

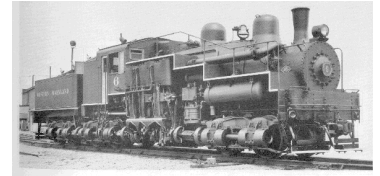
# LocoGear

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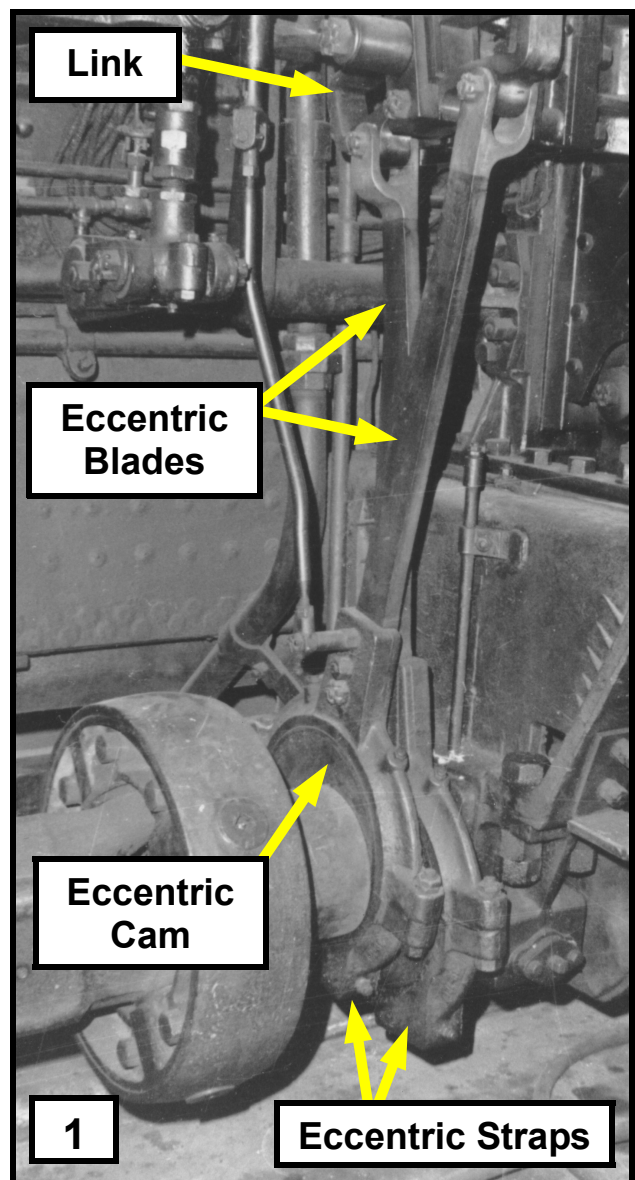


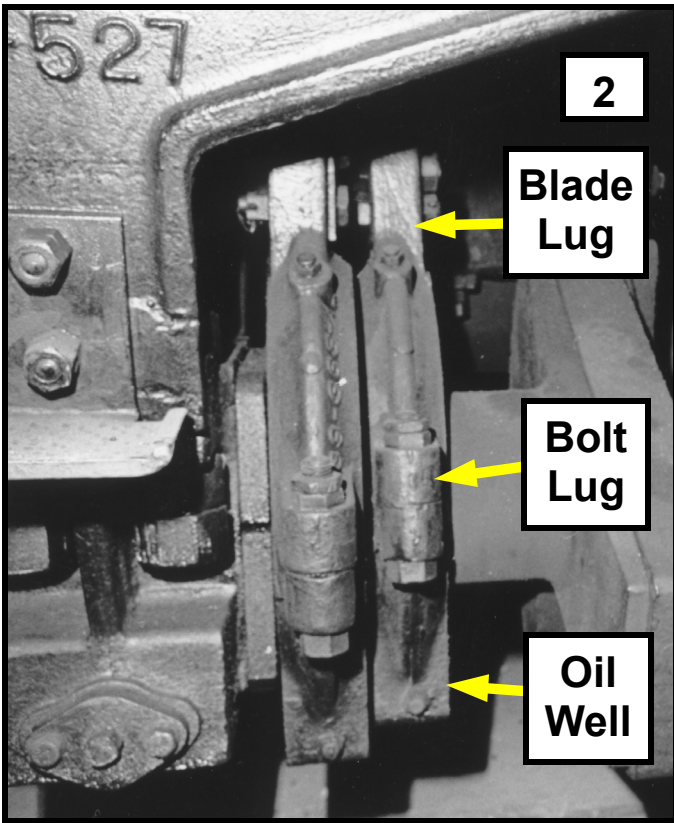
### Machining Instructions for Eccentric Straps Lima Card Number 392-A-5110

The following instructions are for machining the Eccentric Straps (Lima Card Number 392-A-5110) which were used on the **Western Maryland Railway #6**. Six of these Eccentric Straps were used on the **Western Maryland Railway #6**. The Eccentric Straps are attached to the Eccentric Cams (Lima Card Numbers 392-A-5108 and 392-A-5109) located along the #85 Crank Shaft (Lima Card Number 745-A-5023). The Eccentric Straps are also connected to the Eccentric Blades (Lima Card Numbers 392-A-5112, 392-A-5113, 392-A-5114, and 392-A-5115) which connect to the Link (Lima Card Number 583-A-5007) which operates the cylinder valves.

Like many other parts on the **Western Maryland Railway #6**, similar Eccentric Straps and Eccentric Blades were also used on the **Greenbrier, Cheat & Elk Railroad #12**. The drawing used for the Eccentric Straps used on the **Greenbrier, Cheat & Elk Railroad #12** (Lima Card Number 392-A-5018) is referenced on the above Lima drawing for the Eccentric Straps used for the **Western Maryland Railway #6**. Also, the single drawing with three variations used for the Eccentric Blades on the **Greenbrier, Cheat & Elk Railroad #12** (Lima Card Number 392-ABC-5002) is referenced on the above list of four drawings for the Eccentric Blades used for the **Western Maryland Railway #6**.

A scale drawing of the Eccentric Straps is





located on page three. Lima made each of the Eccentric Straps with two steel castings (Lima Pattern Numbers 39-368A for the top half and 39-121 for the bottom half) along with a brass casting (Lima Pattern Number 39-456) for the inner liner. For the live steam model, the Eccentric Straps can be machined from brass bar stock.

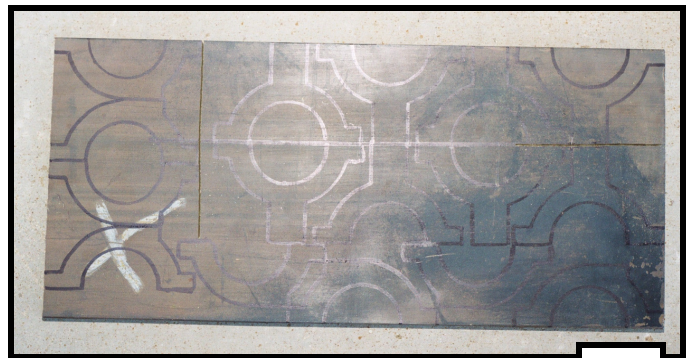
The Eccentric Strap Bottom Halves are all identical. The Eccentric Strap Top Halves are machined with three facing forward and three facing backward. It will be helpful to mark each pair of halves with a number stamp or marking pen during machining to keep them from being mixed up. What is different about the Eccentric Strap Top Halves are the way the blade lug at the top is facing. The Eccentric Blades are attached to this blade lug with three bolts. Photos 1 and 2 show this well (prototype photos by Jim Salmons). This blade lug has a slot that the Eccentric Blade fits into that faces the adjacent Eccentric Strap. The three bolts that hold each Eccentric Blade to the Eccentric Strap blade lug have the bolt head on the “inside” of the Eccentric Strap and the nuts on the “outside” face of the blade lug.

Lima lubricated the Eccentric Straps with grease fittings. On the Live Steam model, an oil hole with oil cup is used. This oil hole with oil cup

is facing out toward the right side of the locomotive.

