt that can enter and clog the moving parts.

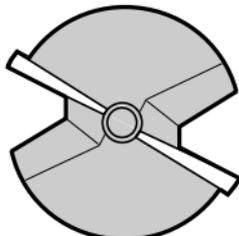
Ball-bearing guides should be considered as consumable and non-serviceable items and may need replacing during the life of the cutter. Never try to clean a ball-bearing with solvent, as this will dilute the grease lubricant. It is virtually impossible to replenish the grease and any attempt to do so could prove dangerous or cause serious damage to the workpiece, as the ball-bearing is likely to collapse.

## 2.16 Pin guided Cutters

Some basic shapes, such as ogees, core box, chamfer, rebating and trimming cutters are available with pin guides. These are used in similar applications as bearing guided types, yet are less versatile. They have the advantages that they can be used to shape or profile intricate shapes due to the smaller pin diameter. However, extra care is needed to prevent the edge of the workpiece or template burning due to the frictional heat.



*Ref. 10H/1*



*A pin guided chamfer cutter, ideal for intricately shaped workpieces such as sign lettering*

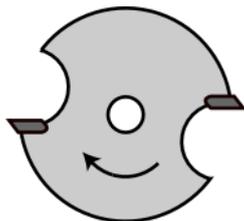
## 2.17 Arbor mounted cutters

Arbor mounted cutters consist of single or multiple slotting cutters assembled on an arbor, using spacers, shims and ball-bearing guides to adjust their proximity and depth of cut. This form of cutter offers a high degree of versatility, as the basic components can be mounted in different combinations, using the shims, washers and spacers to vary their spacing. In production operations, arbor mounted cutters can be used to save downtime and costs when changing or re-sharpening cutters and allow matched cutter sets to be fitted without affecting the machine settings.

### Precautions when using slotters

Take care that all arbor mounted cutters are fitted correctly in respect to their rotational direction. If in doubt about the correct rotation direction, this can be ascertained by reference to a standard router cutter. Always fit shims or spacers to prevent slotter tips touching the guide bearing or adjacent cutters. When fitting two or more cutters, always stagger their tip positions to minimise stress on the arbor and router. In use, periodically check the tightness of the nut.

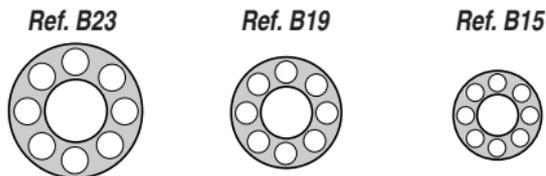
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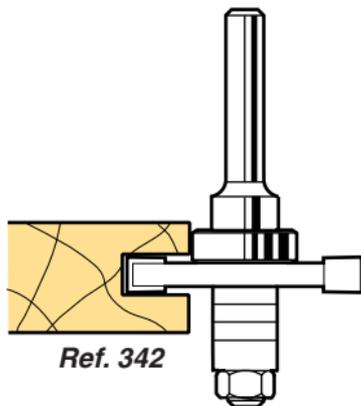
*A typical groover with two cutting tips*

The Trend Biscuit jointer Set Ref. 342 consists of an arbor, 4mm groover and three bearings. This allows three different depths of groove to be jointed, for biscuit sizes 0, 10 and 20.

*Three sizes of bearing*

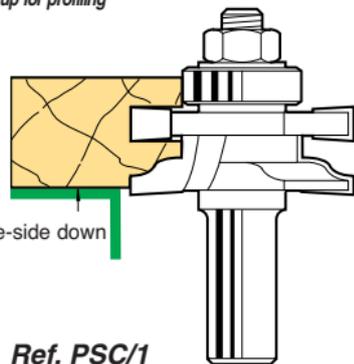


*Three sizes of biscuit*

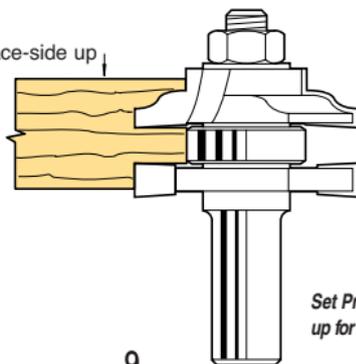


Another versatile tool using this technology is the profile scriber where the groover, bearing and profiler are re-arranged to give perfect matching profile and scribe moulds. When in use the cutters should be staggered to each other at 90° to reduce cutting impact. The bearing is the datum point of this tool and should be in contact with the timber at all times. This type of tooling should only be used with the router mounted in a fixed position.

*Set Profile Scriber Cutter,  
up for profiling*

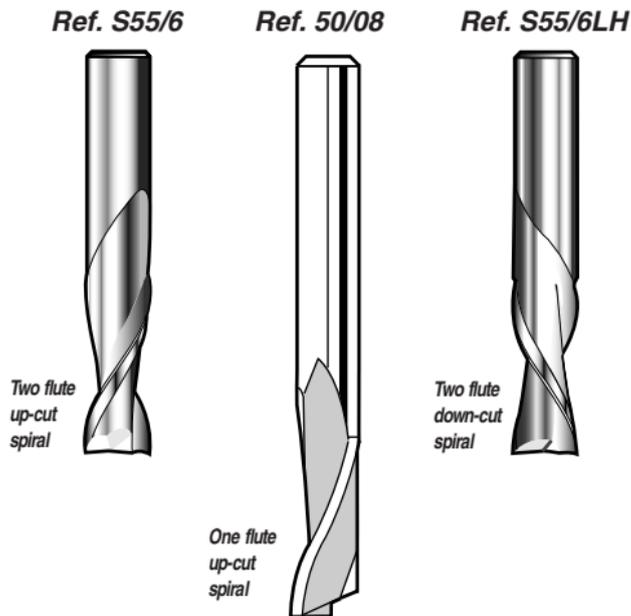


*Face-side up*



## 2.18 Spiral cutters

Spiral cutters feature either one or two helical flutes which are ground to specific helix angles. In either a single or two fluted form, they are generally used for high feed rate applications such as CNC routing in production environments or for machining specialised materials such as aluminium extrusions.



## Production spiral cutters

The two flute types are available as either up-cut or down-cut spirals (i.e. the direction of the flute spiral in relation to the direction of cutter rotation). They produce a constant slicing action, with up-cut (right-hand) spiral cutters giving the advantage of better chip dispersion away from the cutting edges.

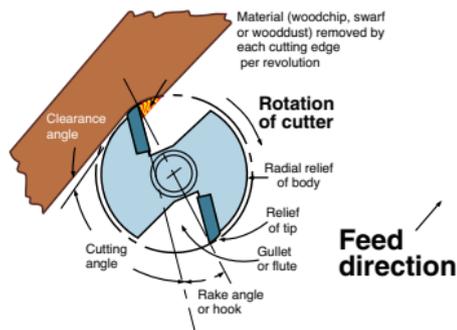
Down-cut (left-hand) spirals, although forcing chips down onto the workpiece to reduce feathering or breakout, aid in keeping the workpiece down onto a jig or vacuum bed.

This action also aids heat dissipation and gives the optimum finish as wood grain is sheared cleanly. Opposed spirals can be used for simultaneously trimming facing laminates or veneers on man-made board or natural timber cores.

## Aluminium industry cutters

Single flute helical or spiral cutters, generally have an over centre cutting edge for plunge cutting. Produced in a special high quality grade of HSS steel (HSSE), they are extensively used on aluminium alloys in the window industry. They will plunge in and cut alloy extrusions more efficiently, when used with a coolant, as well as plunge and slot UPVC plastic.

## 2.2 Cutter Geometry



### Clearance angles and radial relief

Trend cutters are designed to ensure adequate chip clearance and to limit friction, therefore preventing overheating along the cutting edges and workpiece face. Care must be taken to stay within the chip clearance characteristics of a specific cutter while machining, by working at a suitable feed speed and not exceeding the recommended cutting depth and cutter speed in relation to its size and the application.

### Rake angle and cutting angle

This is calculated to ensure the correct cutting action of the cutting tip to suit the application. A low rake angle produces a scraping action. A higher rake angle produces a deeper cutting or planing action.

### Gullet or flute size

This dictates the maximum amount of material each cutting edge is capable of removing per revolution.

### Chip limitation

To comply with generally accepted safety regulations (BG Holz), safety router cutters above 16mm diameter have a chip limitation of 1.1mm. This does not affect the efficiency of the cutter and reduces the likelihood of kickback. It ensures that if personal contact is accidentally made, the degree of injury possible is minimised.

### Centre tips

Centre tips ground onto the end of cutters are designed for plunge cutting and drilling applications. The tip must again, have its own clearance and cutting angles to ensure that the material is machined and not ground or burnt away. Some cutters, including straight flute profiles that do not have centre tips, are designed for profiling or trimming applications only. They will in most cases have clearance for lateral cutting but not for plunge cutting.

### The shank

The shank is machined to precise tolerances to ensure correct mating and grip within the router collet and to turn concentrically to the router axis. The most common sizes in the UK are 6.35mm (1/4"), 9.5mm (3/8") and 12.7mm (1/2") diameters. Larger sizes are available for high volume production equipment and applications. Metric, 8mm diameter shanks have been introduced in the UK in recent years to cater for smaller router users needing to use larger types of cutters safely. Generally shanks of 8mm and 12mm diameter are manufactured for the European market. The correct geometry of a cutter is critical in order for it to perform correctly at its high optimum cutting speed. The angles such as rake, cutting and clearance are carefully designed to suit each type of cutter. This varies according to its size, the cutter material or to suit its specific application.

## 2.3 Cutter Materials

### 2.31 HSS - High Speed Steel

Good quality HSS Cutters are machined from a single piece of High Speed Steel, to the required flute profile and ground to a fine edge. Inferior types have a body produced from cast steel. Generally HSS cutters are less expensive than their TCT grades, but are more suited to those applications where a superior finish is required on specific materials such as non-abrasive natural timbers, PVC and acrylics (non-tinted varieties). HSS cutters are often used in conjunction with more durable TCT cutters of similar size and profile, the latter removing the bulk of the waste and the former to make a light finishing cut to achieve a non-feathered edge.



### 2.32 TCT - Tungsten Carbide Tipped

These routers cutters again have the body and shank machined from high grade steel, but with tungsten carbide tips brazed onto each flute. They are more durable than HSS cutters, although they cannot be honed to such a sharp edge. Designed for cutting the most abrasive materials, under normal conditions they will outlast HSS grade cutters by many times over. They are able to keep their cutting edge more efficiently and preclude the need for constant re-sharpening. Small sized cutters have a solid carbide insert set into the shank rather than TC tips brazed to the flute(s). Tungsten carbide is a extremely hard material, but is prone to chipping when knocked or dropped against hard surfaces or other cutters. Applications include routing natural timbers, plywood, chipboard, fibreboard including medium density fibreboard (MDF) and hardboard, glass fibre reinforced plastics (GRP), acrylics (tinted variety) and other abrasive plastics such as Tufnol®, and solid surface materials such as Corian®.



