ROTARY KNIFE WOOD TURNING

By

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Basic principles

To outsiders and even skilled wood machinists rotary knife turning is just ordinary moulding cutters mounted on a horizontal spindle, and slowly rotating wood held up to them. This would just about work on a short plain straight job in hardwood.

From an engineering perspective it is unknown technology, I quote my late Father-in-law, who,when he learned what line I was in, produced a file handle and said "Ican tell it has been hand turned because you can see the tool marks each end", I soon put him right.

Rotary knife tooling is by far the most complicated in the wood industry, even a plain job with little shape about 10 inches long would require 12 cutters mounted on 4 cutter plates. A complex turning of the same length could need up to 50 cutters mounted on 50 holders mounted on a 12 inch piece of hexagonal sleeve, on the cutterspindle.

All these cutters are individually set to the profile of the turning, the principle being for the cutters to cut only down the grain of the wood (apart from parallel sections). This mimics the action of the hand turner with a gouge, cutting down from the largest diameter to the smallest. The cutters must all have some overlap to get a smooth blend inbetween each.

Balance

In an ideal world, all cutter set-ups should be perfectly balanced. In practice a degree of unbalance can be tolerated on certain machines, for example Fells B.H and H.H type machines say up to 18 inch capacity. This is because the cutterspindle bearings are bolted solidly to the cast iron bed of the machine, which has a damping effect on any vibration. On longer H.H. and H.S.A type machines more accurate balancing is necessary because of the tendancy of the longer spindles to flex a fraction in the middle with any vibration producing dig in marks on the turning.

On turret lathes such as Fells G.J.C. nearer to perfect balance is required because the cutterspindle assembly pivots in operation. Holders and cutters must be balanced in pairs(or threes) to within about 1 gram or less.

On Fells G.J.G and G.J.F turret lathes perfect balance must be achieved, due to the light weight (aluminium) back and top spindle castings, which of course pivot as on the G.J.C..

Up to now we have only been talking about static balance, to achieve dynamic balance cutters and holders must be positioned diametrically opposite the other half of the matched pair.

Non round turning

This is produced by fitting a shaped cam on the work spindle, which as it slowly rotates, imparts movement toward and away from the rotating cutters (or on turret lathes causes the cutter spindle assembly to move similarly). In theory the cam shape is the same as the required section to be turned, but in practice as the cam fits over a 1½ inch shaft, the minimum cam dimension can only be about 2 inches. Few turnings are required as large as this, most are smaller, so the cam has to be larger than the required turning.

Sounds simple, you just make the cam the same shape as the job but bigger.

This works O.K for ovals, but problems arise when doing say a rectangle with radiused corners. This is because the point of cut is actually a varying point on a 12 inch to 14 inch diamemter cutting circle, so the corners of the cam have to be a much larger radius than the required shape to enable the cutters to take the corners off sufficiently. The cam shoe (what the cam bears against) must be the same radius as the cutting circle in use.

Tapered turnings

Most single work spindle machines have the facility to off set the tailstock centre from the drive centre. This enables tapered turnings to be produced without either varying diameter tooling, or excessive cutter projection on the smaller end of the turning. On short jobs, however,the wood has a tendancy to creep round on the drive centre,this doesn't matter on round turnings but on cam work, the wood after a few revolutions gets out of line with the cams.Anything over 12 inches should not be a problem though.

This tailstock adjustment can also be used to ajust the size of one end of the turning independently from the other.

Pre-drilled blanks

To overcome the difficulties of drilling holes dead true in round turnings, it is possible to turn on plug centres which accurately fit holes pre-drilled in the blanks. Unless the holes are small, on the tailstock end, (less that 1 inch diameter) a revolving tailstock centre is desirable to reduce friction.

If the turned part goes right up to the hole (and therefore the cutters beyond the hole) the feed direction should be reversed (to go anti-clockwise when viewed from the tailstock end), if the machine has this facility. This reduces the tendacy of the wood fibres to break off in the hole.

The pre-drilled blanks have to be fitted between the centres and removed by hand, so it is very important that the wood is dry (less than 12% moisture content), if not the holes will shrink and be too small to fit over the plugs.