On the Eccentric Strap Bottom Half Lima designed an oil well with a pipe plug facing outward from the right side of the locomotive. On the live steam model, this oil well is unlikely to provide any added functionality to the Eccentric Strap, so it is not made to be functional, but just for show.

The following steps should be used to machine the Eccentric Straps. For most of these operations, the same setup and cuts can be made to each of the Eccentric Strap parts one after another until all parts have received that machining step.



1. Cut a paper template for both the Eccentric Strap Top and Bottom halves and lay them out on a sheet of 3/8" thick brass bar stock. Use a “Sharpie” type making pen to trace around the templates leaving a line about 1/16" thick. Leave some extra space between each piece for the kerf of the band saw blade (see photo 3). *Note that the 3/8" thick brass sheet in photo 3 is 6" x 18" and has enough room for eight pairs of Eccentric Straps. An extra pair of Ec-*

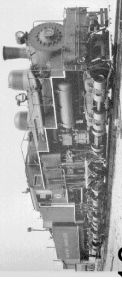


# Western Maryland Railway Shay #6

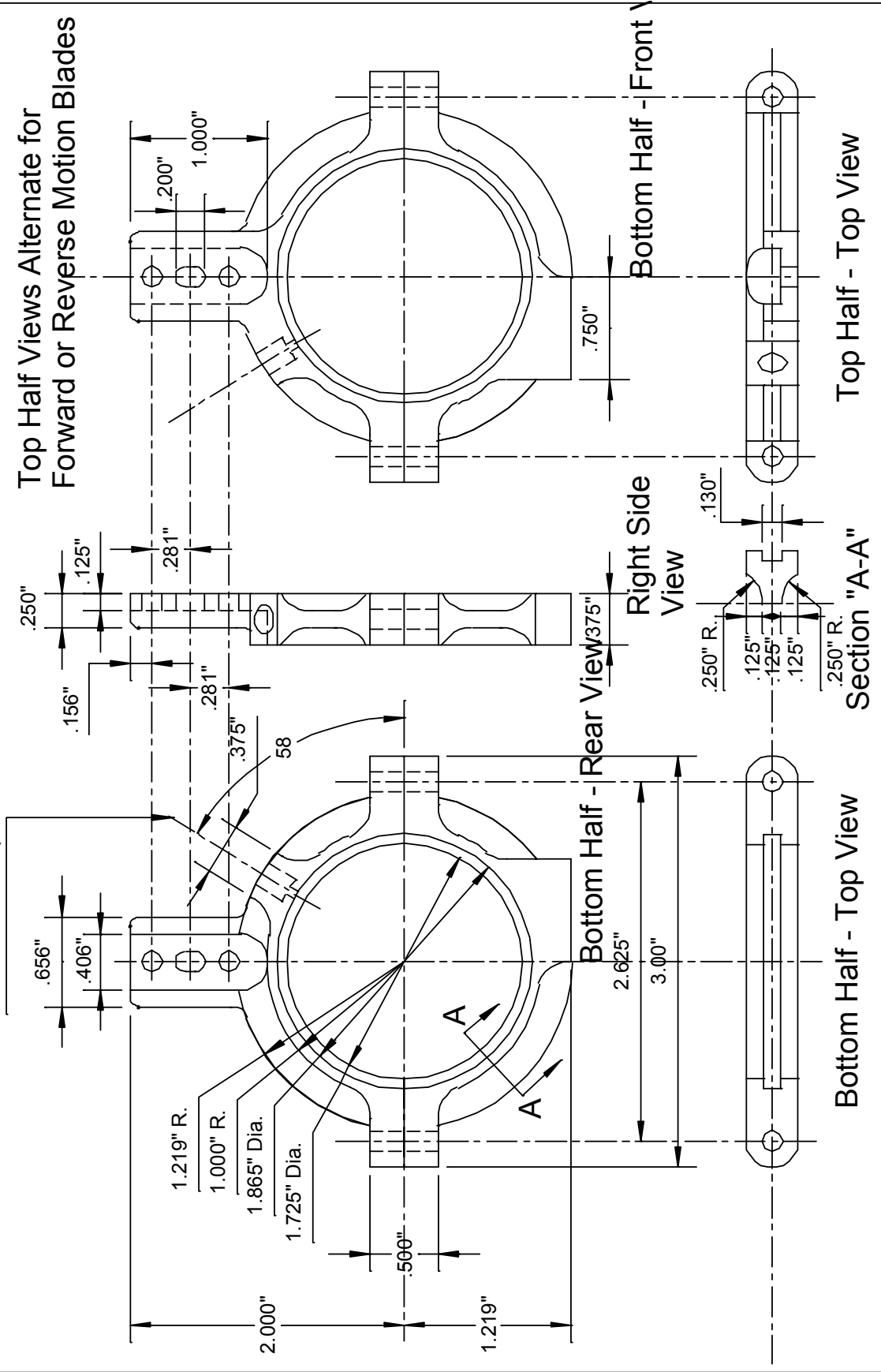
Eccentric Straps

Lima Card Number 392-A-5110

Drawn by John D.L. Johnson 8/15/2005  
6 Required  
Made From Brass



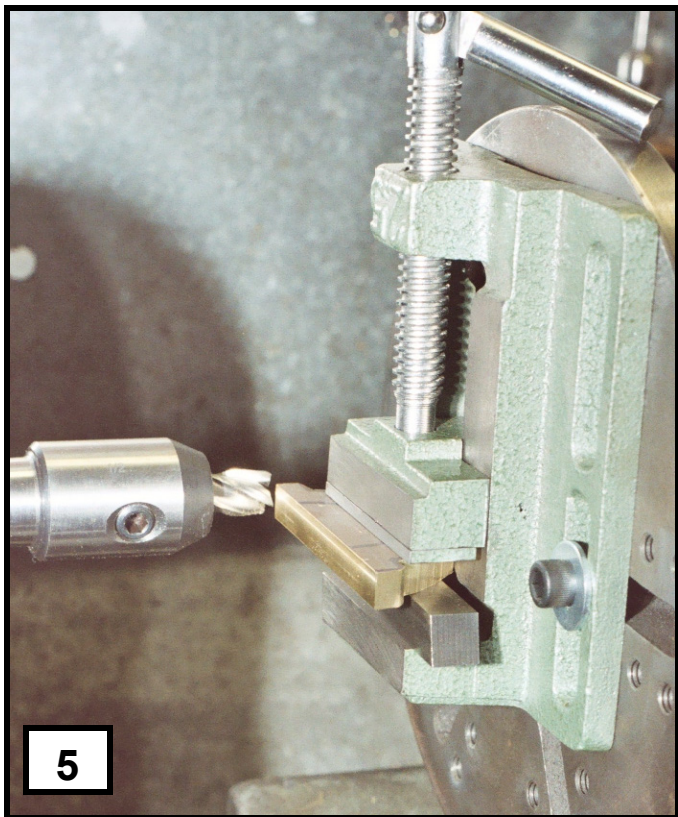
1/16" & 3/16" Drill for  
Push Fit for Oil Cup