## 2.33 STC - Solid Tungsten Carbide

Solid tungsten carbide cutters are ground from a solid piece of tungsten carbide and provide the greatest durability when used under stress load conditions and where heat build-up can potentially damage the cutter or the material. They can also be ground to produce better plunge cutting characteristics than TCT and can be re-sharpened many times more. As tip brazing operations are unnecessary a harder grade of carbide can be used which will prolong the cutter life even further.



**Note:** Grades of tungsten carbide vary according to manufacture. Trend TCT and STC grades of cutters are produced with micro-granular grades of carbide that ensure a true sharp edge is obtained during the manufacturing process and is maintained for longer, ensuring maximum tool life.

## 2.34 ReplaceableTip Cutters

Replaceable tip cutters are comprised of a solid tungsten carbide blade held by retaining screws to a ground steel body. When dull, the blade can be rotated to expose up to three more cutting edges. While initially they are more expensive than standard TCT cutters, they prove effective in high production applications where 'downtime', required to change tooling, is kept to a minimum while allowing constant machine settings to be maintained. Their use is normally aimed at fixed head applications i.e. Computer Numerical Controlled (CNC) routers. The smaller size cutters, are limited to hand held applications where abrasive materials necessitate the frequent renewal of a keen cutting edge.



## 2.35 HSSE - Super High Speed Steel

Super High Speed Steel cutters are produced from a specially developed high grade steel, precision ground to the highest tolerances. They are generally used for specialised applications, typically by window and door fabricators for machining aluminium and UPVC extrusions. They are able to resist the abrasive nature of extruded anodised aluminium and will plunge drill and mill lateral slots in this material. However, they do require the use of a continuous coolant such as a water soluble oil or mist spray to maintain low cutting edge temperatures and to reduce the likelihood of 'weld back'.



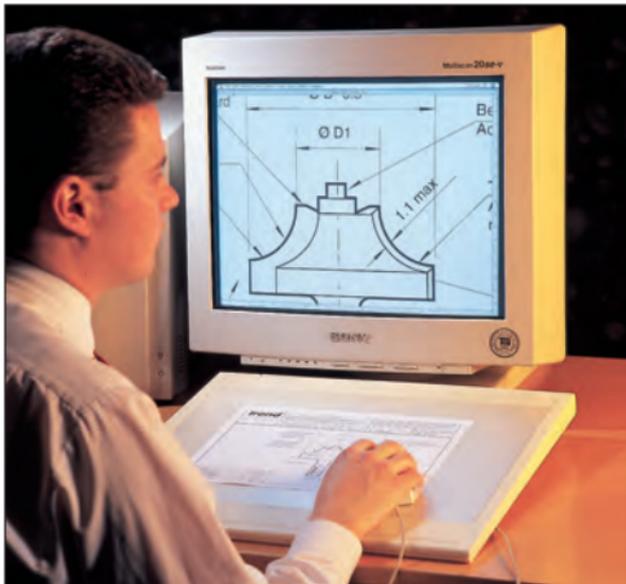
## 2.36 PCD - Poly Crystalline Diamond

Polycrystalline Diamonds are bonded to tungsten carbide tips under extreme pressure and intense heat, resulting in a cutting edge that outlasts normal TCT many times over. Their expense warrants use only in very specialised or high-cost production applications on CNC or other large industrial fixed head routers with automatic feed. PCD tooling offers the highest cutting performance available with current manufacturing technology.



## 2.4 Cutter Quality

The key to achieving ultimate performance and durability is in selecting cutters produced to high standards of materials and workmanship. Always ensure cutters are purchased from a reputable manufacturer who has a quality control system such as ISO 9002. Access to practical after sales technical support and advice, from the manufacturer or agents, is essential in ensuring confidence and satisfaction when purchasing your cutter.



The Trend Technical Support Department, staffed by experienced tradesmen and engineers, are available to give practical advice on cutter selection, setting-up, jig-making and routing techniques. Their expertise is trusted by thousands of routers users each year, ranging from DIY enthusiasts and professional woodworkers right up to multi-national manufacturing organisations.

The **Trend Professional Range** tooling will satisfy the most demanding applications of professional woodworkers, builders and joiners. In manufacturing industry, Trend tooling fulfils the needs of modern routing technology, when complex machining performance relies on the highest possible standard of tooling. A wide variety of tooling forms and designs are offered for virtually any application or material in use today.

The **Trend Trade Range** is a select range of Tungsten Carbide Tipped router cutters. The range features 2mm micrograin Tungsten Carbide tips for cutting the most abrasive materials to give extra long life. They are Teflon® coated which is indicated by a distinctive black colouring. They can be used on hardwood, softwood, fibreboard, plywood and particle board. They have etched dimensions on extra long 40mm shanks for quick identification.

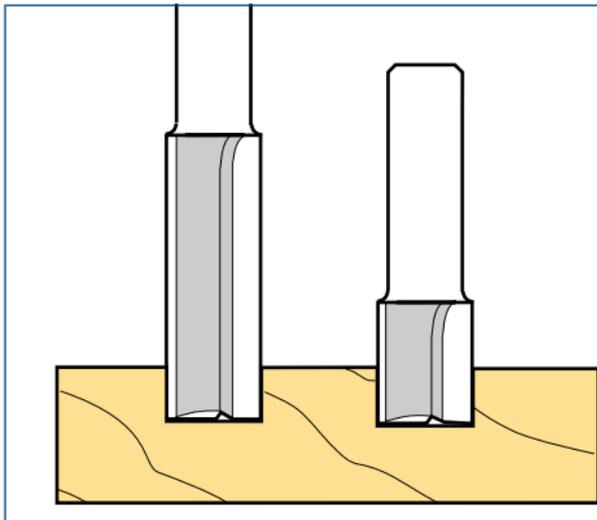
The **Trend Craft Range** is specifically suited to the needs of the leisure craftsmen and home improvement enthusiast for performance and value. The range has tungsten carbide tipped cutters with 1/4" diameter shanks, although certain popular shapes are offered on 8mm and 1/2" diameter shanks. They can be used on all man-made boards including medium density fibre board (MDF) and chipboard, as well as natural timbers and plastics.

## 2.5 Shank Diameter

Large diameter cutter shanks are inherently stronger and therefore less susceptible to side deflection. Having a larger surface area, they provide a better grip in the collet, making them less prone to release and turning. Whenever economically possible, always use the largest shank diameter available for a specific cutter. It also follows that deeper cuts can be made in relation to the router power available. Shanks should also be of the correct hardness to prevent scoring, a problem that often becomes apparent with poor quality cutters.

## 2.6 Cutter Length

Although cutters are available that have extra long cutting edges relative to their cutter diameter, for production applications, it is advisable to restrict the length to the shortest possible. Particular care must be taken when using cutters with long cutting edge lengths, by making only fairly light cuts in a series of shallow steps to reach the full depth of cut.



Whenever possible, use a cutter of a similar cutting edge length as the final depth of cut. As a general rule when using cutters below 6.3mm (1/4") diameter, on hard or abrasive timbers and materials, the cutting depth is best kept to no more than half the shank diameter.

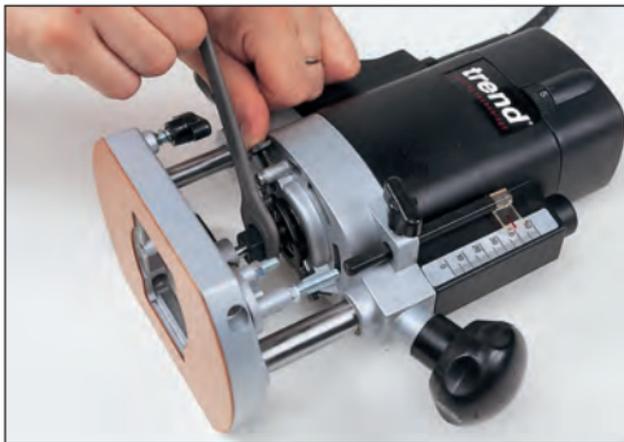
When it is necessary to use an over-length cutter, follow the general rules of cutting in shallow steps to minimise any stress on the cutter while under load. These are that the depth of cut should not exceed either the diameter of the cutter, up to 12.7mm (1/2"), or the diameter of the shank, whichever is smaller. This keeps the side load on the cutter, the amount of waste that needs to be removed and the friction between the cutter and workpiece, to a minimum.

Some edge moulding cutters remove less waste on the initial passes than on subsequent ones, so it is possible to take deeper cuts at first, but take shallower cuts as more of the cutting edges engage the timber, until the full profile is reached.

# 3 ROUTING PROCEDURE

## 3.1 Fitting cutters

Always take extreme caution when removing the protective wax from a new cutter. Do not pull it off as the sharp cutting edges could cause injury. Carefully slit the wax with a sharp knife along the internal angle of the flute and prise the coating away. Before using a new cutter wipe off any protective oil to prevent it transferring and possibly marring the surface of the work.



## 3.11 Inspection

Always inspect cutters before fitting them in the collet, checking for damage sustained in previous use, dullness, chips or resin build up. Check that ball-bearing guides on self-guiding cutters are neither too tight nor too sloppy and that the screw holding the bearing in place is tight. Remember that any damage to the shank, such as scoring or deformation, will damage the collet. The shank should be maintained in as smooth and as clean a condition as new. A cutter shank with a burr on it will result in an inaccurate cut and may cause vibration. Over tightening of the collet often distorts it and causes grooves in the shank. Dirt or grit adhering to the shank will have a similar effect. It is therefore important that the shank is regularly examined and cleaned. When inserting the cutter into your router, ensure that the collet and collet nut are completely free of debris. Round brass wire brushes for the correct diameter for the collet are available for removing debris.

### 3.12 Shank length

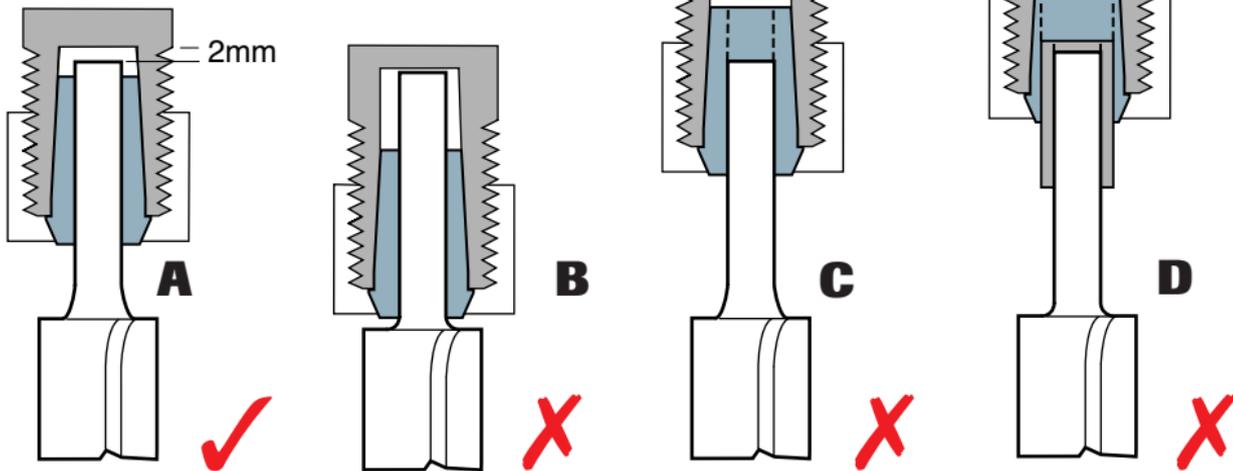
Always insert as much of the shank as possible into the collet and at least three quarters of the shank length as a minimum, to decrease the chances of deflection of cutter when under load. This in turn will prevent damage to the collet, reduce wear and stress on the routers bearings and avoid the likelihood of shank breakage.

