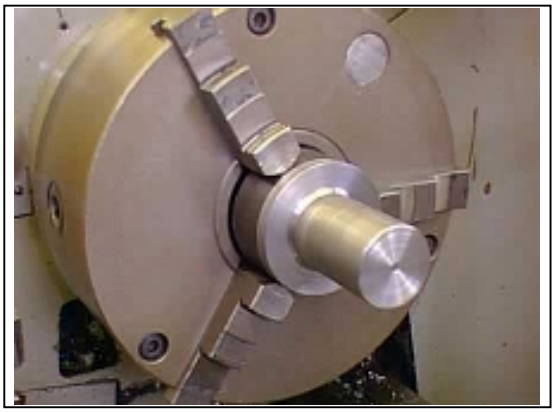
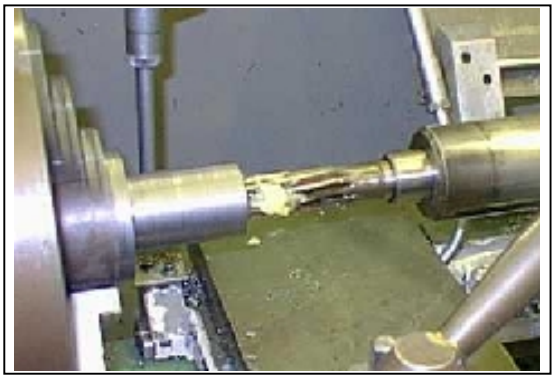
4.2 Hub Manufacture and Runner Assembly

1. Select hub dimensions for 120, 160 or 200 pcd runner as appropriate from the drawings provided (See Appendix B). Cut metal bar to length using available equipment. The machine shown is a horizontal band saw. One length is required for the hub and one of the flange plate.

2. Carry out as many operations as possible on one side of the hub before turning around. Face off one end of the bar and machine the hub extension to the correct length and diameter leaving a 2mm fillet radius. Clean up the edges.



3. Centre drill the hub and drill out to just below the tolerance diameter. Ream to the exact bore required for a push fit (H7 tolerance fit). For example, for a generator shaft of diameter 24 to 30mm the tolerance of the fit should be +0.034mm. This is a close fit which still allows easy removal of the runner for servicing in the field. See Note below before reaming the whole length.

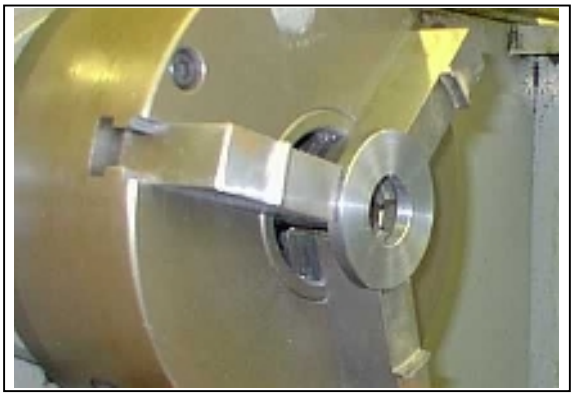


4. Turn the hub around in the lathe and face off.

5. Machine to the correct diameter and chamfer

Note: A useful modification (not shown) is to drill and tap a smaller hole (e.g. M12) through the centre of the 'runner-end' of the hub. A bolt can then be inserted when removal of the runner is required. The bolt will act as a puller and free the hub extension from the shaft.

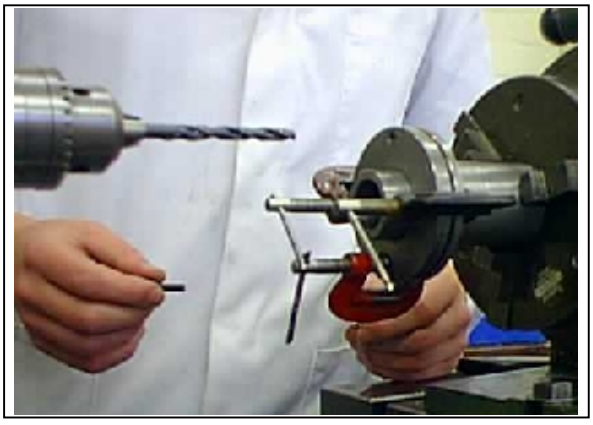
6. Machine the flange using soft jaws in the chuck which allow work pieces of short length supported from behind. Face off, centre drill and finally drill to the correct diameter. Clean all edges. Turn around and face off.



7. Assemble a dividing head onto the bed of a milling machine and centre. Alternatively use a dividing head which can be mounted vertically and fixed to a pillar drill.

8. There are various methods which are used for centring on workshop machines. One method which can be used to centre the dividing head is with a 'wiggler.'

9. Mount the hub in the dividing head with the flange plate firmly clamped as shown. Locate the position of the first hole with a centre drill and drill out to the correct diameter. When the hole has been made, lock the hub and flange plate together with a nut and bolt.



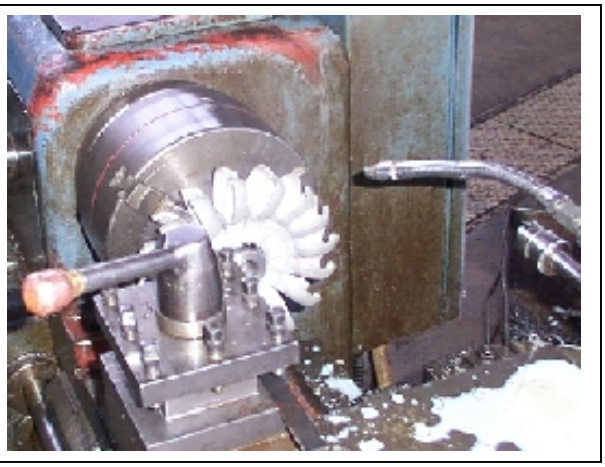
10. Using the divisions on the dividing head, drill another hole on the opposite side, exactly 180° from the first. Put a bolt in the hole on the opposite side as shown. Remove the clamps and using the dividing head divisions, drill the remaining holes. In this case, 16 buckets and hence 16 holes were required. The locking 45° divisions where used to drill the first 8 holes accurately. The remaining 8 holes where drilled between the first to give a total of 16 holes with the centre of each 22.5° from the next.