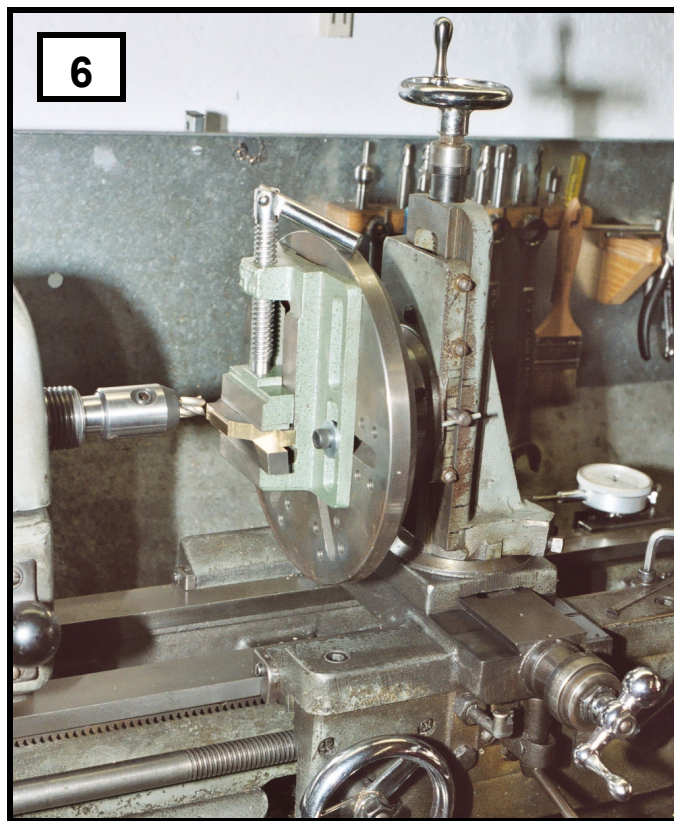


*centric Straps can be made to be used for a Crank Shaft driven water pump.*

2. Rough cut each piece using a band saw with a metal cutting blade. Cut close to, but not into the lines traced from the templates, leaving about 1/16" of material on all sides for machining (see photo 4). **Do not cut out the center hole because this will be removed later when turning it on a lathe.**



3. The first machining step is to square and finish the top edge of the Eccentric Strap Bottom Half and the bottom edge of the Eccentric Strap Top Half. These surfaces will contact each other when the two halves are later bolted together. These surfaces will also become each parts "datum surface" for all measurements. Clamp each part in a milling vise and skim cut this surface with a 1/2" end mill. Only remove enough material to get a smooth finish over all areas of this surface (see Photo 5).
4. This step is performed on the Eccentric Strap Bottom Halves only. Place the first Eccentric Strap Bottom Half into the milling vise with the datum surface flat against the bottom of the vise so that the bottom surface of the Eccentric

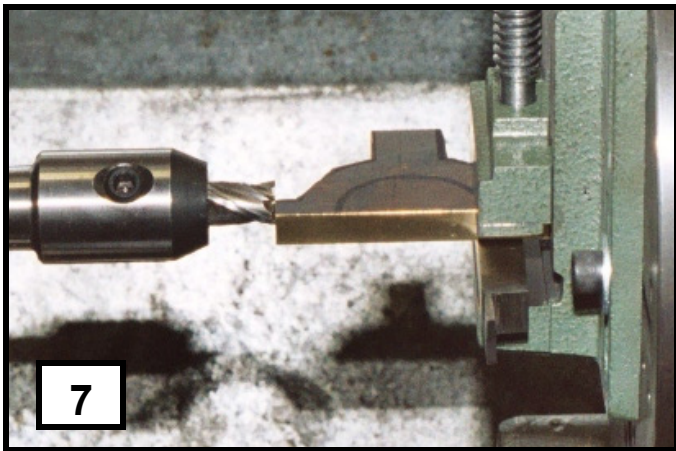


Strap Bottom Half will be machined. The first part will be used to set up the same cut for the other Eccentric Strap Bottom Halves. Take a skim cut off this surface large enough to measure its distance from the datum surface. Remove this part and measure this distance. Be careful not to adjust the relationship between the end mill and the milling vise. Remount the part into the milling vise and set a dial indicator or DRO to the dimension measured. Continue to take additional cuts on this surface until the dimension of this surface is 1.219" from the datum surface (see Photo 6). This cut can now be repeated on all other Eccentric Strap Bottom Halves.

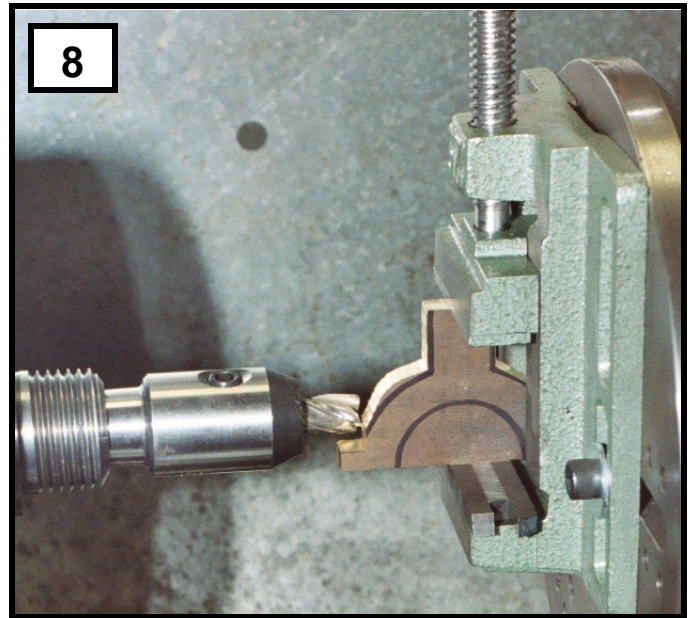
5. This step is very similar to the previous step and is performed on the Eccentric Strap Top Halves only. Place the first Eccentric Strap Top Half into the milling vise with the datum surface flat against the bottom of the vise so that the top surface of the Eccentric Strap Top Half, which is the top of the Eccentric Blade lug, will be machined (similar to Photo 6). The first part will be used to set up the same cut for the other Eccentric Strap Top Halves. Take a skim cut off this surface to measure its distance



from the datum surface. Remove this part and measure this distance. Be careful not to adjust the relationship between the end mill and the milling vise. Remount the part into the milling vise and set a dial indicator or DRO to the dimension measured. Continue to take additional cuts on this surface until the dimension of this surface is 2.000" from the datum surface. This cut can now be repeated on all other Eccentric Strap Top Halves.

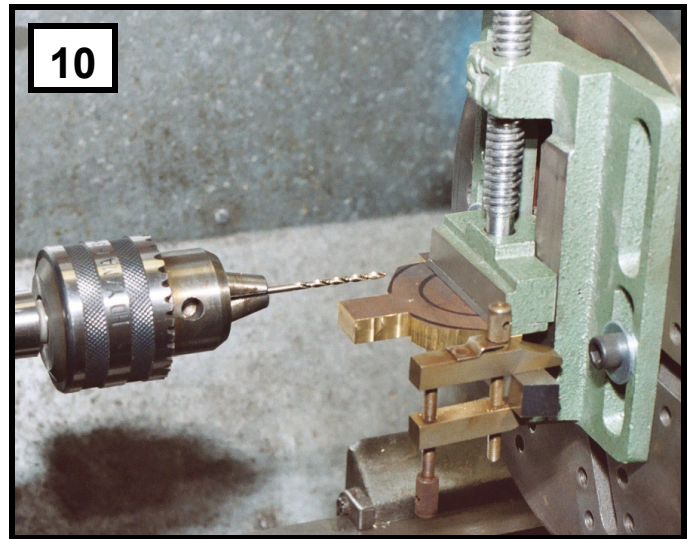
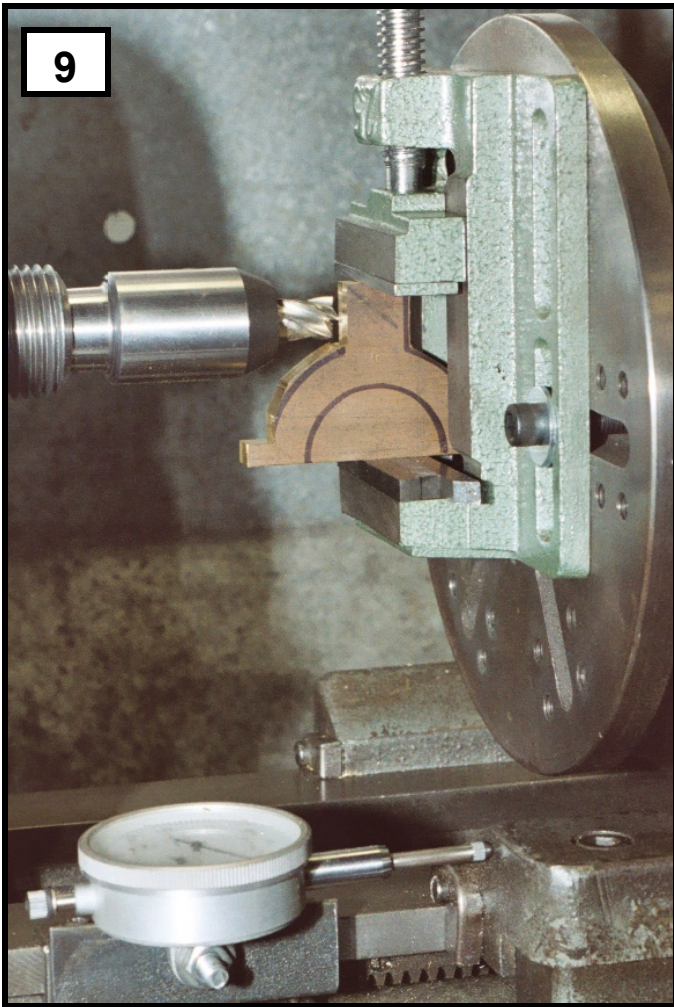