Do not allow the end of the cutter to be in contact with the internal end of the armature recess, see diagram A. Always maintain a gap of about 3mm to prevent a hammer action being induced which will cause the cutter to creep from the collet.

Ensure that the collet does not engage on the flange of the cutter (the curve between cutter body and shank), see diagram B.

Never clamp a short portion of the shank in the collet to 'dangle' the cutter to get that extra length, see diagram C.

Never use collet reducers as a means of extending the length of the shank, see diagram D.



### 3.13 Tightening collets

Do not use excessive force to tighten the collet nut, as over-tightening will distort the collet assembly and score the cutter shank, causing the shank to bind or even break.

To prevent damaging the collet nut, always use the correct size spanner to give a perfect sliding fit across the flats of the nut.

Ensure the router manufacturer's correct collet assembly procedure is carried out.

Use only medium pressure to avoid over-tightening, but do make sure that the nut is tightened sufficiently, otherwise the cutter will rotate within the collet, scoring the cutter shank, possibly leading to it binding or breaking.

Always keep metric and imperial shank cutters separate and clearly marked. Attempting to use a 6mm diameter shank in a 1/4" (6.35mm) collet will distort and damage the collet.

Inferior grades of cutters often have shanks machined to incorrect tolerances, which will lead to collet problems.

Worn or damaged collets should be discarded. It is strongly advised that the collet nut is also replaced at the same time.

### Jammed cutters

To remove a cutter which has jammed into the collet, gentle taps should be applied to a point behind the cutter head. But avoid hitting the tips.

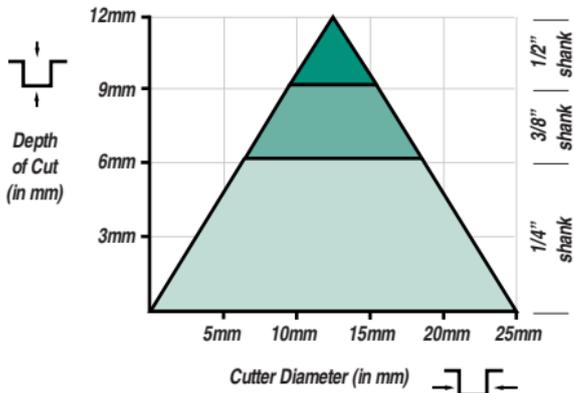
Levering the cutter out of the collet can sometimes be achieved by inserting a spanner, (size to match shank diameter), under the base of the cutter and applying gentle leverage pressure, but insert a protection piece (card or thin plastic) between the spanner and cutter to try to avoid damaging the tungsten edges.

If this occurs repeatedly with one particular cutter, inspect the shank for damage or fatigue. If this situation occurs with many different cutters, replacing the collet and collet nut will be necessary.

## 3.2 Setting Depth of Cut

A guide to the optimum plunge depth that can be cut in a single pass is that the depth of cut should not exceed either the diameter of the cutter when using cutters up to 1/2" diameter, or the diameter of the cutter shank, whichever is smaller. Taking shallow passes will reduce the side load applied to the cutter and reduce the risk of shank breakage.

### Pyramid chart to assess cutting depths



**Example:** Ref. 3/6 (10mm diameter cutter)  
For 1/2" Shank maximum depth of cut = 10mm  
For 1/4" Shank maximum depth of cut = 6mm

## Guide criteria relative to the chart

- The cutter has a standard shank length.
- The cutting length of the cutter is not excessive relative to the depth of cut.
- The workpiece is of medium density timber.
- A feed speed of 2-3 metres/minute is maintained.
- The cutting edges are clean and sharp.
- At least three quarters of the cutter shank is gripped in the collet.

If any of the above criteria cannot be met, take shallower and therefore more passes until the full depth of cut is reached. Often a 'feel' for the correct cutting depth is achieved, where noise, feed pressure, router revolution will indicate that too deep a cut is being attempted. Never force a cutter to rout too deep a cut in one pass. Stop routing, re-adjust cutting depth and continue.

Similarly, feed speed should be balanced with the cutting depth. Often router users feed too fast at the expense of finish, this occurs because the chips are not able to disperse efficiently. This interferes with cutting performance.

### 3.3 Direction of Cut

The feed direction is the direction in which the cutter is fed into the material or, in the case of table mounted or fixed routers, the material into the cutter.

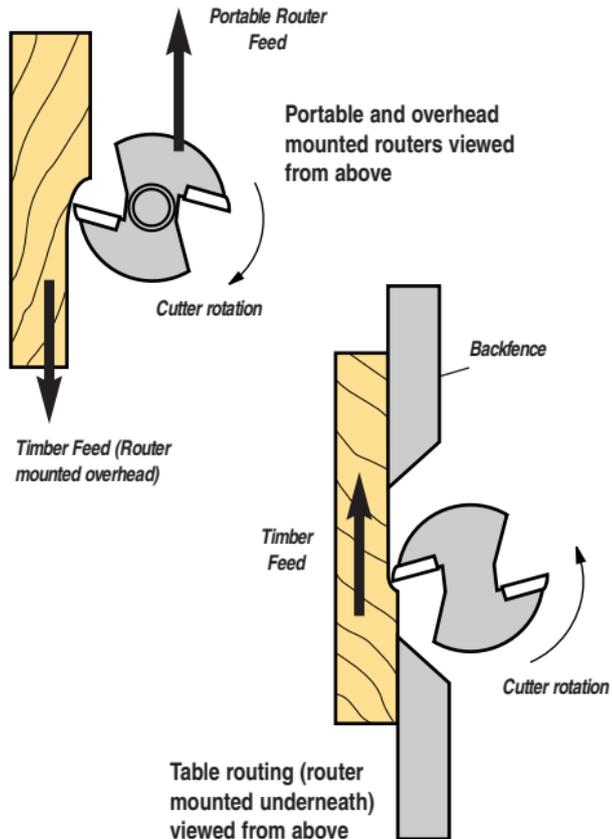
Following the correct feed direction will ensure safer and easier working, and allow the cutter to cut efficiently. The correct feed direction is always against the rotation of the cutter.

This can be ascertained by looking at the cutter itself. Routing machines generally always rotate in a clockwise direction (looking down from above), and this determines the direction in which the cutter rotates and subsequently the feed direction.

If the feed direction is incorrect, the forces involved in cutting will also cause the cutter to push itself, away from the guiding edge of the work or template and hence the router and its guide (i.e. guide bush, side fence or edge of the router).

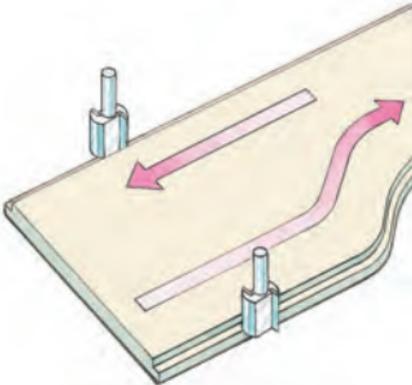
When routing inverted in a table, the feed direction is right to left. If the material is fed in the wrong direction the material could be ripped away from the operator.

It is a good practice to mark the direction of feed (right to left) on the worktable backfence when using your router inverted on a table. With portable routers the rotational direction of the cutter can again be marked on the top of the machine, although with experience this will become obvious.



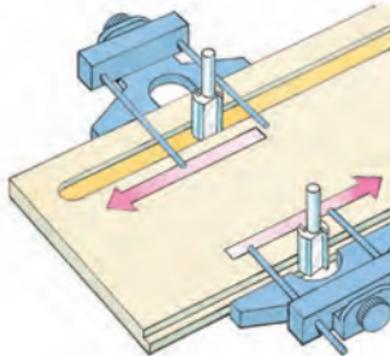
## Edge trimming or moulding

When edge trimming, rebating or moulding, the router's feed direction should generally be against the rotation of the cutter. This rule applies whether the cutter is guided by a fence or mechanical aid or when using a bearing guided cutter.



## Side Fence Work

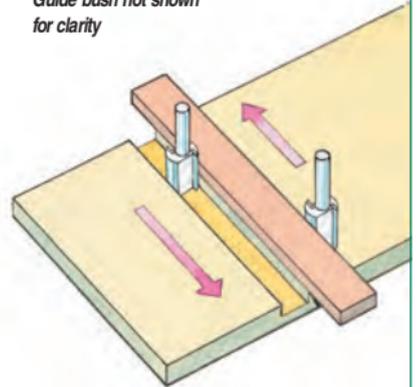
When using the side fence, the router's feed direction should again be against the rotation of the cutter, this having the effect of pulling the fence in against the edge of the work.



## Straight edge guides

When using straight edge guides, the router's feed direction should again be against the rotation of the cutter, to pull the base of the router against the guide.

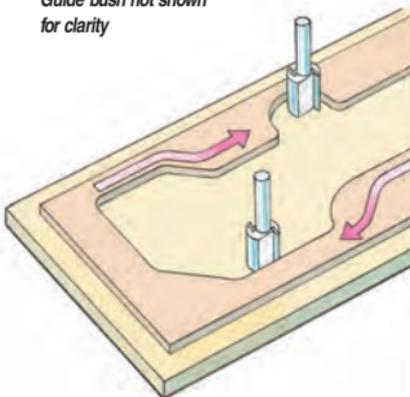
*Guide bush not shown  
for clarity*



## Internal templates

When using internal templates, the router's feed direction should be in a clockwise direction. The cutter will tend to pull the router and guide bush against the template.

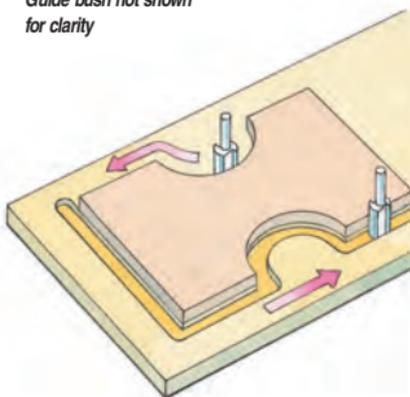
*Guide bush not shown  
for clarity*



## External templates

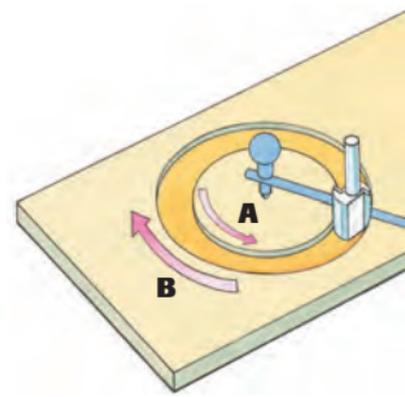
For external templates the router's feed direction should be anticlockwise. The cutter will tend to pull the router and guide bush against the template.