11. An alternative method of drilling the hub is to use a pillar drill with a vertical dividing head as shown. After drilling the first 8 holes using the locking 45° divisions, rotate the dividing head by 22.5° and drill the ninth hole. Then, holding the drill bit in the hole, slacken the chuck and rotate to 0° whilst keeping the work piece stationary. This allows the position of the remaining 7 holes to be located using the locking 45° divisions once again.

12. Once all the holes have been drilled do not disassemble immediately. Instead use a centre punch to make a mark on the rim of the hub and a mark opposite on the rim of the flange plate. This will ensure that the holes will still line up if there are any slight errors in the distance between them. Ideally the flange plate will fit in any position.

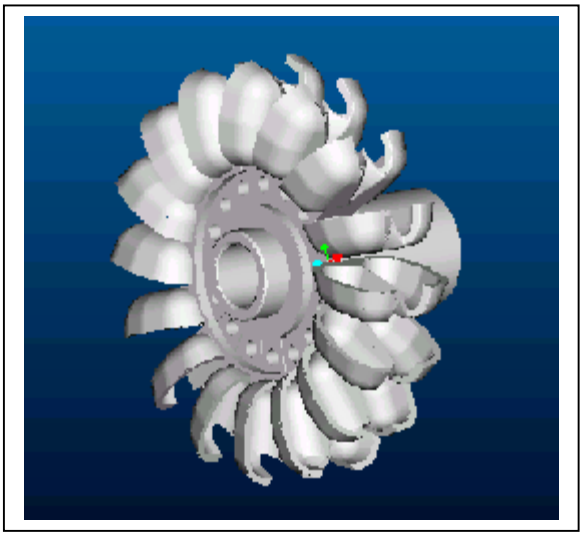
13. When the drilling is finished, each hole on the hub and the flange plate should be lightly countersunk to remove burrs.

14. Attach the buckets onto the hub using the threaded holes and mount in the lathe. The buckets should be spaced evenly around the hub. The angle between each bucket depends on the number of buckets used. Different bucket designs work best with different numbers of buckets on the hub. A template from paper or clear acrylic plastic which can be centered on the hub and has division lines marked at the correct angle can be used to check the bucket spacing. Alternatively, a jig can be made which



holds the buckets at the correct angle. Fully tighten the bolts before machining the buckets. If Allen key bolts are used, this process will be easier as the clearance between bolt heads is often small.

15. Face off the side of bucket roots together in the lathe and machine the recess (see Figure 5) to allow the flange plate to be fitted opposite the hub.



16. Whilst machining, check the progress using the flange plate until it locates snugly in the recess. Once the flange plate fits, the hub can be removed from the lathe and the final assembly carried out. The tolerance of the plate fit should be as close as possible to prevent the bucket angles from changing. The short bolts that have been used to allow the bucket machining in the lathe must be removed and new ones added that pass through the hub and bucket root and have sufficient clearance to allow the flange plate to be tightened in place.

17. It is important that the buckets can be reassembled in their correct positions if they are removed from the hub. Remove one bucket from the hub and using a centre punch mark the empty space on the hub.

18. Mark the first bucket with the number 1 in a visible place on the root.

19. Working in a clockwise direction, remove each of the other buckets one at a time and mark with numbers from 2 to 16.

20. Drill out the tapped hole in each bucket so that the fixing bolt will just pass through the hole.

21. Reassemble the complete runner with flange plate, tightening each bolt evenly. It is important that the buckets are not allowed to work loose when the runner is in use. For this reason, spring washers or nylon-lined self-locking nuts should be used to secure the bolts.

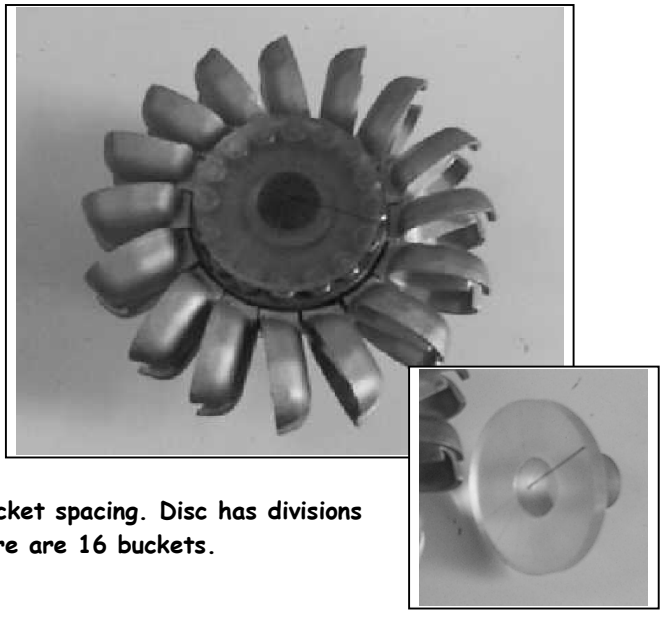


Figure 6 Assembled Pelton with acrylic disc to check bucket spacing. Disc has divisions which are marked every 22.5° because there are 16 buckets.