6. This step is performed on all Eccentric Strap parts. The Bolt Lug ends of the Eccentric Strap parts are all 3.000" wide from end to end. Clamp each part in the milling vise (as shown in Photo 7) with the part perpendicular to the vise. Use a machinist square to align the part when clamping. Start by machining off one end of each Eccentric Strap part cutting away the marking pen line. This will bring this surface of the part to its final location and be a datum surface for the next cut. Then take one part and turn it end for end in the milling vise with this machined surface flat against the bottom of the milling vise. Take a skim cut off the other end so that it can be measured for its distance from the datum surface. Remove this part and measure this distance. Be careful not to adjust the relationship between the end mill and the milling vise. Remount the part into the milling vise and set a dial indicator or DRO to the dimension measured. Continue to take additional cuts off this surface until the dimension of this surface is 3.000" from the opposite end. This cut can now be repeated on all other Eccentric Strap parts.



7. This step is also performed on all Eccentric Strap parts. The Bolt Lugs of the Eccentric Strap parts are all 0.250" thick. Clamp each part in the milling vise (as shown in Photo 8) with the part perpendicular to the vise. Use a machinist square to align the part when clamping. The center axis (datum surface) of the Eccentric Strap is positioned flat against the fixed jaw of the milling vise. Use the opposite Bolt Lug as a second datum surface flat against the bottom of the milling vise. **Note that in Photo 8, the Bolt Lug extends through the milling vise and is flat against the table surface.** Use a dial indicator or DRO to position the end of the end mill 0.313" beyond the end of the Bolt Lug. Take a skim cut off this surface and measure the thickness of the Bolt Lug. Set a dial indicator or DRO to this dimension and continue milling this surface until it is 0.250" thick. This cut can now be repeated on both ends of all Eccentric Strap parts.

8. This step is performed on the Eccentric Strap Top Halves only. Clamp each part in the milling vise (as shown in Photo 9) with the part perpendicular to the vise. The position of the part in the milling vise is identical to the previous step. Position the end of the end mill even with the end of the Bolt Lug. Set a dial indicator to zero and advance the endmill toward the Eccentric Blade Lug and begin milling this surface to 1.172" from the end of the Bolt Lug and for a length of 0.700" from



the top of the blade Lug. This cut can now be repeated on both sides of the blade lugs on all other Eccentric Strap Top Half parts. The result of this step will make the blade lug 0.656" wide.

9. This next step is performed on the Eccentric Strap Bottom Halves only to machine the vertical surface of the oil well. Clamp each part in the milling vise (similar to that shown in Photo 9) with the part perpendicular to the vise with the oil well toward the end mill. The position of the part in the milling vise is identical to the previous two steps. Position the end of the end mill even with the end of the bolt lug. Set a dial indicator to zero and advance the endmill toward the oil well and begin milling this surface to 0.750" from the end of the bolt lug and for a length of 0.250" from the bottom of the part. This cut can now be repeated on all other Eccentric Strap Bottom Half parts.

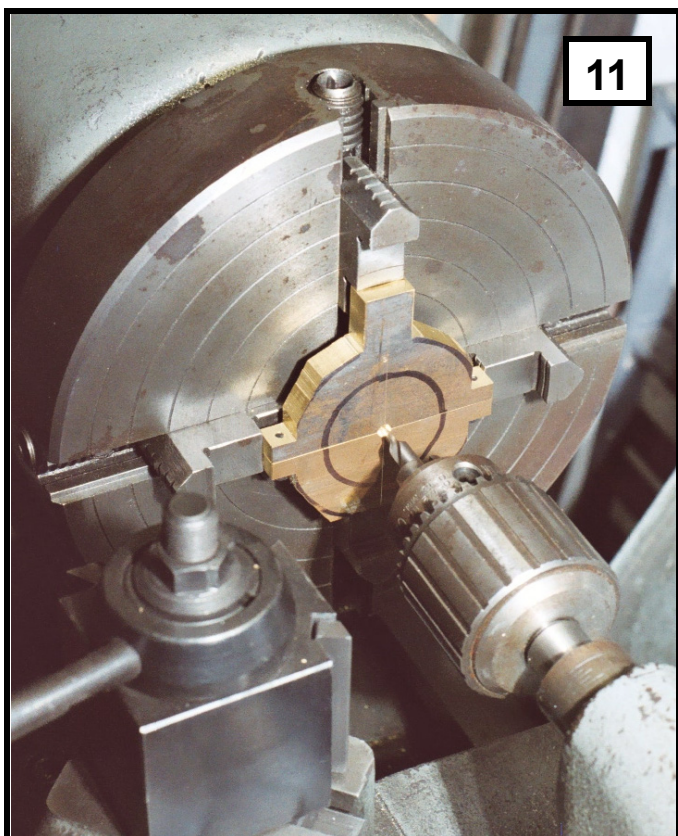
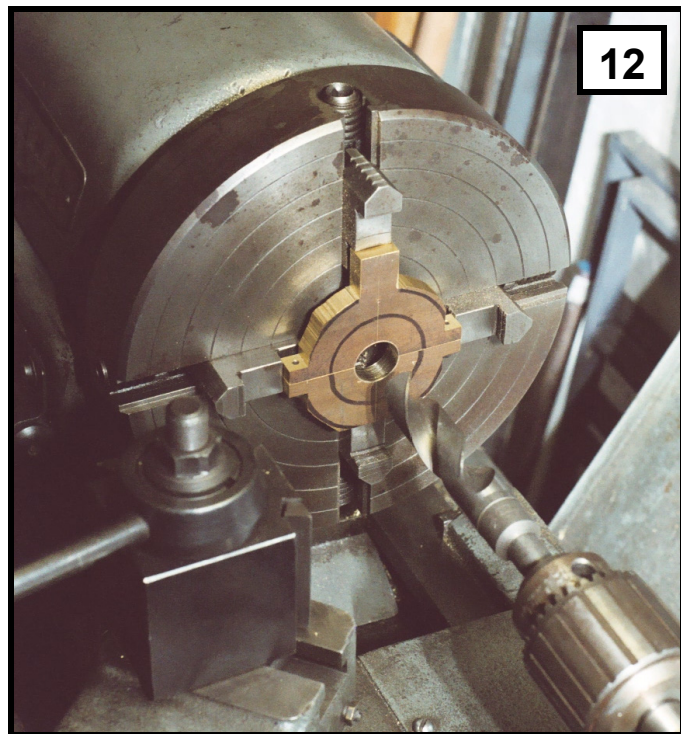
10. Most of the remaining steps require the Eccen-

tric Strap halves to be held together with bolts. A #6-32 tpi machine screw will be used to hold the two Eccentric Strap halves together. These will be replaced once the Eccentric Straps are completed with a scale bolt and double nut. This step, to drill the bolt holes in the Bolt Lugs, will be performed on all Eccentric Strap halves. To setup this drilling procedure, place an edge finder in the jaws of the drill chuck and indicate the inside of the fixed jaw of the milling vise. Then set one of the Eccentric Strap pieces in the milling vise and indicate the edge of the Bolt Lug. Position the center line of the drill 0.188" from these two surfaces. This will drill a hole at the center of the Bolt Lug. Use a #36 drill for the holes in the Eccentric Strap Top Halves which are later tapped and a #28 drill for the pilot holes in the Eccentric Strap Bottom Halves providing clearance for the bolts. A machinist clamp attached to the fixed jaw of the milling vise provides a stop for the parts so that the bolt holes will all be drilled at the same position (see Photo 10). A parallel should be used to keep the part away from the bottom of the milling vise so the drill bit does not damage the vise. Drill the holes in both Bolt Lugs on each part. After drilling, the holes in the Eccentric Strap Top Halves are tapped with a 6-32 tap using a bench vise to hold them. Bolt the Top and Bottom halves of the Eccentric Straps together.