*Guide bush not shown  
for clarity*



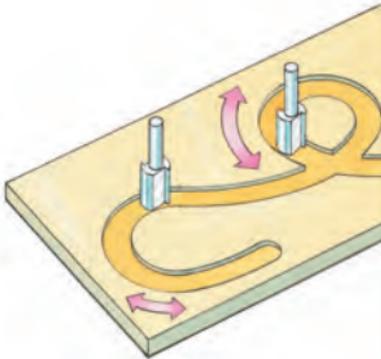
## Circles and arcs

Dependant on which arc or circle you want to cut, feed the router in the direction shown. The cutter is braced against the centre point rather than trying to pull away and possibly pull the point off centre. Always hold the centre point of the beam trammel to prevent it inadvertently 'jumping out'.



## Freehand work

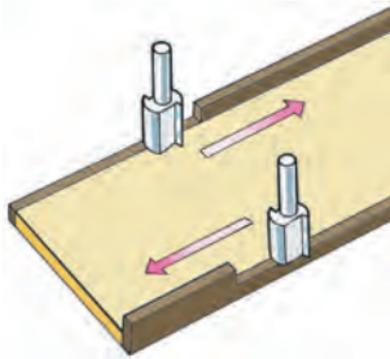
Freehand work can in theory be cut in either direction. However, it is generally better to adopt one direction only for as much of the operation as possible, generally keeping to the right hand side of the outline. Wherever possible it is advisable to rout with the direction of the grain, because routing across the grain can cause misdirection of the router.



## Trimming vertical edges

When trimming vertical lippings flush with the surface, it is necessary to cut in the opposite direction, i.e. with the rotation of the cutter, to avoid break-out and chipping on the edge of the vertical face.

When using the router to trim a vertical liping (i.e. hardwood or plastic laminate), the router is fitted with a stepped base to lift it clear of the uncut liping (never leave more than 2 to 3mm of liping protruding).



## Preventing running splits

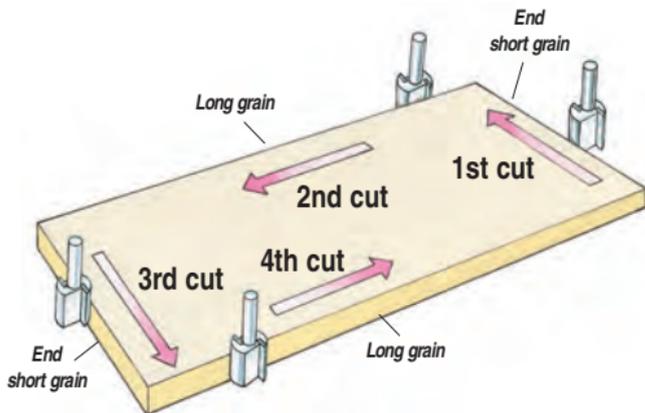
Some timbers such as Douglas Fir have a tendency to split in front of the cutter, when edge trimming or moulding.

This can be overcome by making very shallow steps or cutting at 90 degrees to the edge at regular intervals before removing the waste in the normal way.

## Trimming with and across the grain

When trimming or moulding all four edges of a natural timber panel, care must be taken to avoid excessive break-out at the end of the crosscuts (i.e. cuts across the grain).

To help avoid this problem, always cut across the short grain first before the long grain. Any chipping or break-out at the end of the cut will then be removed when the side (long grain) cuts are made. It is also advisable to score the cutting line across the face of the workpiece with a cutting gauge or knife first to remove any risk of tearing the surface grain.

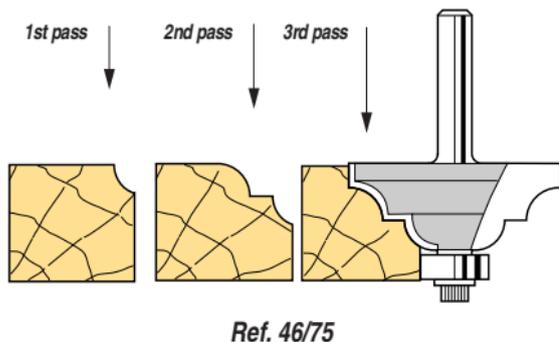


When trimming or moulding only across the grain (i.e. leaving the long grain edges square), spelch battens can be clamped at the ends of the panel to prevent break-out.

### 3.4 Progressive cuts

When using large moulding or panelling cutters, the full depth of cut must be reached in a series of shallow steps.

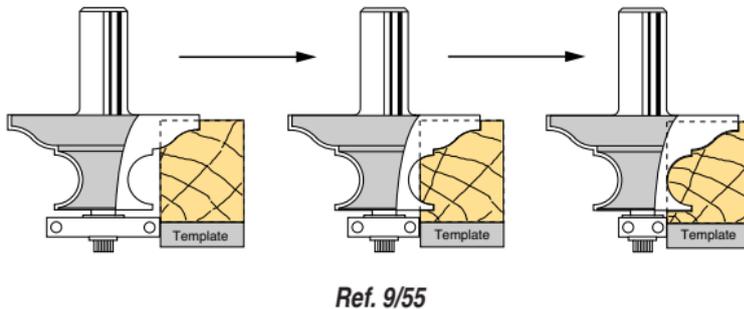
Where the cutter features an open shape, each step can be made vertically, using the fine height adjuster to guide the cutter on each pass until the final depth is reached. The quality of finish will be improved if the final cut is kept very light.



Where the cutter features a closed shape, increasing depths vertically is not possible. If a side fence or back fence (i.e. table fence) is used, then this can be adjusted using the fence to make incremental cuts.

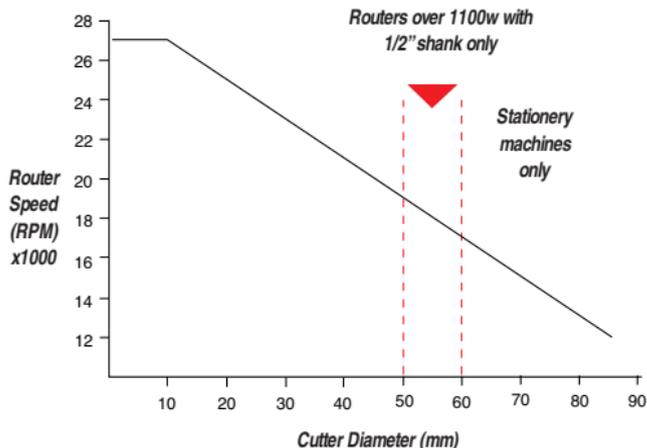
For both straight or curved work, ball-bearing guided cutters can have alternative diameter ball-bearings interchanged before each pass, effectively increasing the width of each pass. This is imperative if small intricate workpieces are to be moulded safely.

The cutter shown, the classic ball-bearing guided corner bead (Trend reference 9/55) is fitted with a 30mm diameter bearing (ref. B300A), then a 19mm bearing (ref. B19A) followed by the standard 12.7mm bearing (ref. B127A).



## 3.5 Router Speed

With the advent of electronic speed control the question of choosing the correct router speed arises. Recommended router speeds can vary depending on the power of the router, the type of material being cut and the feed speed. An important point to remember is that if the router is under powered the cutting speed under load will be drastically reduced and a poor performance will result on all but the smallest size cutters. So several passes with the router should be made if a single deep pass causes the motor revolution count to drop below 70% of the no-load running speed. Using a sharp cutter at the correct peripheral speed will ensure a good finish.



If restricted to a single speed router, you will not be able to run large diameter cutters at their optimum lower cutting speeds.

One advantage of the variable speed feature is their 'soft start', when the motor slowly builds up speed and avoids the 'jerk' which can be disconcerting for some router users.

For ascertaining the correct cutter speed relative to the diameter of the cutter, the peripheral speed can be calculated as follows:

### Formula for finding the peripheral speed of a rotating cutter

$$= \frac{\text{Cutter diameter} \times \pi \times \text{router spindle speed}}{1000}$$

When peripheral speed is in metres per minute

Cutter diameter is in millimetres

Router spindle speed is in revolutions per minute (RPM)

Note:  $\pi = 3.14$

**Example:**

The optimum peripheral cutting speed (PS) recommended for natural timbers is 1520 metres/minute. For example a 20mm diameter router cutter running at the optimum cutting speed.

$$\text{RPM} = \frac{\text{PS} \times 1000}{3.14 \times D} = \frac{1520 \times 1000}{3.14 \times 20} = 24,000\text{rpm approx}$$

Separate variable speed controllers are available for connecting between the router and the power source. However, these are unlikely to offer full wave rectification or speed compensation, and do not maintain the available power evenly throughout the speed range. Inferior types of speed controller can also affect the smooth running of a router, particularly at lower speeds.

**Special Note:**

Optimum cutting speeds based on spindle cutting experience are not binding when applied to router cutters because of their varying geometry. Use therefore for guidance only. Always use the spindle speed for large diameter cutters as recommended by the manufacturer.

## 3.6 Feed Speed

To minimise wear on the router motor bearings, prevent cutter damage and improve the finish left on the cut face, it is important to maintain a constant and optimum feed speed.

Although an optimum feed speed or rate can be given, variations in the type of material, type and condition of the cutter and the available router power will have an effect on this. It is therefore down to the operator to judge by the sound of the router's motor whether the motor is laboured. In time, the operator will acquire a feel for the router and a feed speed relative to the work in hand, will come naturally. It will be found that a narrow cutter can be used at a higher speed than a wider one, although very narrow cutters will need a slower feed speed and smaller depth of cut to prevent cutter breakage.

Feed speeds will also be affected by the type and density of the wood, the grain direction and any variations in the texture of the material along the cutting line. Beware of hard knots as these can damage the cutting edges or even chip or fracture TCT tips. Also avoid 'dead' or loose knots as they can be ejected and cause injury, as well as cause tip fracture.

If the cutter is inclined to burn the material, it is a sign that either the cutter is blunt or that the feed speed is too slow.

In production applications where precise controlled machinery can maintain control of speed, higher router feed speeds can be maintained. This also has a beneficial effect on cutter performance as a larger chip size can improve the finish of the cut and maximise tooling life.



# EN847-1/2 (HOLZ BG) SAFETY/QUALITY STANDARD



The Trade Association accident statistics show that woodworking accidents, especially hand injuries, are the most serious and the most frequent. The reporting of large numbers of serious accidents, has led to the establishment of an international standard for the design and manufacture of tools for the wood industry EN847-1/2 - Tools for Woodworking. The Munich based Holz BG Institute is the governing body where testing is carried out and certificates issued to manufacturers complying to the following requirements:

- Cutters should have a precise geometric design, as well as the use of high quality materials complying with DIN standards, to ensure a safe tool with a high degree of precision and balance of the tools in their production.
- Thickness of chip limit with a maximal cutting edge projection 1.1 mm over the total length of the cutting profile. This is to limit the injury to any part of the body, that may come in contact with the rotating tool.

