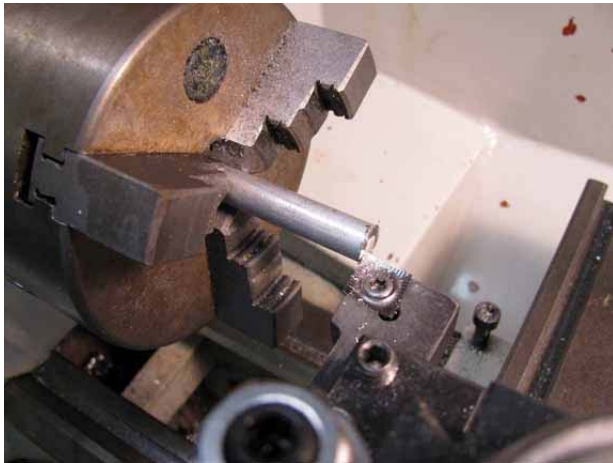


## Cornerstone Electronics Technology and Robotics Week 22

### Making a Coupler on a Metal Lathe and Sandwich PCB

- Administration:
  - Prayer
  - Turn in quiz
  - Review frequency and period
    - Show two periods on an oscilloscope and calculate the frequency. Verify with a frequency counter.
- Building Robots for Beginners, **Chapter 20, Couplers**
  - A coupler connects two things together.
  - Our coupler will allow us to attach/remove the wheels onto/from Sandwich.
  - **SAFETY ISSUES:**
    - **Work area:**
      - Keep your work area clean and well lit.
      - Do not operate power tools in explosive atmospheres, such as in the presence of flammable liquids, gases, or dust.
      - Keep bystanders and visitors away while operating a power tool. Distractions can cause you to lose control.
      - Overconfidence and being in a hurry contribute to accidents.
    - **Electrical power tools:**
      - Double insulated tools are equipped with a polarized plug (one blade is wider than the other). If the plug does not fit fully into the outlet, reverse the plug. If it still does not fit, do not use the tool.
      - Avoid body contact with grounded surfaces such as pipes, puddles of water, and electrical conduit. There is an increased risk of electric shock if your body is grounded.
      - Do not expose power tools to rain or wet conditions.
      - Do not force tool. Use the correct tool for your application.
      - Do not abuse the cord. Never use the cord to carry the tool or to pull the plug from an outlet.
      - Always rollup an extension cord from the plug end to assure that the cord has been unplugged.
    - **Personal Safety:**
      - Stay alert, watch what you are doing and use common sense when operating a power tool.
      - Dress properly. Do not wear loose clothing or jewelry. Contain long hair. Keep your hair, clothing, and gloves away from moving parts.
      - Avoid accidental starting. Be sure switch is “off” before plugging in.
      - Remove adjusting keys or wrenches before turning the tool “on”.
      - Use safety equipment. Always wear eye protection.

- **Using the Lathe to Machine the Coupler:**
  - Use the calipers to determine the diameter of the motor shaft and then select the next larger drill bit size from the Drill Size Chart.
    - Drill Size Chart as .pdf file:
      - [http://www.cornerstonerobotics.org/excel%20doc/week22\\_drill\\_size\\_chart\\_with\\_lines.pdf](http://www.cornerstonerobotics.org/excel%20doc/week22_drill_size_chart_with_lines.pdf)
  - Again use the calipers to determine the diameter of the Lego #6 axle and then select the next larger drill bit size from the drill bit chart. Measure the axle across its widest point. Let the instructor check your selections.
  - **UNPLUG THE LATHE!**
  - Insert the 3/8" diameter rod (9.52mm) in through the rear end of the lathe headstock so the end of the rod is about 25mm beyond the jaws of the three-jaw chuck. Center the 3/8" rod in the lathe chuck and tighten the lathe chuck as tightly as possible. **Have the instructor check the tightness.**
  - Using the toolholder with the diamond insert, "face" the end of the rod. The lathe chuck direction of rotation is such that the top of the work rotates toward the operator. See the photos below.