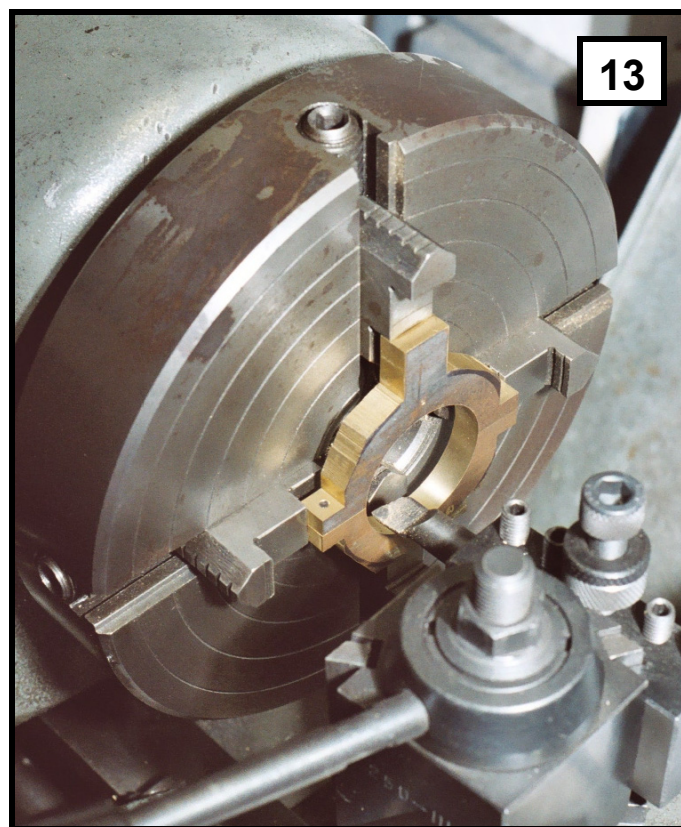
11. The next several steps (11 through 14) will make the center hole in each of the Eccentric Straps. These steps should be followed for



each Eccentric Strap, one at a time, with the two halves bolted together. This hole wraps around the Eccentric Cams. Mark the center of this hole along the joint between the two halves of each Eccentric Strap. Position the Eccentric Strap in a 4-jaw lathe chuck with the center mark on center in the lathe. Take care to keep the chuck jaws away from the hole. If the jaws must be behind the hole, clamp the Eccentric Strap away from the jaws with enough clearance for the drills and lathe tools to cut through the Eccentric Strap. There are at least two methods to do this and maintain a perpendicular alignment. One method is to use parallels while clamping the Eccentric Strap in place. Be careful to remove them before turning on the lathe! Another method is to make a ring with an inside diameter larger than the center hole and as long as necessary, about 1/4-inch, to position the Eccentric Strap away from the chuck jaws.

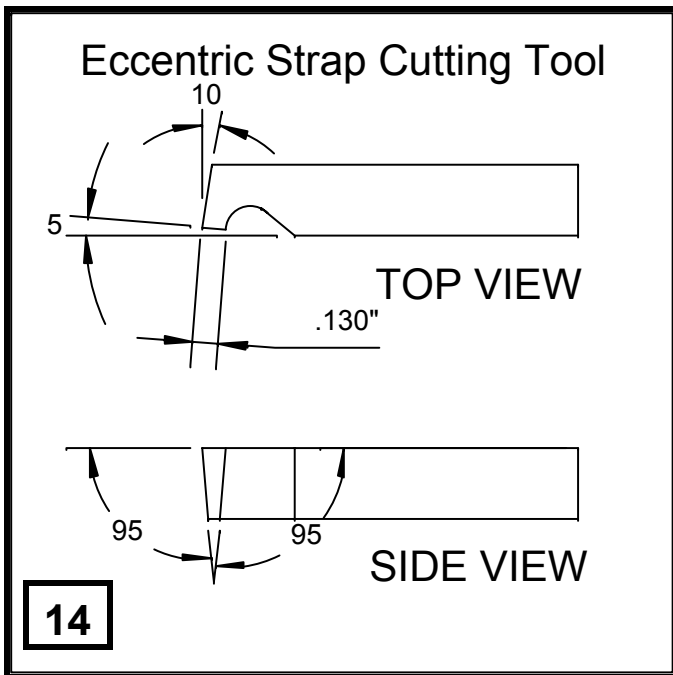


12. Begin drilling the Eccentric Strap center hole with a drill center as shown in photo 11. Use successively larger drills to make the hole large enough to begin using a boring bar (see photo

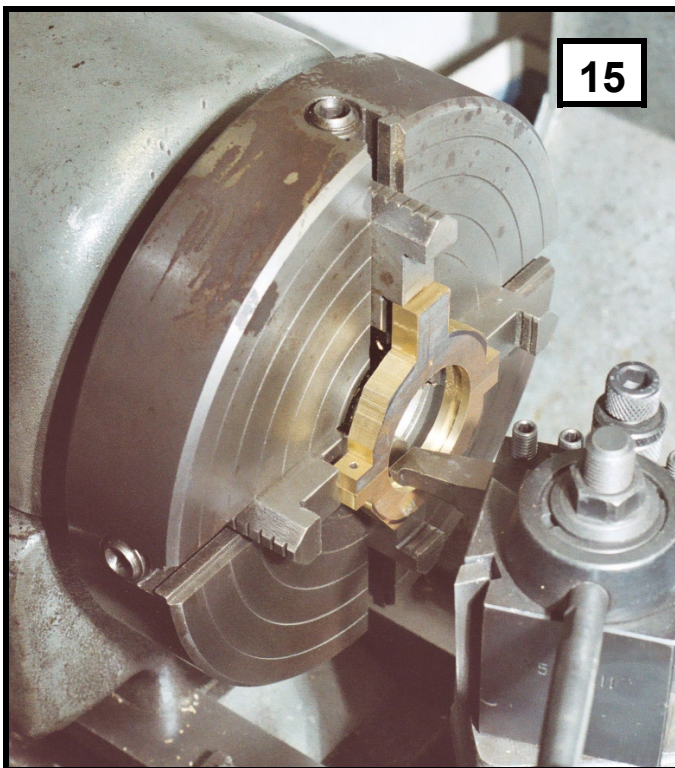


12).  
13. With a boring bar, enlarge the Eccentric Strap center hole to 1.725" diameter (see photo 13).  
14. The Eccentric Strap center hole has a 0.130" wide square groove 0.070" deep centered be-

