WKW

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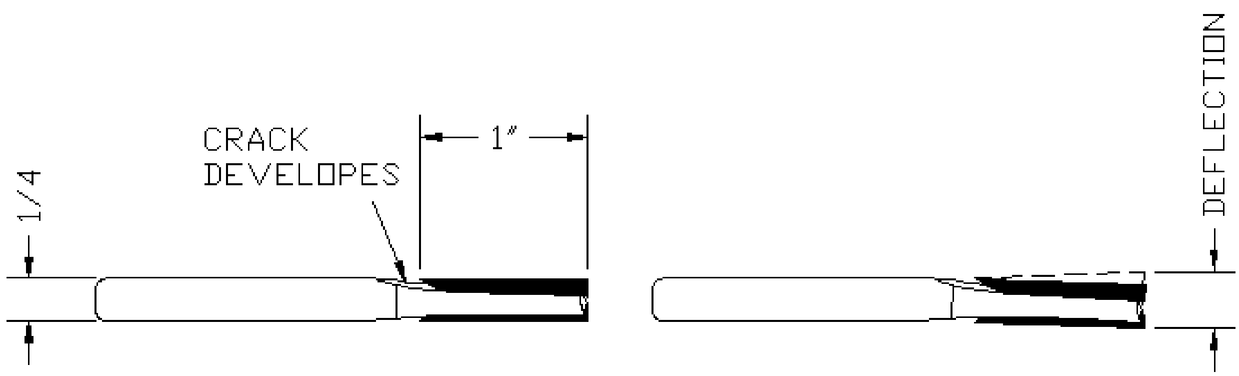
Router Bit Trouble Shooting

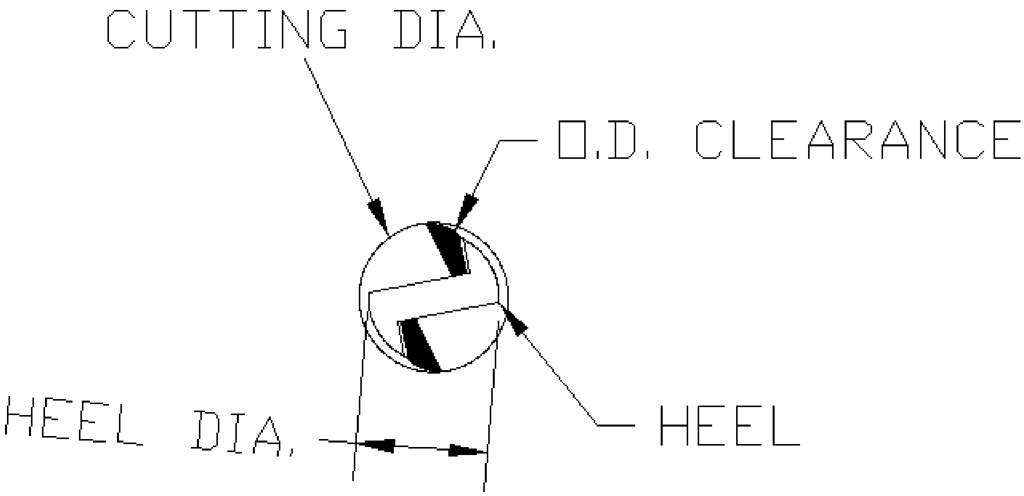
- **Tool Breakage:**

Tool breakage can be caused for several reasons and close attention should be made to all parameters and application characteristics for proper tool specifications.

- **Cutting Length Too Long:** This condition causes breakage due to higher deflection prevalent in long tools. Router bits that have a cutting length exceeding the maximum recommended length will have harmonic vibrations set up that will concentrate at the weakest part of the tool. This weak point is usually in the area where the flute runs into the shank. Calculating the maximum recommended cutting length for a particular diameter tool can be determined by using (2.5 x shank diameter). If the deflection and subsequent vibration is prolonged or severe, breakage will occur.



- **Low O.D. Clearance/Drag:** Deflection of the tool during the cutting process can also lead to severe drag, increased tool pressure, and high cutting temperatures by permitting the O.D. relief portion of the tool to run against the surface just machined, causing overheating and premature cutting edge wear.