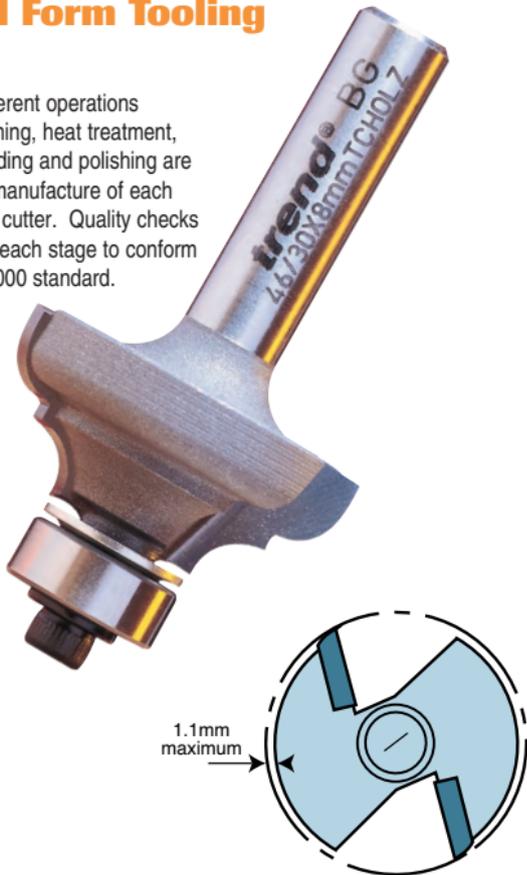
- Restricted maximum chip clearance width, including the regrinding range as a function of the cutting flight circle. This is intended to limit the kickback energy to a minimum and to prevent injury to the user.

- Maximum rotation speed is determined according to the tool dimension & materials with the help of a computer program. The tests include dynamic balance and overspeed testing to twice max RPM.

Trend's professional TCT (H/W) router cutters are designed and manufactured to the EN847-1/2 (Holz BG) standard. Confirmation of this can be found on the shank and on the packaging of each product. Claims by manufacturers that their router cutters have the Holz BG form e.g. cutters with a round body should not be interpreted as having passed the Holz BG test. Cutters confirming to the Holz BG test have a specific test number.

## Round Form Tooling

Up to 45 different operations including turning, heat treatment, brazing, grinding and polishing are used in the manufacture of each Trend router cutter. Quality checks are made at each stage to conform to the ISO 9000 standard.



The professional tools have passed extensive tests carried out by the HOLZ B.G. Institute of Munich. These tests include dynamic balance, overspeed testing (to twice max 48,000 rpm) manufacturing design and material structure.

B.G. test numbers are:-

**BG-TEST  
159-001**

BG Test 159-001 for  
profile/shaped cutters

**BG-TEST  
159-002**

BG Test 159-002 for  
straight/fluted panel cutters



The number 159 has been assigned to Trend tooling. Tools under 15.9mm are exempt from BG Test Standards as are plug making tools, boring bits and drills.

# 5

# CUTTER DAMAGE & BREAKAGE



Although the structural and metallurgical composition of components that are used in the construction of a quality router cutter are designed to withstand professional and industrial use, damage or breakage can and does occur for many reasons. A detailed examination and statistical analysis indicates three distinct causes.

## 5.1 Incorrect cutter selection

The result of using the wrong type of cutter for a particular application, can result in rapid failure of the cutting edge. For instance, abrasive materials will quickly take the edge off HSS steel cutters.

## 5.2 Incorrect application by user

Incorrect application accounts for a large proportion of problems relating to cutter failure. These are as follows:

## 5.21 Cutting too deeply

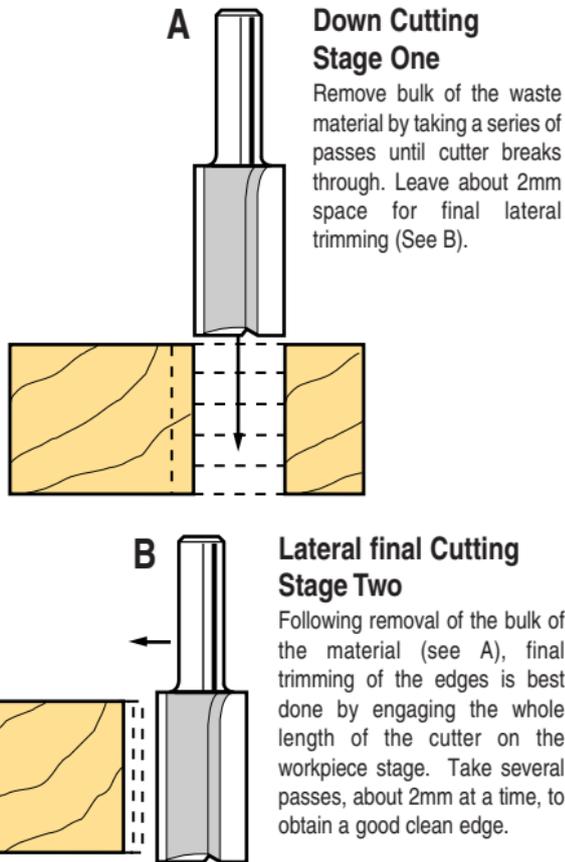
Deep cuts must always be made in a series of shallow steps to avoid placing too much side stress on a cutter, to allow waste to clear quickly and to minimise friction between the cutting edges and the material being machined.

## 5.22 Excessive cutting edge length

Avoid using too much of the cutting edge length on each pass. When trimming shapes with either a ball-bearing guide (fitted to the shank of the cutter) or when using a guide bush, a minimal amount of material should be removed. Rough cut using a bandsaw (maximum 3mm overlap) or jigsaw to leave minimal material to remove when trimming. This will not only provide a better finish but reduce the wear on the cutter and reduce the likelihood of damage to the cutter.

## 5.23 Feed rate

Using too fast a feed rate will prevent the effective clearance of waste material, causing the cutting edges to overheat. It can also cause waste to compact within the gullet (the space in front of the cutting edge), deflecting the cutter and forcing it to run out of line. Smaller cutters have inherently smaller gullets and hence feed rates should be decreased to allow chips to be ejected freely. Too slow a feed rate will tend to cause build up of friction and heat. This is due to the longer length of time that the cutting edges are in contact with the face of the work on each revolution. Heat build-up will have a detrimental effect on the metallurgical composition of the tip resulting in early loss of the cutting edge continued use will cause excessive tool deflection and shank and/or tip breakage.



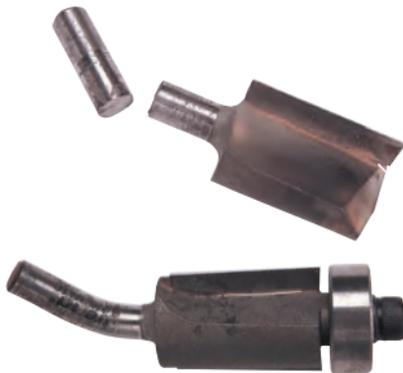
## Tip Breakage

Tip breakage is generally caused by excessive side pressure on the cutter, hitting a foreign object such as a clamp or a vice jaw, a nail or screw hidden within the workpiece or hard or loose knots within the grain. It could also be the result of poor brazing or inadequate tip support through poor cutter design and manufacture.



## Bent or Broken Cutter Shank

Bending the cutter shank is generally due to excessive or intermittent side pressure being applied to the cutter, particularly if the shank is not set far enough into the collet or too deep a cut taken in one pass. Fretting and scoring can be caused by overtightening the collet. This can also be caused by a damaged collet or vibration resulting from slack router motor ball-bearings or a seized ball-bearing guide.



## Burnt Cutting Edges

This is mainly a result of routing at too slow a feed speed, although excessive heat can build-up due to waste compacting around the cutter, cutting too deeply on a single pass, or simply using blunt cutters or using a grade of cutter that is not suitable for the material being cut.



## Over heated bearing guides

Bearing assemblies should be regularly cleaned to prevent binding. Bearings are greased packed for life. Attempts to lubricate the ball-bearings with thin oil or clean them with solvents will only accelerate failure. Bearing guides should be replaced immediately any wear or fault becomes apparent.



## Resin build-up

Resin from natural timbers, especially softwoods will adhere to the cutter, collet, baseplate and plunge columns of the router. This can be aggravated if the surfaces are pitted or scored, as caused by the use of coarse wire wool or stiff brushes. Scraping with a metal blade will also cause deep scratches that allow resin to adhere.



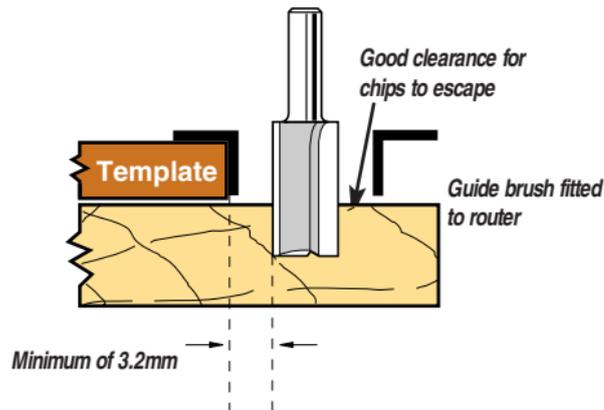
## Repeated re-sharpening

Repeated re-sharpening will reduce the clearance angles behind the cutting edges, eventually allowing the cutter body to trap waste or rub against the cut edge of the work. There are limits to the number of times that a cutter can be resharpended, in particular with small diameter cutters.



## 5.24 Directional reversals

Violent or sudden changes in feed direction will cause deflection of the tool beyond its natural metallurgical elastic limits. A similar effect can also result from running into a knot, or continued pressure by the operator once the spindle speed has noticeably decreased.



## 5.25 Swarf build up

This can occur when repeated passes are made along the same groove at increasing depths, particularly when using narrow cutters. Chips can build up after each subsequent pass and compact within the groove. The cutter then has to clear both the chips from the new depth as well as those already compacted within the groove. The result of this will be overheating and premature failure of the cutting edges.

Swarf should therefore be cleared prior to each cut. The use of dust extraction will often help to solve this problem. The use of a guide bush fitted to the base of the router can cause waste to become trapped beneath it, again packing it into the cutter flutes. Leaving adequate clearance between the outside diameter of the cutter and the inside diameter of the guide bush should help to alleviate this problem. The recommended minimum gap is 3.2mm (1/8").

To allow better waste clearance, the guide bushes for more recently introduced routers, tend to have cutouts to allow waste material to clear freely and to aid vacuum extraction.

## 5.26 Premature ball-bearing guide failure summary

- (a) Seizure is the most common form of ball-bearing failure and is generally caused by solidification of the grease due to excessive heat, or to the ingress of dirt and dust. The only solution is to replace the ball-bearing. Bearings cannot be re-greased.
- (b) Ball-bearing seizure can occur due to resin build up. Delay trimming laminate edges until the adhesive has thoroughly dried. If not, glue will enter the ball-bearing guide, preventing it from turning freely.
- (c) Ball bearing de-greasing is generally attributable to a solvent being used to clean the ball-bearing. Therefore always remove resin deposits by scraping. Do not clean a cutter with the ball-bearing guide still attached. Remove all surplus solvent from the cutter before refitting the ball-bearing.
- (d) Always check that the screw or nut holding the ball-bearing is tight, both before and regularly during use. The high revolutions of a cutter can cause the cap-head screw to vibrate loose, causing the cutter to damage the workpiece.