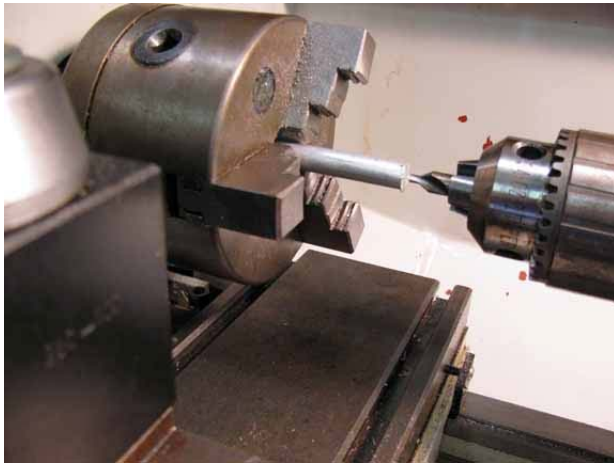
**Facing the End of the Rod**



**Position of the Diamond Insert**

- Insert the drill chuck into the tailstock then tighten the center drill in the drill chuck. Park the carriage against the headstock. See the photos on the next page. Move the tailstock to within about 2mm of the 3/8' rod and tighten. **Have the instructor check the tightness of the tailstock.** Drill a center hole to the correct depth with a center drill. This hole will be used for stabilizing a live center and guiding the other drill bits you will use. Traditional twist drill bits may tend to wander when started on an unprepared surface. Once a bit wanders off-course it is difficult to bring it back on center. A center drill bit frequently provides a

reasonable starting point as it is short and therefore has a reduced tendency to wander when drilling is started.

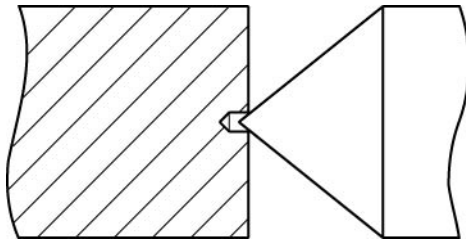


**Carriage Parked against the Headstock**

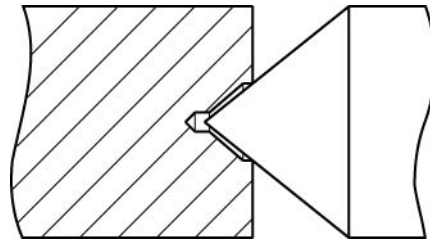


**Center Drill in Position**

Be sure that the center hole is drilled to the proper depth; see the illustrations below.

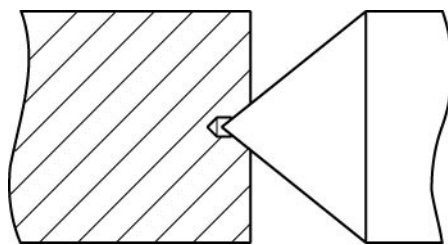


**Center Hole Too Shallow**



**Center Hole Too Deep**

**Improper Live Center Seating**

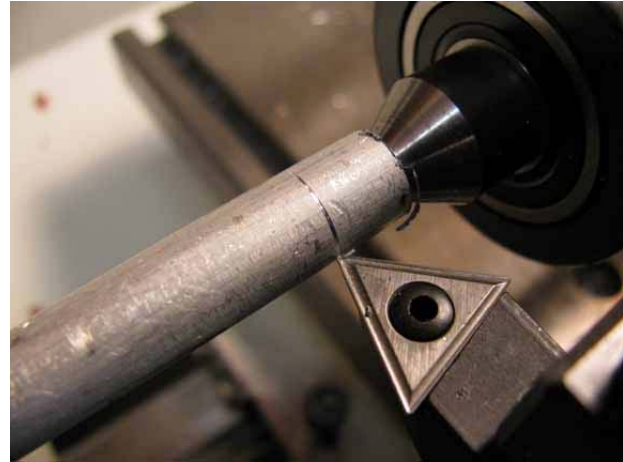


**Proper Live Center Seating - Center Hole at the Correct Depth**

- **UNPLUG THE LATHE!**
- Measure in 32mm from the end of the rod and place a mark.
- Extend the rod to about 70mm from the face of the chuck.
- Support the end of the rod using a live center. Make sure that the live center mounted to the tailstock spindle is extended out of the tailstock; this gives room for the carriage to get into position for milling the rod to the end. See the photo below. **Have the instructor check the tightness of the lathe chuck and tailstock.**



**Rod and Live Center in Position**



**Triangle Insert Just Touching Rod**

- Using the toolholder with the triangle insert, just barely touch the rod with the insert as shown in the photo above.
- Read setting on the handwheel on the carriage. In the photo below, the handwheel reads 0.006
- Back off the triangle insert from the rod.
- Move the carriage to the end of the rod and adjust the handwheel to 4 thousandths deeper than the previous 0.0006" reading. Engage the feed lever and mill the rod to the mark.