Deflection of the tool that is not severe enough to cause complete carbide failure may be severe enough to cause intermittent rubbing and deflection on the heel of the carbide tip resulting in chipping and/or rapid cutting edge wear. If the vibration or deflection is not initially severe enough to break or chip the tool, the overheating and premature dulling resulting from the O.D. relief rubbing against the work will rapidly deteriorate the cutting edge to the point where inadequate O.D. clearance forces the tool to deflect past the elasticity limits of the tool and breakage will occur.

- **Exceeding the Maximum Recommended Feed Rate:** If the feed rate is pushed beyond that recommended for the application several things occur:

1. The router RPM decreases. (This is easily detected by the sound of the router slowing down)

2. The router bit deflects and rubs the work piece.

3. The flutes become clogged with work material due to inadequate chip space.

The cutting force at the tool cutting edge can be doubled, quadrupled, and occasionally exceed ten times normal with a reduction in RPM of the router. Most tools are designed to withstand temporary overloads of cutting force, but to design a tool to stand up under loads surpassing four to ten times normal would not be practical. It is much wiser to apply the tool properly. In most cases, the cause of RPM reduction and high cutting forces is inadequate router horsepower for the feed rate desired. Switching to a higher horsepower router normally solves the problem.

Flutes clogged with material cannot effectively cut the work material and router RPM becomes slower due to higher cutting forces and more horsepower requirements. In addition, the heat generated by the cutting action cannot be carried away with the chips if the flute area is clogged. This results in higher cutting edge temperatures, premature dulling and subsequent rubbing of the O.D. relief.

- **Failure to Sharpen a Dull Tool:** Dull tools can easily break due to several conditions that become increasingly prevalent as the tool cutting edges wear. Among these is a reduction in O.D. relief, increased cutting edge wear, more deflection in the tool, cutting edges chipping and over heating.

- **Chipping of the Cutting Edges:** Carbide tip dulling normally occurs in three distinct stages. During the first stage, a properly sharpened carbide cutting edge will wear rather rapidly. When the bit is first put into service it has a tendency to "hog in" or pull into the cut. This condition occurs during the first few minutes of the operation. The router bit should then stabilize and feeding at a recommended feed rate should be easily accomplished. The third stage is indicated by the router RPM reduction, harder pushing characteristics or poorer finish. This stage is extreme and will result in carbide particles chipping away from the cutting edge if the tool is not sharpened prior to, or in the early phase of the stage. If a particle has broken away from the cutting edge, more chipping will follow if the tool is not immediately sharpened.

- **Using the Wrong Router Bit for the Application:** Each specific application requires a specific router bit if optimum results are to be achieved. Slight deviation from the optimum normally results in lower tool life. Large deviations may result in poor work finish, tool vibration, deflection and breakage.

- **Extreme cutting Force Due to Excessive Chip Load Per Tooth:** If the recommended feed rate is exceeded, cutting forces at the tooth reach a point where the elasticity strength of the tool is exceeded. If this condition occurs, chipping of the cutting edge, rapid dulling and tool breakage will occur. Chipping of the cutting edge is extremely prevalent on carbide tipped router bits if the chip load per tooth is excessive. Complete carbide tip "pop-out" can occur from this high cutting force.

- **Incorrect Sharpening Procedures:** If the tool geometry originally designed into the tool is altered during sharpening, the cutting angle, clearance angles and overall performance of the tool may degrade to a point where higher horsepower requirements are necessary and performance will suffer.

- **Dirty, Worn or Defective Collets:** Collets that are not cleaned prior to insertion of a new tool may lodge foreign material between the router bit shank and the collet inside diameter. If this occurs, the router bit will rotate "off center". This condition sets up a vibration, reduces tool clearances and results in the same type of defect encountered when long slender tools are used. If the collet is "egg shaped" or out of round, proper clamping cannot be obtained. Dirty, worn, or defective collets are the most prevalent cause of tool breakage.

- **Worn Router Bearings:** Bearings should be checked frequently for acceptable runout. If the manufacturers recommended tolerance is exceeded, the bearing should be replaced. Failure to replace worn bearings will result in "off center" rotation and vibration.

Improper Use of the Tool: Vertical plunging with a router bit is an acceptable practice providing that the tool is kept reasonably vertical during the operation. Plunging through the work piece with a tool slightly slanted from a vertical position results in excessive deflection forces on the side of the tool. Plunging a router bit into a work piece at a high feed rate for the purpose of stopping the router rotation rapidly has several detrimental effects.