Work Steadies

These are devices to support a slender turning against the downward force of the cutters, generally required when the length is about ten times the diameter or more, or less if the job is thinner in the middle than at the ends.

On older machines they are usually cam, weight or spring operated. Newer machines have pneumatically operated steadies which means the pressure can be controlled via a regulator to suit the job being done.

They all do the job, but the force imparted on the turning means that the wood bends to a varying degree, producing variations in centre diameter, especially with springy timbers suchas certain pieces of Ash.

Most of the foregoing information is applicable to turret lathes. Cutterblock balance is (as previously mentioned) very important.

On most turret lathes the cutterspindles can be swivelled to produce taper turnings without excessive cutter projection, and also to adjust end sizes of turnings.

To obtain accuracy it is imperative that 4 identical round cams are used for round turnings, the cam shoe shape is not important, but for shaped section work it must be the same radius as the cutting circle, The tailstock end diameter will however vary on each of the four stations due to the engineering impossibility of boring the four holes, for the tailstock barrels. absolutely crack on.

This inaccuracy can be overcome by inserting a bit of paper under one side of the seating of the threaded tailstock centres thus:-

To increase the diameter, insert it nearest the cutters.

To reduce the diameter, insert it farthest the cutters.

This will only work if the threads (usually left hand) are loose enough to be screwed in by fingers and tightened up with a spanner. It is helpful if the four stations are clearly numbered, so four samples can be produced, numbered, measured, and bits of paper inserted accordingly.

When doing shaped cam work it saves time (and money) in the long run if a spare cam shoe is obtained and kept only for shaped work as a worn one used for round work affects the shape produced thus:-

On ovals the error will hardly be discernable, but when doing flat sided work (e.g. paint brush handles) a larger radius will produce a hollow flat on the work. For this reason when the shoe becomes worn at points of cam contact, it must be all re-shaped to the correct radius, not just the worn bit smoothed out.

This effect can be used to advantage by having a cam shoe of smaller radius to produce a "flat" with actually a slight crown to help later sanding and finishing operations.

This is far less trouble than accurately machining four cams with a slight crown on the flat, only to find that a later job required a perfect flat.

Cont.....

To ensure firm blank clamping between the centres, the tailstock barrels need to be periodically cleaned out, to remove the build up of dust etc.,The frequency that this needs to be done, depends on the type of wood being turned,dry Beech, Birch or Ash etc., say every one or two days, but resinuos pine, or worse still, rubberwood from the outside of a tree, every two or three hours might be necessary.

The trigger release mechanism will also affect the clamping.The moment of release can be adjusted with a set screw, but if the holding spring is weak, it will release the tailstock barrel too soon.
To cure this, the spring must be tensioned more or replaced.

Machines with enclosed gearboxes (G.J.G and G.J.F)only require the oil level to be checked every few weeks, and topped up if needed, at the same time all the grease nipples should be lubricated.

The G.J.C on the other hand with its cogs guarded, but not sealed in, needs to be cleaned of shavings and dust regularly, and the cogs lightly oiled. On older machines there can be as many as fifty grease nipples to be attended to, so an air operated lubrigun is a worthwhile investment, if more than one machine is installed.

Obviously a powerful waste extraction system will keep the build up of shavings and dust to a minimum, but if shavings or wood chips are allowed to build up in the cog teeth, jamming or even cog or casting breakage can occur.

For this reason the feed drive should incorporate some potential slip, a flat drive belt will provide this, a vee belt is not recommended.

The tailstock barrels may require cleaning, even though they are clamping satisfactorily, due to a dirt build up on the keyways. The symptom of this is a jerky indexing, which if not rectified can cause the turret to jump out of step with the machine cycle. If this occurs, completely stop the machine. The turret has to be manually rotated back whilst simultaneously holding the turret lock levers and the drive clutch levers hard against their respective springs. The cutterspindles must also be held away from their cams. This definitly a two person job.

Rotary knife turning machines, especially turret lathes need lots of operator experience to work fast and efficiently, producing high quality work.

Even after forty five years of operating, setting and maintaining, I still found there was something new to learn right up to my retirement, perhaps if I worked for the next forty five years I might know it all!!.