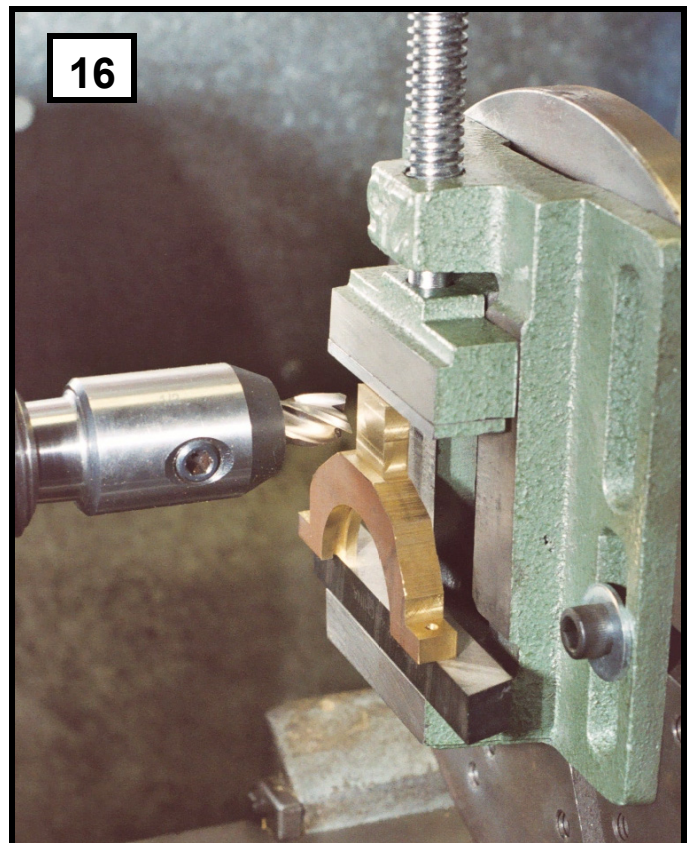




tween the front and rear surface of the Eccentric Strap. A specially ground lathe tool bit is used to make this groove (see diagram 14 for the dimensions of this lathe tool bit). Use a standard High Speed Steel lathe tool bit blank, either 3/8" or 1/2" square. The top of the tool bit is flat since brass cuts better with no relief angle. To setup the cut while the lathe is stopped, lock the tool bit at center height in the lathe tool



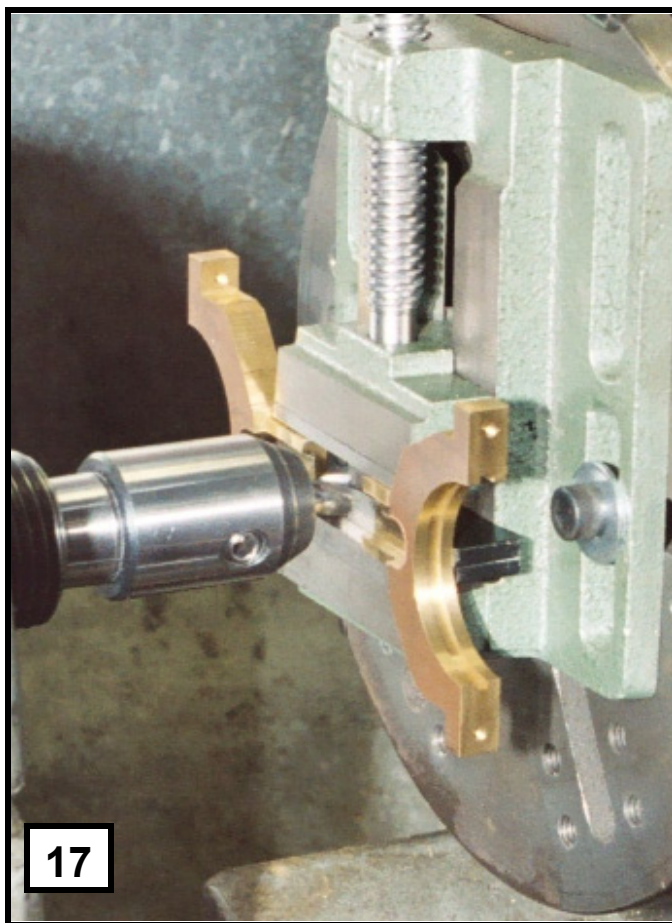
post with the 0.130" cutting edge flat against the inside of the Eccentric Strap center hole. Move the tool bit out of the hole and place the end of the tool bit against the front surface of the Eccentric Strap and set a dial indicator or DRO to 0.375". Return the cutting tool into the Eccentric Strap center hole and advance the cutter into the hole until the dial indicator or DRO reads 0.122". Move the cutting edge to the inside surface of the center hole and set the lathe cross slide dial or DRO to 0.000". Start the lathe and advance the cutting tool into the Eccentric Strap making a square groove around the inside of the Eccentric Strap center hole 0.070" deep. Repeat this cut on all Eccentric Straps (see photo 15).



15. The next several steps will machine the Eccentric Strap Blade Lug. The Blade Lugs are off center to allow the bolts that hold the Eccentric Blades to pass each other. Until this point, all of the Eccentric Straps have been made identical. The off center Blade Lugs must alternate between the six Eccentric Straps with three on the forward side and three on the rear side. Mark each Eccentric Strap accordingly. Unbolt the Eccentric Strap halves and clamp the Top



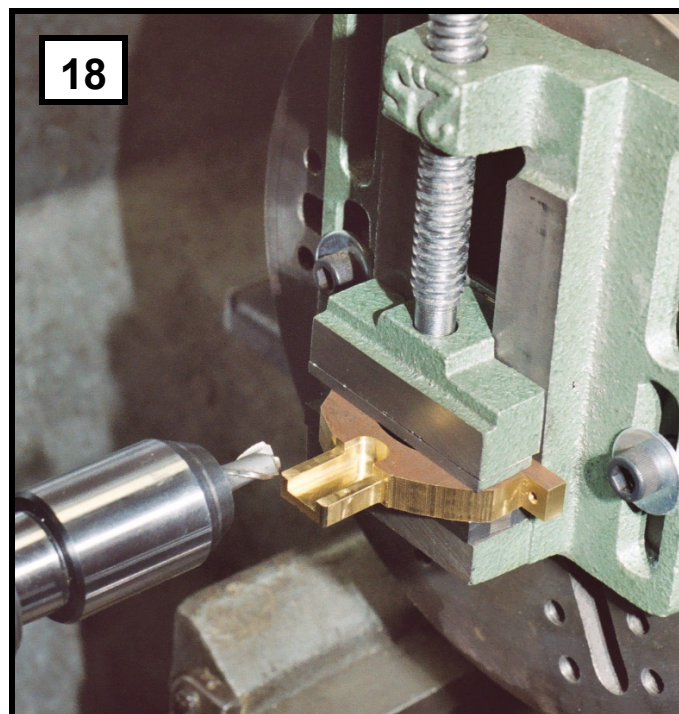
Half in a vise with the Blade Lug facing away from the end mill and toward the bottom of the vise. Use parallels to position the Eccentric Strap Top Half perpendicular to the end mill. NOTE: Do not over tighten the Eccentric Strap Top Half in the vise or you may distort the center hole. Machine off 0.125" of the Blade Lug for a distance of 0.700" from the top end of the Blade Lug (see photo 16). This will make the Blade Lug 0.250" thick. Repeat this step on each of the Eccentric Strap Blade Lugs.