# 6

# CUTTER MAINTENANCE & STORAGE



Router cutter care and maintenance plays a major role in preserving cutter performance and prolonging life.

## 6.1 Cutter Care

It is essential to keep cutters clean. After every routing operation remove the cutter from the collet and clean it. If you are not re-using it in the immediate future, lightly spray with an anti-corrosion agent such as Rustbuster® and store it separately to other cutters and tools. However avoid spraying bearing guides with Rustbuster®.

It is important to keep the surface of the shank clean and smooth. If tarnished or showing signs of surface corrosion, the shank should be cleaned with very fine wire wool and preferably polished with metal polish to remove any fine scratches (this is to avoid providing a key for the resin to adhere to).

Keep the cutter edges clear of resin or other baked-on residue, as this will prevent waste from clearing freely, causing the cutting edges to overheat. It will also forestall the need to exert undue pressure on the cutter and minimise stress on both the cutter, ball-bearing guide and the router.

Resin can be removed with Resincleaner®, cellulose thinners, lighter fuel or other solvents. However, do take all necessary precautions when handling solvents, particular those relating to personal safety and fire risks. When handling solvents wear suitable rubber gloves to prevent skin irritation as well as eye protection in case of accidents. Remove the ball-bearing guide of self-guiding cutters or take extra care to prevent any surplus solvent entering the ball-bearing. Stubborn 'baked-on' deposits can be removed with very fine wire wool, a fine wire brush or a piece of stiff plastic (a small piece of plastic laminate is ideal for this purpose). Avoid touching the cutting edges as this will dull their edge.

Ball-bearing guides and solid pilot pins should also be kept clean, although the former should only be scraped clean, without using a solvent. Pilot pins left with resin deposits adhering to the surface, will leave a rippled finish and possible burn marks on the workpiece.

When cutting pine or other timbers that are rich with resin, the cutter should be cleaned more regularly with Resincleaner® and coated with a dry lubricant spray such as Trendicote® spray. Being a PTFE based coating, this will temporarily reject the resin deposits, preventing them from adhering to the metal. Repeated use of this spray prior to cutting, will significantly reduce the accumulation of resin and waste deposits. Some cutters are available coated with a resin resisting coating. In our tests, these have shown to have a short lived effect.



## 6.2 Storage

Cutting edges are easily damaged by poor storage or careless handling. This is particularly the case with tungsten carbide tipped cutters which are more brittle than HSS. A good storage system is therefore essential in order to prevent unnecessary damage to your collection of cutters. Router cutters should be separated to prevent the cutting edges from touching each other.



Before storing your cutters, apply an anti-corrosion spray such as Rustbuster®. This is particularly important if the cutters will be stored in humid conditions, such as in a shed or workshop, that suffers from excessive changes in temperature. This will prevent surface corrosion forming that will cause the cutter to bind in the collet. Be sure to keep spray away from the ball-bearing guide.

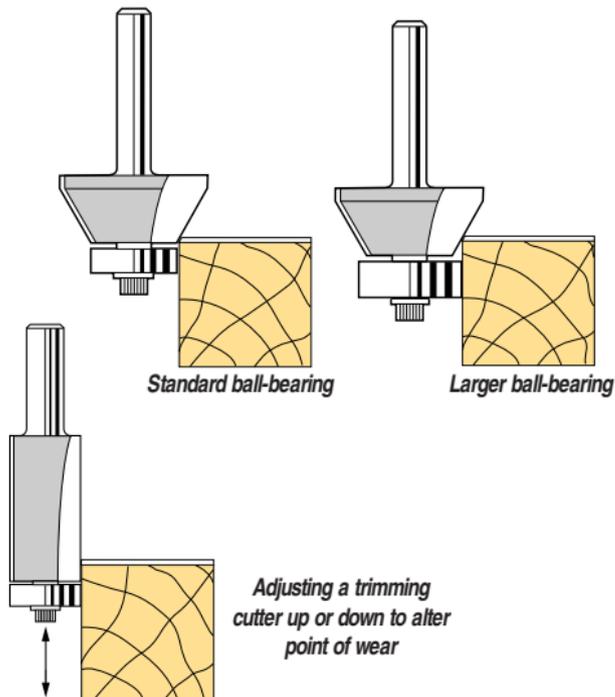
Cutters can be left in their protective wallets and either stored in a box or hung up on hooks for easy identification. If the packaging is to be discarded, then a home-made block of wood or plastic can be pre-drilled to accept the shanks. Ensure enough space is left between the cutter to prevent the tips touching and aid identification and retrieval without cutting your fingers. Keep this type of rack away from the work area where it is likely to get knocked over. A useful tip is to make the holes slightly oversized so that no undue effort is required to remove them from the hole as this can cause injury - remember cutters are very sharp, or should be!

## 6.3 Extending the life of a cutter

To prevent excessive wear of the tungsten carbide when trimming laminate, adjust the height of the cutter at regular intervals. This will ensure that wear is evenly spread along the complete length of the cutting edges. To spread the wear in this way when trimming with a chamfer cutter, it will be necessary to use a larger ball-bearing which will change the point of wear.

The life of a trimming cutter can also be extended by trimming only 3mm in one pass. The use of an overlap trimmer to pre-trim the laminate to this margin will greatly help in prolonging it's life. By adopting this method the quality of finish will be improved.

### Changing the ball-bearing guide to alter point of wear on cutter



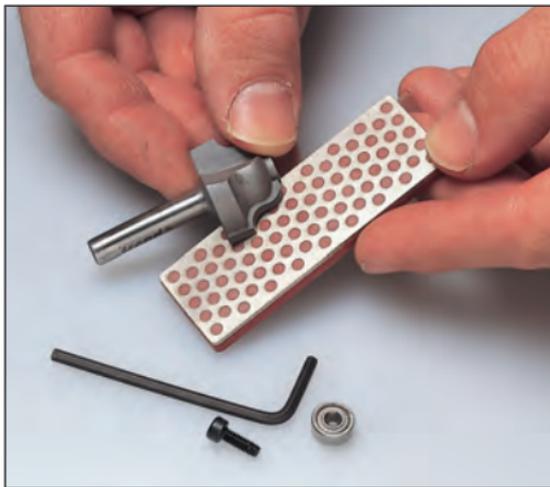
## 6.4 Maintaining cutter edges

Using blunt cutters will always result in a poor finish, overheating and add unnecessary stress to the cutting tool and router. The edges of a cutter must therefore be kept keen and sharp for all machining operations. When the edges have become dull, but before they become blunt, they can be honed back to a keen edge. This procedure will extend the life of the cutting edges extensively before a cutter may require professional re-sharpening. Once a cutter has become blunt, the cutter is best re-sharpened by a local saw doctor or sent back to the manufacturer (possibly via the sales outlet or agent) who in the case of quality cutters, should be expected to offer such a service.

## 6.5 Cutter honing

Regular honing of a cutter will return a true sharp cutting edge to the tips. This should be carried out by honing on the flat face of the tip only. This will not alter the shape of the cutter or the relief and clearance angles. For HSS cutters, this can be carried out using standard oil stones such as India and Carborundum. Do remember though that these stones themselves wear quite easily and require regularly dressing to keep the grinding face flat and even. This applies to the honing of router cutters, as the wear tends to be concentrated on the edges, rather than across the width of the stone as with hand planes or chisel blades.

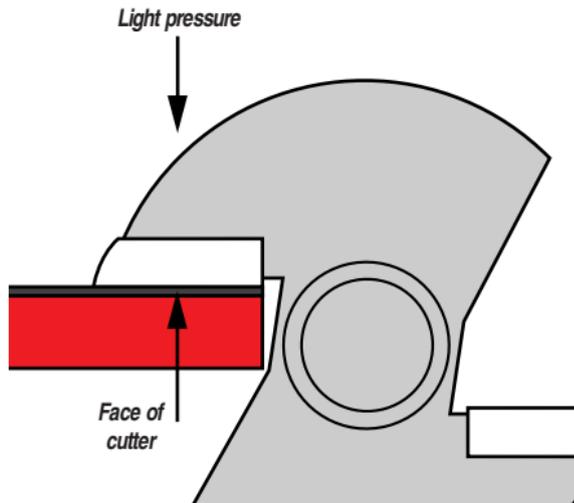
Diamond Sharpening stones, offered by Trend, are very effective for honing router cutters in both tungsten carbide and HSS. For router cutters it is advisable to use the 600 grit (red) to maintain a fine smooth face. The 300 grit grade (blue) can also be used if necessary to bring an edge quickly to the cutter. Lubricate the stone with water to lubricate and disperse the metal particles. However, do remember to dry the stone before storage. The stone can also be cleaned with an eraser. Hone the cutter using light strokes only as the diamond particles embedded in the stones nickel layer cut quickly. Remember to hone each face an equal number of times.



[www.trend-uk.com](http://www.trend-uk.com)

To hone the face of the cutting edge, press the flat face on the surface of the stone and ensure it is kept flat while drawing it back and forth along the edge several times. The amount of material removed will depend on the grade of the stone, so only use coarse stones if the cutting edges are particularly dull.

Repeat this procedure on each edge of a cutter, using an equal number of strokes for honing each face. With HSS cutters a slight burr may be produced. On straight cutters the burr can be gently removed by making a very fine stroke with the narrow bevelled cutting edge flat against the face of the stone, or for shaped cutters, using a narrow leather strop.



Ball-bearing guides should be removed from the cutter and care taken not to run the ball-bearing locating spigot against the stone. The latter is even more important for pin guided cutters, as marking the pin will effect its ability to run smoothly along the edge of the workpiece. Always ensure that the cutter is cleaned of all resin deposits, as this will be transferred to and clog the sharpening stone.

## **6.6 Cutter re-sharpening**

If the cutter is actually blunt or chipped then it should be re-sharpened professionally. The grinding procedure, to the flat face of the cutter, will remove the deepest chip, but may involve removing a good deal of the carbide. In certain cases the chips may be so deep that it is not feasible to grind the edge as the tungsten carbide would be left so thin as to make it dangerous. Alternatively re-grinding the profile of the cutter may enable the deep chips to be removed, but this will also necessitate the re-grinding of the body of the cutter to ensure correct chip clearance and relief angles are maintained.

In many cases with less expensive small diameter cutters, it is possibly uneconomic to re-sharpen them. With poorer quality cutters, the carbide may not be fit for re-sharpening and there is the risk of the carbide cracking during the grinding operation. Under normal circumstances, it should be possible to re-sharpen professional grade cutters up to at least four times, depending on the type of cutter.

When purchasing cutters, in particular those with complex shapes, selecting quality professional grade cutters such as those in the Trend Professional Range will always prove a far better investment as they can be successfully sharpened many times over.