1. Bearings in the router become worn prematurely.

2. Tool material strength factors are temporarily exceeded. Repeated use of this "stopping" technique may result in complete fracture to the tool.

Protection of carbide tools is a must if cutting edge chipping is to be prevented. Careless placing of rotating tools on work benches, floors, etc. can only result in damaged tools and possibly employee injuries. A chipped cutting edge is a potentially broken tool if it is not reconditioned prior to use. This is especially true in carbide tipped router bits.

- **Improper Clamping of the Work Piece:** The work piece is usually one of two situations.

1. The work piece is clamped and the router moves through the work piece. If this method is used, the work piece must not be permitted to move in any direction. Otherwise, vibration, tool deflection, poor work finish, tool rubbing, and router breakage may occur.

2. The router is clamped and the work piece is moved past the router bit. If this method is utilized, the router must be rigidly clamped to insure that no movement other than router bit rotation and work piece feeding occurs. Machine vibration must be kept to a minimum. If high frequency vibration occurs at the router bit, it may combine with tool vibration frequencies and result in tool fracture. The work piece should be guided in a manner which permits minimum work piece vibration or misalignment with the router bit during the cut.

- **Tool Wear:** Normal cutting edge wear progresses in three overlapping steps.

1. Rapid wear of a freshly sharpened cutting edge when it is first put in service.

2. Gradual wear for a period of time.

3. Rapid wear resulting in excessive heat, increased cutting forces and tool breakage if the tool is not sharpened when it enters this stage of wear.

A tool that entered the third stage of wear can usually be detected by either the additional power required to push the tool through the work piece or by passing the cutting edge across one's thumb nail. If the took removes a thin layer of thumb nail cleanly, with only the force required to move it across the nail, it has probably not entered the third stage of wear. An additional check may be accomplished by lightly passing the end of the thumb nail along the length of the cutting edge. Any noticeable surface roughness normally indicates a chipped edge or a dulled tool. The tool should be resharpened in either case. Wear lands greater than 1/64" wide indicates a completely dull tool.

- **Tool Wear Other Than Normal:**

1. Feed rates too slow for the RPM of the router and the hardness of the work material result in excessive heat at the cutting edge and rapid wear land development.

2. Use of too many cutting teeth for the feed rate employed results in inadequate feed per tooth requirements necessary to remove heat from the cutting edge.

3. Abrasive characteristics of the work material break away the particles at the cutting edge and result in a rapidly developed wear land.

4. Improper Rockwell hardness permits rapid deterioration due to the extreme soft or brittle condition at the cutting edge. (HSS tools)

5. Microstructure defects in the steel or carbide.

6. Runout of the tool due to defective collets or router bearings, bent tool, unbalanced tool, and excessive feed rate permits heel portion of router bit to rub the work piece resulting in excessive heat and premature cutting edge dulling. This condition may also result in chipped and/or broken teeth.

- **Tool or Work Piece Burning:** The primary cause of either tool or work piece burning is the generation of heat at the cutting edge of the tool due to improper cutting actions. Improper cutting action can be caused by several factors:

1. Dull cutting edges require more horsepower to push them through the work material. If the horsepower is not available, the router RPM slows down, cutting forces increase, extra heat if generated because more resistance to shear is encountered. The added heat is passed to the tool or the work piece or both resulting in a burned condition.

2. Too slow a feed rate or too many cutting teeth results in inadequate chip load per tooth to dissipate the heat generated during the cutting action. Since the heat cannot pass off with the severed chip it passes to either the work piece or the tool or both.

3. Alteration of tool geometry due to improper sharpening techniques results in higher cutting force and heat generation.

4. Router bit runout due to worn collets, defective router bearings, use of long slender tools or unbalanced router bits, permits the heel of the tool to come in contact with the work piece and excessive heat is generated on the tool and/or work piece.

- **Poor Work Piece Finish:** Poor work piece finish can be attributed to the following:

1. Inadequate number of cutting teeth. If feed rates are high, more cutting edges may be needed to increase the tooth marks per inch and decrease the tendency of the router bit to “hog in” during the heavy cutting required with few teeth and high feed rates.

2. Router bit runout caused by collet wear, router bearing failure, bent tool, use of long slender tools, and high feed rates.