**Handwheel Setting at 0.006"**



**Milling the Rod to 32mm from the End**

- **Drilling the Coupler:**
  - **UNPLUG THE LATHE!**
  - Move the end of the rod back to about 25mm beyond the jaws of the three-jaw chuck and setup the tailstock to drill the motor shaft hole. **Have the instructor check the tightness of the chuck and tailstock.**
  - Using the smaller diameter drill bit, drill a hole to a depth of 32mm into the rod. Test fit the motor shaft into the hole.



**Small Drill Bit in Position**



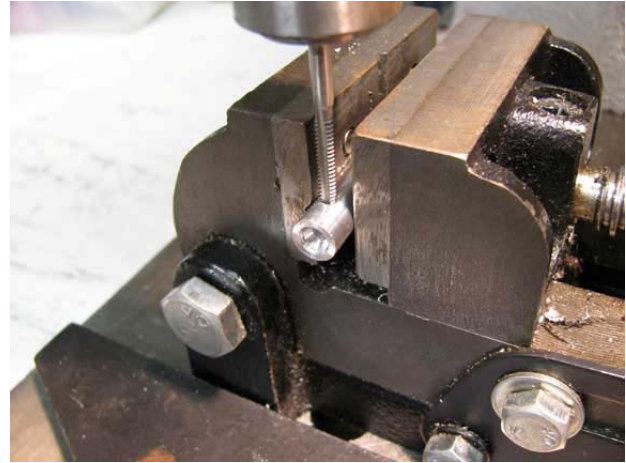
**Drill to Mark on Drill Bit**

- Now use the larger drill bit and drill a hole to a depth of 12mm into the rod. Test fit the Lego axle into the hole.
- **UNPLUG THE LATHE!**
- Remove the rod from the lathe.
- Measure a length of 25mm from the end for cutoff.
- After the rod has been cut, let the piece cool before handling.
- Have the instructor grind the cut end of the rod.
- Deburr the ground end.

- **Drilling and Tapping for the Setscrews:**
  - Place a mark 7 mm from the end with the smaller drilled hole.
  - From the Tap/Drill Chart, select the proper drill bit for a 6 x 32 setscrew.
    - Tap/Drill Chart as .pdf file: [http://www.cornerstonerobotics.org/excel%20doc/week22\\_tap\\_drill\\_sizes.pdf](http://www.cornerstonerobotics.org/excel%20doc/week22_tap_drill_sizes.pdf)
  - Clamp the coupling into the drill press cross vise.
  - Drill one hole at the mark halfway through the coupling.
  - Tap the hole using a 6 x 32 tap and install the setscrew.