With shaped cutters which are chipped, sharpening will alter the profile of the cutter, the deeper the chip the more carbide will be removed by grinding. In most circumstances the change in the size of the profile or mould produced by the cutter will not be detectable, but where the dimensions of the mould are crucial, for example, if it is part of a jointing set, then a poor joint will be obtained. It is therefore advisable to supply the matching cutter for modification to match the pair. With arbor mounted jointing cutters, shims can be used to compensate for the thickness of tungsten carbide removed during the sharpening process.

When ball-bearing guided trimmers are sharpened, the sleeve on the ball-bearing may need to be reduced to the same diameter. Often the ball-bearing will require replacing with a smaller size which will require bushing to the correct diameter of the cutter. The extra cost of this should be born in mind. Your cutter supplier should be able to supply you with a standard price list for sharpening all types of cutter.

# 7 COLLETS



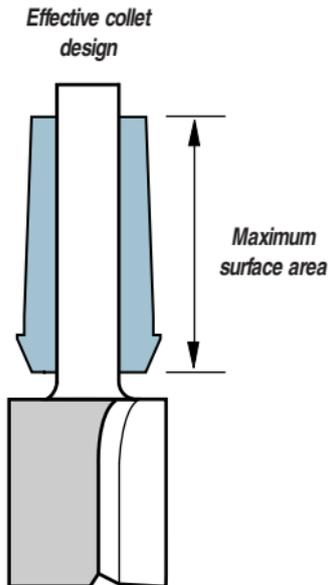
## 7.1 Collet Design

The design of the collet and its method of gripping the shank of a router cutter, plays an important part in reducing inherent security and alignment problems. A well designed collet assembly must always hold the cutter securely and concentric to the centre axis of the router's motor spindle, in order to eliminate any vibration. This is especially important with larger cutters.

It must therefore be designed to exacting tolerances and capable of standing up to continuous use. Any undue wear or intolerances will cause eccentric rotation of the cutter under load and lead to poor cutting performance, vibration, premature wear of the cutter and possible failure of the router's main bearings.

## 7.11 Collet Length

The collet must have an adequate surface area in contact with the cutter shank to ensure adequate grip and cutter rigidity. This will also place less stress on the cutter shank and reduce the risk of 'cutter creep' (whereby the rotational forces allow the shank to work its way out of the collet).



## 7.12 Steel quality

The collet must be manufactured from high quality tempered sprung steel. Collets of a poor quality will tend to wear and 'bell-mouth' prematurely.

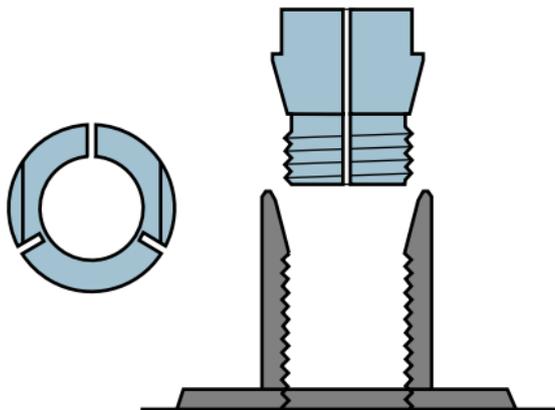
## 7.13 Expansion Slits

Good quality collets feature a number of slits to allow even gripping around the cutter shank. It therefore follows that collets with fewer slits will not provide such uniform grip on the shank and coupled with the fact that for economy, they are often produced from lower quality steel.

These collets can also suffer from the inability to release the cutter. Poor quality collets tend to exert uneven pressure over the surface of the cutter shank, often marking the face or creating a burr. This can be further accentuated by using poor quality cutters having shanks machined to imprecise tolerances. Multi-slit collets tend to mark the cutter far less, and have the ability to hold shanks which may be slightly over or undersized.

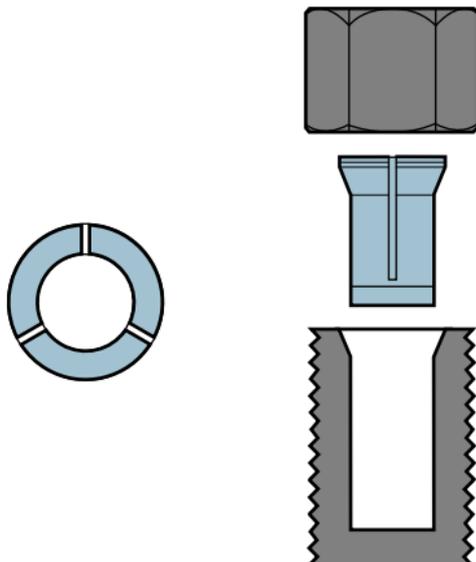
## One piece collets

One piece collet assemblies are machined directly into the end of the armature spindle with a separate locking nut to close the side slits around the cutter shank. Being machined in this way, the collet will not have the quality, temper or design characteristics of a separate quality collet assembly. This design also calls for complete dismantling of the router and replacement of the armature to rectify any wear or accidental collet damage. The method of tightening this type of collet generally involves inserting a loose bar through the armature, and using one spanner to tighten the collet nut. Alternatively no spanners are required.



## Two piece collets

Two piece collet assemblies have a tapered collet that screws into the end of the motor spindle. As the collet is tightened it compresses into the spindle, thus tightening the collet around the cutter shank. The method used for tightening this type of collet usually involves locking the spindle with either a loose bar or a spanner and tightening the collet with a second spanner. Some modern routers have a spindle lock button which means only one spanner is required.



## Advanced collet systems

Three piece collet assemblies use a separate tapered collet. The collet is inserted into a matching tapered socket machined concentrically into the end of the motor spindle. With the recommended cutter shank length inserted into the collet, the collet nut is tightened to compress the collet and grip the cutter shank.

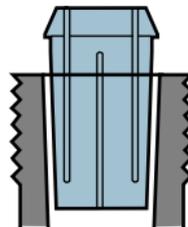
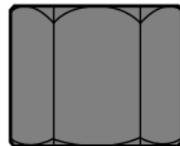
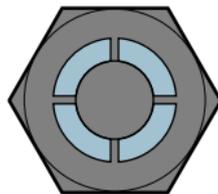
More advanced collet assemblies have a ring machined within the nut that engages the collet, automatically releasing it from the end of the spindle as the nut is undone. Older style collet nuts had a separate steel ring inserted in the collet nut.

Quality collets of this type are typically made of high quality, polished tempered steel and have multiple slits, ensuring cutter security and concentricity. This type of collet often features slits starting from alternate edges of the collet to provide even pressure over the full surface area of the cutter shank.

A double lock system is incorporated by some manufacturers, whereby when undoing the nut it will loosen and then re-tighten before loosening for a second time. This prevents the shank being released if the collet nut accidentally undoes with the router running.

Later designs of advanced collet systems have collet and collet nut factory assembled and should not be separated.

Always fit the collet into the collet nut before threading onto the router spindle.

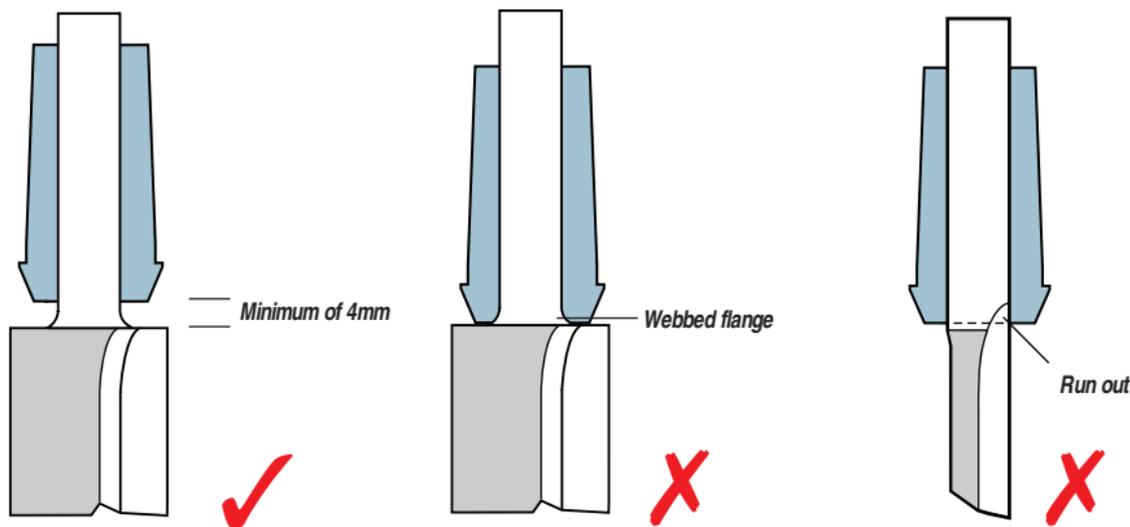


## 7.2 Preventing collet problems

If your router uses the multi-split type collet, it is important to assemble the collet in the correct order. When changing a collet, always spring the collet thimble into the collet nut before threading the nut onto the router spindle. Ignoring this sequence can distort the collet and cause the shank to jam.

Always insert the cutter into the collet so that the full length of the collet is in contact with the shank. Leaving a clearance gap between the end of the cutter shank and spindle face of less than about 2mm, will ensure that the cutter cannot be driven out of the collet by the vibration action of the motor spindle.

Ensure that the collet does not tighten on the webbed flange of the cutter or on any part of the run-out of the gullet that may be machined into the shank, as this will leave the shank insecurely held.



## 7.3 Collet maintenance

Insufficient collet maintenance has been shown to be one of the most common causes of cutter damage and breakage. The quality and condition of the collet is crucial in maintaining accuracy and concentricity between the router and the cutter. Maximum productivity and trouble free operation can only be achieved from the router and cutter if the collet enables the router to maintain a high level of precision.

Ensure at all times that the collet is kept perfectly clean and free of corrosion. Resin can migrate up the slits of the collet and deposit itself around the cutter shank and inside faces of the collet. This resin build-up, if not regularly removed, will prevent inadequate contact between the internal collet face and cutter shank. This will cause unequal pressures to be transferred from the collet to the cutter, setting up resonance causing the shank to slip. This can then cause collet burn, the deposits being transferred onto the shank itself in the form of brown markings. This resin build-up can be removed by using ResinCleaner® and a wire brush. Airguns will only remove loose dust and dirt and may force grit into the router.

Surface corrosion can form on the inside face of the collet as well as on the cutter shank, restricting cutter insertion and withdrawal.

Surface corrosion can also cause scoring of the mating faces and may damage the collet beyond repair. (Refer to section 6 - Cutter Maintenance).

Dust, corrosion or grit will decrease the collet's ability to grip or release the cutter shank. Other problems will include shank slippage, bit or collet seizures, excess vibration and shank bending or breakage. A fine wire brush will remove these deposits. Do not use glass paper as these will leave scratches which can cause further problems.



If either the collet or the collet nut are found to be faulty it is advisable to change both items as soon as possible. Do not use cutters with damaged shanks, particularly in new collets, as the problem could be repeated. To prevent cross-threading and possibly damaging the threads of the collet or collet nut, the inside of the nut should be cleaned and kept free of burrs. Unless produced from low grades of steel, damage to the threads should be limited to the nut itself. If in doubt, replace the nut at the same time as the collet, particularly as its cost will be somewhat less.