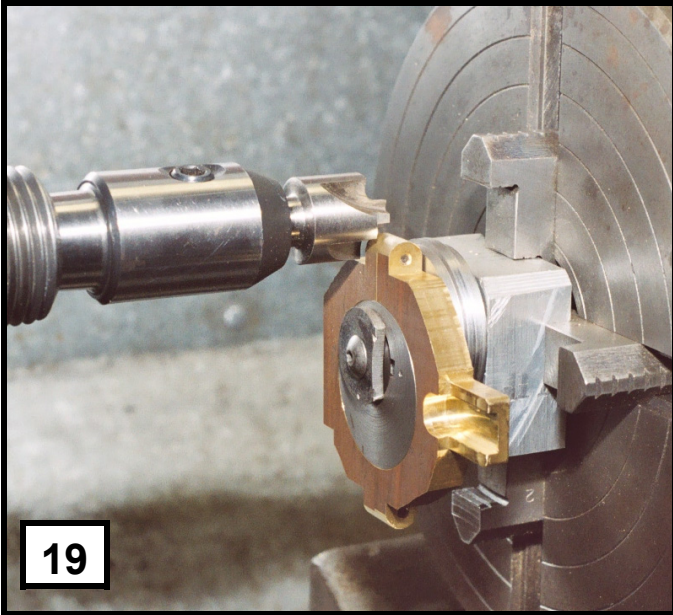
16. The Eccentric Blades fit into a slot centered along the Blade Lug 0.406" wide, 0.125" deep, and 1.000" long. A 3/8" end mill should be used to cut this slot. Note that the end of this slot near the Eccentric Strap center hole does not need to be squared off. Most of the slot along the center of the Blade Lug is where it is 0.250" thick, and part of it will be where the Eccentric Strap is 0.375" thick. A series of milling cuts may be needed to mill this slot. Two Blade Lugs can be machined at a time by clamping them in opposite ends of the vise (see photo 17). Use a center finder in the end mill

holder to position the end mill holder to the fixed edge of the milling vise. Move the vise so that the end mill will be centered 0.328" away from the fixed jaw of the vise. This puts the end mill on the centerline of the Blade Lug. Bring the end mill into contact with the surface of the Blade Lug and set a dial indicator or DRO to 0.250". Make a light milling cut along the surface of the Blade lug deep enough to measure the edges of the slot to the edges of the Blade Lug. Use these measurements to determine the dial indicator or DRO settings for the cuts necessary to make the slot 0.406" wide and centered along the Blade Lug. Mill this slot until it is 0.125" deep and extends 1.000" from the top edge of the Blade Lug. Repeat this step for all six of the blade lugs.

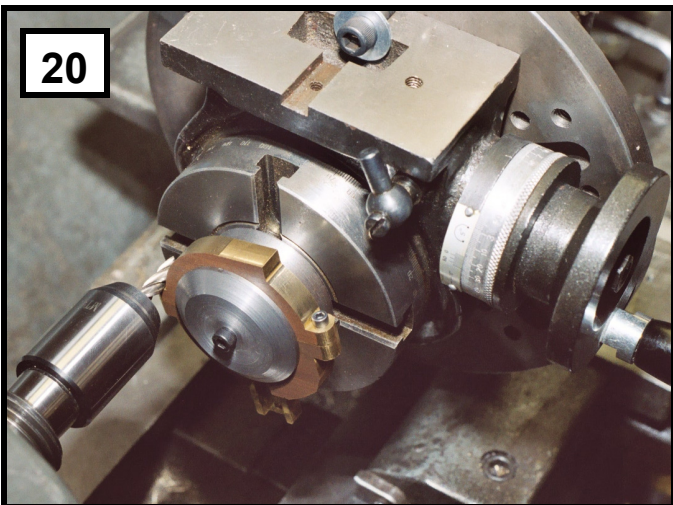
17. The Blade Lugs have three bolt holes along the centerline of the slot. These will later be used to bolt the Eccentric Blades to the Eccentric Straps. Using the same setup as Step 16, replace the end mill holder with a drill chuck and drill the top and bottom holes with a #28 drill along the centerline. The center of the top hole is 0.156" from the top edge of the Blade Lug and the bottom hole is 0.718" from the top of the Blade Lug. The center bolt hole is an oblong hole 0.200" long centered 0.437" from the top of the Blade Lug. Use a 5/32" center-cutting end mill to "drill" and machine this center blot hole.



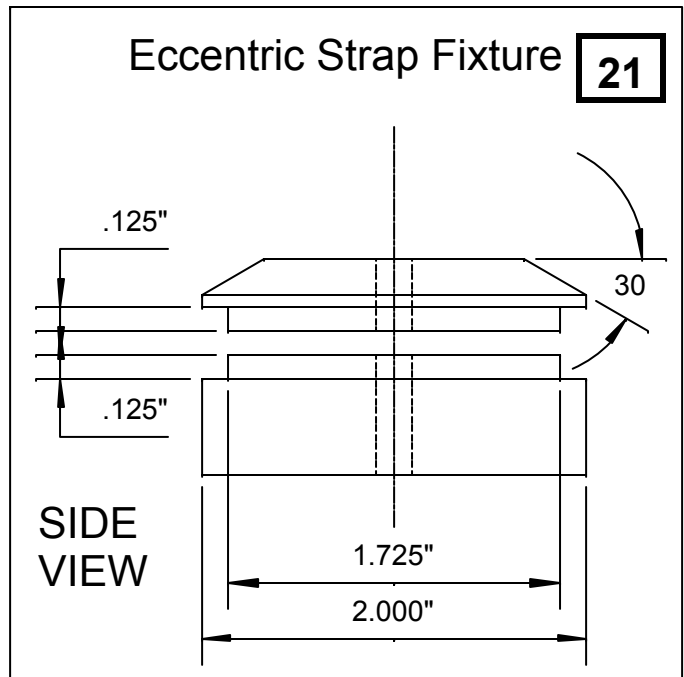
18. The top edges of the Blade Lugs are rounded over. Use a 1/16" round-over end mill to make these cuts. This radius is not a precision cut, but rather just for show (see photo 18). A file could also be used to make this radius. Repeat this cut on all Blade Lugs.



19. The Bolt Lugs are rounded and can be milled with a 3/16" round over end mill (see photo 19). This photo shows an Eccentric Strap held by a fixture comprised of an Eccentric mounted on the Eccentric turning fixture. It could also be held by the fixture used to machine the outside edge of the Eccentric Straps in the next several steps. This radius is not a precision cut, but rather just for show. A file could also be used to make this radius. Repeat this cut on all Bolt Lugs.

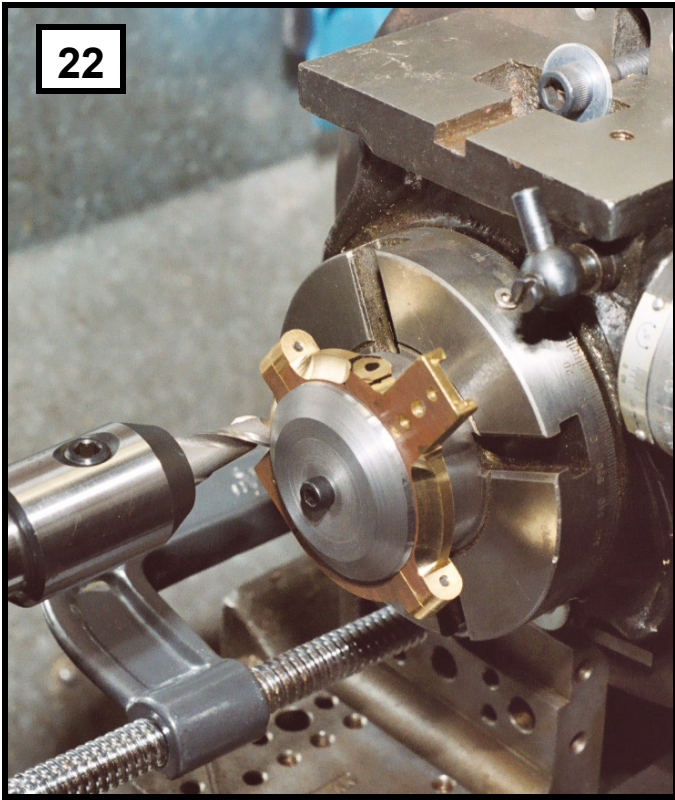


20. The outside edge of the Eccentric Straps has a radius of 1.219". This radius is cut using a 3/8" end mill with the Eccentric Strap mounted on a fixture (see drawing 21) which is mounted on a rotary table (see photo 20). Although this radius is not a precision cut, the end mill should be aligned with the bottom surface of the Eccentric Strap as this radius meets with the flat area under the Oil Well. This cut is made around the Eccentric Strap between the Oil Well, the two Bolt Lugs, and the Blade Lug. The end mill will cut right up to the Oil Well and the Blade Lug leaving a 3/16" transition radius. The milling done in step 7 will not allow a transition radius on top or bottom of the Bolt Lugs. Repeat these cuts on all Eccentric Straps. Note: remove the bolt holding the two halves of the Eccentric Strap together when machining in the area of the Bolt Lug.