**Drilling for Tap**



**Tapping for Setscrew**

- **Final Coupling:**



Side View

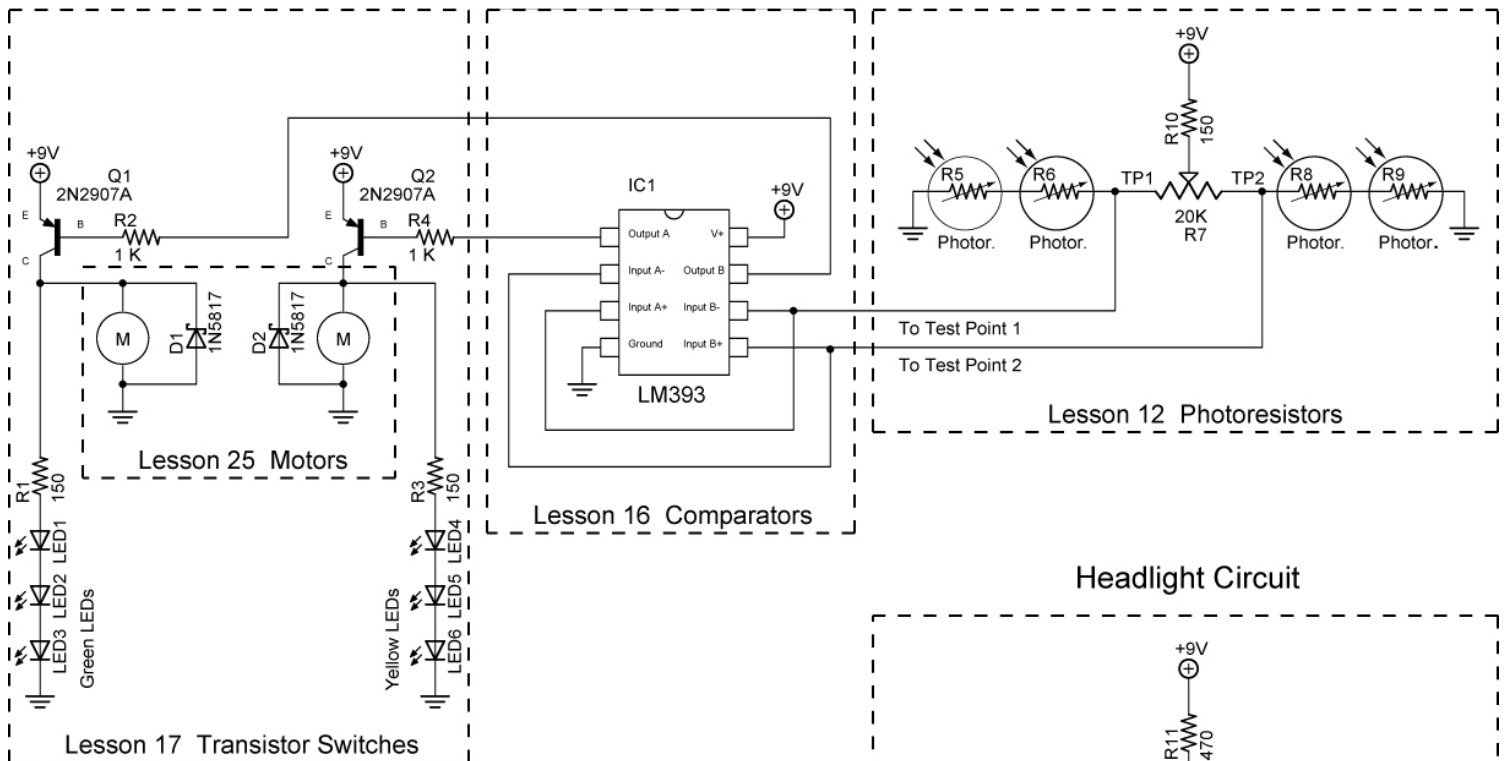


End View

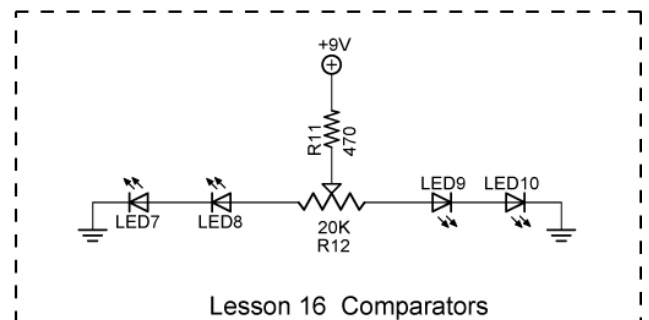
## Electronics Technology and Robotics I Week 22 Sandwich PCB Lab 1 – Soldering Parts to PCB

- **Purpose:** The purpose of this lab is to solder the Sandwich parts to the Printed Circuit Board (PCB).
- **Apparatus and Materials:**
  - 1 – Soldering Iron and Accessories
  - Sandwich Parts including PCB
- **Procedure:**
  - Solder Sandwich Printed Circuit Board:
    - Follow steps on printout from <http://www.robotroom.com/SandwichPCB.html>
    - Wire motors, see page 389 Robot Building for Beginners
    - Wire the battery snap and the power switch in the same manner as the motors in the Sandwich Circuit Review:

### Line Following Circuit



### Headlight Circuit



**NOTE:**  
See Robot Building for Beginners by David Cook  
for final connections including the line following switch.