Keep both the inside and outside tapered surfaces of the collet clean and free from dust, resin and grit. This also applies to the inside taper of the armature and the threads of the nut and armature. Remove deposits with a wire brush and regularly protect the surfaces with light oil, anti-corrosion spray or similar.

An often underestimated problem can arise due to metal fatigue in the collet itself. This is due to excessive heat being directly transferred from the cutter to the collet. Repeated heating and cooling cycles may substantially alter the original tempering of the steel. The sprung steel from which the collet is machined, requires a degree of inherent metallurgical elasticity in order to grip the shank of the cutter. This elasticity is reduced over time and increased tightening of the collet then becomes necessary. This eventually distorts the collet preventing it from exerting an even grip around the cutter shank. Therefore collets that may appear to require excessive tightening should be replaced.

## **7.4 Vibration**

If vibration is noticeable when routing, immediately switch off the router and investigate. First, check the cutter itself to ensure the shank is not bent, damaged or blunt, or that the cutting edges are not chipped.

Vibration may often result from collet wear, causing the collet to hold the cutter out of line to the spindle axis. This may be due to bell-mouthing of the collet itself.

Collet marks on the shank will indicate that the collet is worn and this can be confirmed by inserting a long cutter and tightening the collet nut. Apply sideways pressure on the end of the cutter. If there is any indication of movement the collet should be replaced. It is often advisable to replace the collet nut at the same time. If wear is not apparent, the problem may be caused by excessive wear on the router spindle or main bearings (refer to section 8 - Router maintenance).

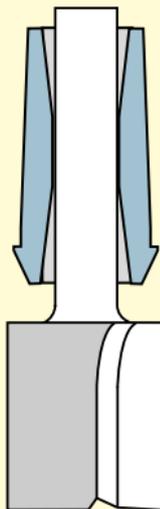
Always remove the cutter from the router after use, to avoid continued pressure be applied between the collet and cutter shank, as this will in time cause permanent distortion. After cleaning lightly oil or spray the collet before storing, particularly in humid conditions, to avoid corrosion forming and subsequent surface pitting.

## 7.5 Reducing Sleeves

The use of 'sleeves' to reduce the size of the collet aperture (e.g. 12.7mm to 8mm or 12.7mm to 6.3mm), can create problems such as seizure of the cutter shank. These sleeves have proven not to tighten up in a totally concentric manner and experience has shown that distortion can cause binding. Avoid therefore using reducing sleeves, except in emergencies and then for short periods only. These sleeves can accentuate run-out (when the cutter works itself out of the collet) and other problems which may already be present in the collet assembly or router spindle and bearings.

For flexibility in your routing applications, it is worth investing in a complete set of alternative size collets to suit your router and allow to make full use of the comprehensive range of cutters available.

### Bell Mouthing



Bell-mouthing is a condition whereby the collet becomes distorted or worn at the top and bottom, leaving less contact area between the collet and cutter shank. The symptoms of this can be slippage and run-out. A slipping cutter will result in 'galling' of the shank surface caused by the two un-lubricated surfaces turning against each other at speed.

If this 'galling' is excessive, both the cutter and the collet will require replacing.

# 8

# ROUTER MAINTENANCE



## 8.1 Router bearings problems

Although designed to accommodate high speeds, router ball-bearings may require replacing during the life of the machine. The indications that replacement is necessary are as follows:

### 8.11 Vibration

First check that this is not caused by a damaged cutter or worn collet. With the router isolated from the power supply and a long cutter fitted, apply pressure to the end of the cutter, any side play or vertical movement will indicate that there is a problem. If you are not sure, have the machine checked by a qualified service engineer.

### 8.12 Excessive noise

The ball-bearings will emit an abnormal noise level if they are worn or if the packing grease has solidified. In both cases replacement of both ball races are needed.

### 8.13 Drop in revolutions

This is normally due to seizing up of the ball-bearing resulting from solidification of the grease. Excessive dust mixing with the grease can cause premature failure. Regularly remove dust from the router using a vacuum extractor. Avoid using an airline as this can force dust particles further into the machine. Worn carbon brushes can also cause drop in the router's revolutionary speed.

### 8.14 Heat build up

The general cause of overheating is through excessive pressure and loading being applied. The use of blunt cutters and the inability of a cutter to discard waste material freely will also induce heat to be transferred through the cutter and collet to the spindle bearings. Regular removal of surface dust can alleviate overheating as a layer of dirt has a damaging insulating effect.

The bearings will last longer if the router is run for the shortest period necessary. It is advised 20 minutes in every hour. Never leave a table mounted router running for any length of time between operations. Soft start routers tend to place less wear on the routers ball-bearings as the initial startup impact is eliminated and the constant speed monitoring feature maintains smoother and unvarying running speeds and stresses on the ball-bearings.

Always return the router to a qualified service engineer for replacement of the bearings or for other major internal components.

However, to save on cost and down time, some maintenance and repair items can be carried out by the operator. These include changing brushes and switches (the latter often being susceptible to the ingress of fine dust). On quality machines, easy access and simple maintenance of these items are allowed for in its design.

Always double check that the machine is isolated from any power supply before attempting to dismantle it. Once dismantled, do not reconnect it to a power supply for testing purposes. Test the continuity of any component, switch or circuit with a low voltage test lamp or multi-meter.



## 8.2 Router Maintenance

### 8.21 Changing brushes

Most routers are designed for end users to change brushes themselves. Remove the relevant section of the casing or caps by unscrewing or removing the locating screws, using the correct type and size of screw driver. This will expose the brushes in their slides or holders. Take the opportunity to clean out any dust, using a soft brush (not a wire brush) and a vacuum extractor. Do not scrape the commutator surface and avoid damaging any of the insulated wiring to the field coil or armature. Disconnect the brush leads and gently lift the brush pressure springs to one side before sliding the brushes out. Clean out the brush slide with a soft brush. Do not use a solvent as this may dissolve the insulation on the motor windings.

If the brushes have worn severely, arcing may have occurred leaving carbon deposits on the commutator and brush slides. This can be removed carefully with a very fine grade flour paper, taking care not to touch the insulated windings (do not use wire wool as it will leave fine metal deposits that will cause further arcing and possible damage). Check that the new brushes slide freely in the slides, holding the pressure springs gently aside. Having inserted the brushes, reconnect their leads ensuring that spade terminals are fully pushed home or screws are securely but not over tightened. Carefully replace the housing section ensuring that it locates correctly and does not pinch or trap any wires or components.

Having replaced the brushes, sparking may be apparent when the router is first used. This should virtually disappear after short use as the brushes bed themselves to the shape of the commutator and any loose carbon dust is burnt away.



## 8.22 Switch maintenance

Not all routers are designed for end users to change switches themselves. When in doubt, arrange for an accredited Service Engineer to do this. Router switches are particularly susceptible to the ingress of fine dust. This packs around the electrical contact mechanism, preventing it from opening or closing or allowing the contacts to make only partial contact, leading to arcing and burning. In all cases it is best to replace a faulty switch rather than to attempt to clean or repair it.

On some routers it is necessary to dismantle the motor housing to replace or clean the switch. If this involves disturbing the bearings and motor assembly, it is best left to a service engineer.

Remove the housing section enclosing the switch, using the correct size screwdriver. Remove any cable clamps as necessary. Carefully note the wiring colour coding and to which terminal each lead is connected.

Release the screws or clips holding the switch in position and disconnect the leads at each terminal. Brush out the switch housing and check the condition and insulation of each lead. Check that all spade terminals are in good condition and show no sign of discolouration or burning and replace if necessary, using the correct tool for crimping them or by soldering them to the leads, to ensure that adequate electrical contact is made. Fit the replacement switch, checking that all connections are sound and that all connections are made to the appropriate terminals.

Check that any electrical insulation is correctly fitted to prevent contact between the leads and that the wires are run as prior to removal, to prevent them being pinched or trapped by the casing. Ensure that the supply cable and lead is correctly and securely clamped before refitting the casing or cover.



## 8.23 Maintaining the plunge action

The routers plunge action not only ensures that the cutter enters into the timber square to its surface, but for many operations also ensures that it withdraws safely above the base-plate, where it presents less danger to the operator and less risk of accidentally catching the work, bench surface or other tools as it is put down. It is therefore imperative that the plunge action operates smoothly and freely.

Depending on the make of router, the method of separating the columns from their slides will differ. If this involves disturbing the bearings and motor assemble, it is best left a service engineer. If this is simply a matter of undoing the retaining nuts or releasing the plunge return stop, separate the plunge base from the motor housing.

Routers fitted with rubber sleeves should be separated and the sleeves cleaned separately by washing. Ensure that they are dry before refitting and that they seal correctly around the columns to limit the further ingress of dust. When external plunge springs are fitted, it is possible to run a solvent soaked rag between the spring coils and column, if they cannot be removed easily.

Remove any resin deposits from the columns using Resincleaner® or a hard plastic scraper. Avoid using a steel wire brush, metal scraper or wire wool other than as a last resort, as these will score the surface destroying the polished finish. Even light scoring will allow resin, grease, etc., to adhere more easily.

Remove any fine traces of resin with solvent before cleaning the surface with metal polish. Do take all necessary precautions for personal safety when using solvents and do not allow solvent to enter the motor housing as it may cause damage to the motor winding insulation and other components.

Clean the slide bearings internally, gently using a round brass wire brush (as used for cleaning collets) or a solvent impregnated rag twisted around a length of plastic rod.

Check that the plunge lock mechanism has not raised the surface of the column. If it has, remove any burr or ridging by lightly filing with a fine file.

Check the plunge lock mechanism and apply a drop of light oil to the lever pivot or side handle screw thread. Before reassembling, lightly lubricate the columns and slides with an anti-corrosion agent or light machine oil.



## 8.25 Other router faults

Other more serious router faults are best dealt with by a service engineer, but do use one that is approved by the router manufacturer. Do insist that new parts are used to replace defective ones as second hand parts can prove dangerous, will have a far shorter life and may cause damage to other components. Request a warranty or guarantee on the repair work and parts supplied.

## 8.24 General care

Keep your router clean by regularly brushing or vacuuming. Use a narrow semi-stiff paint brush to loosen stubborn pockets of dust. Do avoid using an airline as this will force dust further into the machine and its bearings. Check the power lead for worn, pinched or perished insulation, and check that the plug shows no sign of overheating (i.e. discolouration of the terminals and/or fuse caps). Check that the fuse is held tightly in its clips and that the cable is secured by its clamp.

## 8.26 Storage

It is just as important to store the router safely as it is the cutters, to protect them from accidental impact damage, prevent nails and other foreign objects lodging in them and to prevent condensation forming within the motor or on the bare metal components.

Never store your router where dust or debris from other machines will collect on top of it, store high up on a shelf or better still in a case or toolbox.

Many manufacturers such as Trend offer metal or plastic kit boxes for storing and carrying specific power tools. If making your own (i.e. solid metal, plywood etc.) allow for securing the router with turn buttons or turn knobs and rubber pads and allow adequate space for the power-lead, side-panels and other accessories.