3. Work piece or router vibration

4. Dull cutting edges

- **Carbide Tip Chipping:**

1. Tool deflection or runout caused by defective collets, router bearings, or unbalanced tools may permit the heel portion of the carbide to intermittently hit or rub the work piece. If this condition is severe, carbide chipping will occur. Immediately after chipping occurs, a thin groove is worn in the carbide from the excessive heat generated at that point. Tool deflection can usually be detected by visually observing the router bit runout with the tool rotating freely or by burn marks on the carbide tip heel. The burn marks on the heel of a sharp tool are caused by the generated heat of the rubbing action between the carbide heel and the work piece. This burning should not be confused with the burning associated with a dull cutting edge.

2. Microstructure defects in the carbide may permit sections of the carbide to break away during the cutting action. This defect is difficult to detect without microstructure analysis.

3. Permitting foreign objects to bump the carbide or unnecessary rapid plunging of the carbide tool at an angle may result in chipping or carbide fracture.

4. Use of dull tools increases the tool forces and results in carbide particle “pop out” due to extreme pressure generated at the cutting edge. The added heat due to this condition further promotes chipping and deflection characteristics.

- **Tool Breakage**

    1. Excessive cutting length: Select a tool with a shorter cutting length or larger diameter.

    2. Excessive feed rate: Reduce the feed rate, use larger diameter router bit (if horsepower is adequate to handle the increased diameter). Use a higher horsepower (if the feed per tooth recommendation has not already been exceeded).

    3. Dull tool: Sharpen or replace tool:

- **Tool Breakage**

4. Improper tool for application:
   a. Use HSS tools for aluminum, natural woods, and most plastics. HSS can be ground to a keener edge than carbide and stay sharper longer.
   b. Use carbide tipped for laminated and composite wood materials and some hardwoods.
   c. Use solid carbide for CNC applications and small diameter tools in abrasive materials.
   d. Use single edge tools where speed is important and rougher finishes are acceptable.
   e. Use 2 flutes where finish is important.
   f. Use the shortest cutting edge possible to reduce vibration and deflection.
   g. It is recommended that the cutting length not be more than 2 1/2 times the cutting diameter.

5. Extreme cutting force due to excessive chip loading: Reduce feed rate or select a larger diameter router bit (if horsepower of router is adequate to handle the larger diameter tool)

6. Incorrect tool geometry: Replace with proper tool.

7. Dirty, worn or defective collets: Replace collets

8. Worn router bearings: Replace router bearings or router.

9. Improper clamping of work piece: Insure that work or router is clamped securely.

10. Rockwell hardness too high: Return to supplier for analysis, replace with new tool.

- **Breakage of the shank portion of the router bit**

1. High Rockwell hardness on shank: Return to supplier for analysis, replace with new tool.

2. Microstructure defect in steel: Return to supplier for analysis, replace with new tool.

3. Collet worn or out of round: Replace collet.

- **Rapid tool wear**

1. Feed rate too slow: Increase feed rate or decrease router RPM.

2. Too many cutting teeth: Select a router bit with fewer teeth.

3. Abrasive work material: Request special analysis of operation to determine the optimum cutter material and/or design.

4. Improper Rockwell hardness: Replace with proper tool.

5. Microstructure defects in steel or carbide.

6. Improper tool for application:

7. Tool runout: check collet, router bearings, and tool.

- **Tool or work piece burning**

1. Dull cutting edges: Sharpen or replace tool.

2. Feed rate too slow: Increase feed rate or decrease router RPM.

3. Improper tool geometry: Replace with new tool.

3. Improper tool for application: Select proper tool.

- **Poor work piece finishes**

1. Too few cutting teeth: Increase number of teeth or increase router RPM.

2. Router bit runout due to collet wear, router bearing failure, bent tool, excessive cutting length, and high feed rates: Replace defective part or correct procedure.

3. Work piece vibration: Rigidly clamp work piece or control work piece feed procedure.

4. Router vibration: Repair router.

5. Dull cutting edge: Sharpen or replace tool.

- **Carbide tip chipping:**

1. Runout of the tool due to collet wear: Replace collet

2. Runout of the tool due to defective router bearings: Replace bearing or router.

3. Runout of the tool due to bent shank: Replace tool.

4. Runout of tool due to excessive cutting length: Select proper tool.

5. Runout of the tool due to excessive feed rates: Decrease feed rates, increase RPM or select a more appropriate tool.

6. Microstructure defects in the carbide: Replace tool.

7. Improper handling techniques: Do not permit carbide to contact any foreign objects and apply the tool properly.

8. Dull tools: Sharpen or replace tool.