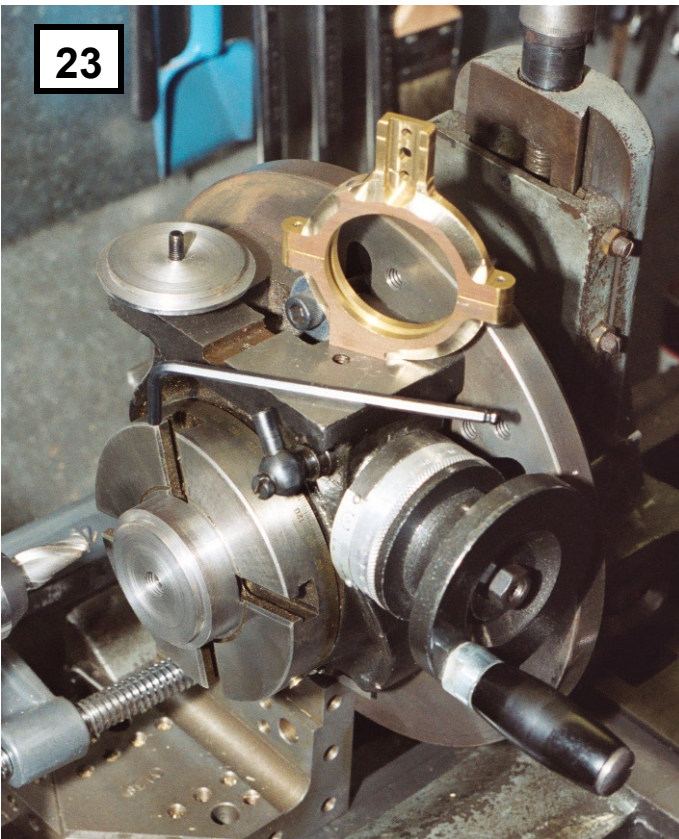
21. The edges of the Eccentric Straps have a .250" radius cut around between the Oil Well, Bolt Lugs, Blade Lug, and the Oil Cup. These radius cuts will create a center flange shape around the Eccentric Straps. This cut is made with a .500" round nose end mill (see photo 22) with the Eccentric Strap mounted on the same fixture mounted on a rotary table as step 20. Although this radius is not a precision cut, align the center axis of the end mill with the outside edge of the Eccentric Strap and cut into the



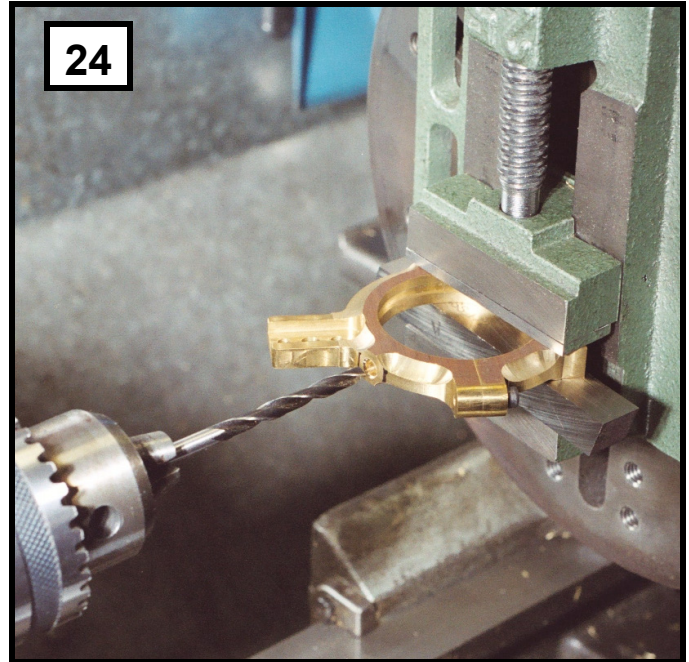


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surface .125" (see Section A-A on drawing 392-A-5110). Note: Extra care must be taken when cutting close to the Oil Well, Bolt Lugs, Blade Lug, and the Oil Cup. Repeat these cuts on all Eccentric Straps. Note: remove the bolt



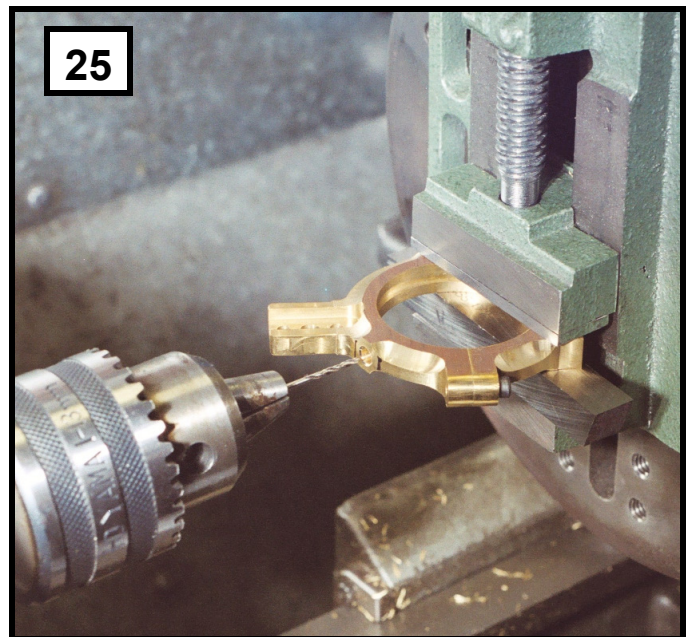
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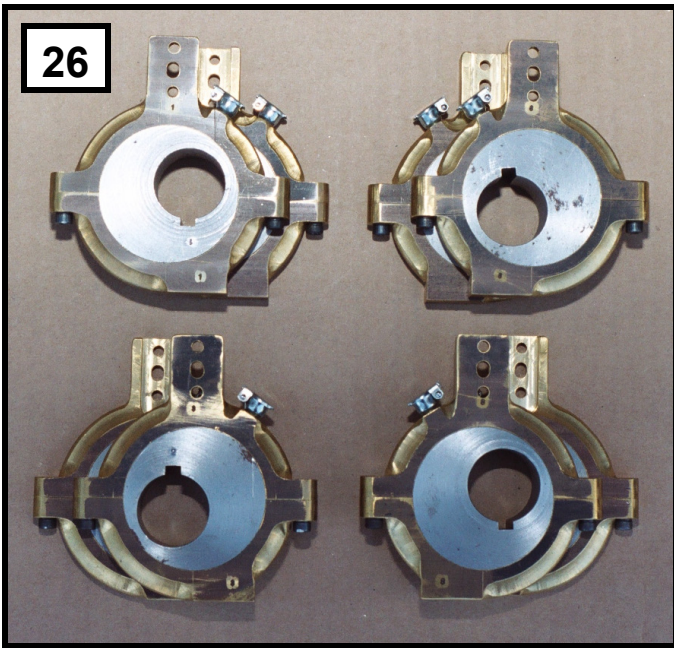
holding the two halves of the Eccentric Strap together when machining in the area of the Bolt Lug.

22. An Oil Cup is used for the lubrication of the Eccentric Strap. Drill a hole large enough for a press fit of a small Oil Cup into the Eccentric Strap leaving about 1/16" of material between the bottom of the hole and the center groove (see photo 24). Then drill a 1/16" diameter hole from the bottom of the Oil Cup hole through to the center groove (see photo 25). Repeat these holes on all Eccentric Straps.
23. The Center Flange made in step 21 can now be hand filed round to give the appearance of a casting like the prototype. This step is not nec-



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essary for function, but will make the Eccentric Straps look realistic.

24. The final step is to press in the Oil Cups. For a finished view of the Eccentric Straps see photo 26. Note: An extra pair of Eccentric Straps shown in photo 26 were made to operate a crank shaft driven water pump.

This completes the instructions for machining the Eccentric Straps.