

COLD WELD COPPER TUBE SAMPLING EQUIPMENT AND PROCEDURES

THE COLD WELDING EQUIPMENT

The equipment needed to take ~ 45 gram water samples in copper tubes is shown in the figures below. Figure 1 shows the cold weld device used to seal the copper tubes. The cold weld is made by a hydraulically actuated crimper system (The Jaws) activated by a foot pedal assembly shown in Figure 2. Figure 3 shows the aluminum bracket for mounting "The Jaws" on a bench. Figure 4 shows the hand press called "The Flattener" used to reduce the volume of the copper sample chamber before taking a sample. Figure 5 shows the hand press called the "Re-Rounder" used to re-round the section of tubing that was previously flattened. This action results in a head-space that is needed to prevent the cold weld seals from rupturing as the water warms to ambient temperatures.

SETUP

Ideally this equipment should be used in a lab environment aboard the ship, but logistically it will probably be necessary to mount the cold welder and re-rounder in the hangar near the rosette. A source of 80psi compressed air is needed to drive the foot pump. The foot pump is calibrated to produce 9,000psi on the hydraulic side when supplied with 80psi of compressed air. If the ship's supply is already equipped with a regulator you still need to attach the water & particle filter before the pump. **Clean air is a must if the system is to last.** The larger diameter 3/8" red rubber hose is used to connect the regulator/filter to the ships air. Put a drop of the supplied hydraulic oil in the air inlet fitting on the footpump before connecting the short (<6') length of 1/4" Nalgene tubing to the regulator. Due to the narrow ID of the tubing, using a longer run of 1/4" tubing will cause problems with crimping. The rack can be bolted through a tabletop or fastened to the table with C-clamps. The re-rounder needs to be screwed into a tabletop near the crimper, so the tubes can be re-rounded as soon as possible. The flattener should be mounted in the lab space used for rolling out the copper tubes. You will need a minimum of six linear feet for rolling out the tubes. The foot pedal will need to rest on the deck while it's in use, but if possible it should be secured to a low shelf to protect it from deck-wash in between stations.

Before the first station, test the system with some dry copper tubing. Store the sample tubing in the bucket filled with fresh or saltwater about 24 hours before the first station. **Both the finished samples and the rolls of copper tubing should be kept inside the ship in a climate controlled area at all times and the endcaps should be put back on the roll.**

SAMPLING STEPS

1. Cut the copper tubing into 30" lengths to accommodate taking two 12" samples at once for duplicates with 3" at each end for attaching the Tygon tubing. Use a sharpie and a tape measure to make marks at 3", 15" and 27" on the side of the copper tube. Replace the cap immediately after cutting the sample tubes for a station. The copper must be kept clean and dry until used or the samples will probably leak.

Do not do this step too early! The copper tubes should be cut and prepped just before you begin sampling. Once they are cut they should be kept in climate-controlled lab space until the last minute before sampling, do not leave them out to warm up in the sun! We want the interior of the copper tubes to be as fresh as possible before sampling.

2. Using a sharpie, label each copper tube with the station (Sta), cast (Ca), niskin (Nis) number Niskin and an 'A' or 'B' to distinguish the pairs. For example, the samples drawn on Cruise RH12 at station 5, cast 3 from niskin 24 would be labelled: **RH12 5-3-24 A and RH12 5-3-24 B**. If you are drawing a duplicate tube at the same niskin you would end up with four 12" copper tubes from the same depth and the second set would be labelled: **RH12 5-3-24-1 A and RH12 5-3-24-1 B**.

3. Use the flattener to compress a section of the copper roughly at the center of each of the 12" sections.

4. Attach Tygon tubing with black tubing adapters to both ends of the copper tube. **Tube A will always be filled first and should be connected to the tubing that leads to the niskin spigot and you'll let the drain tube (top of Tube B) drop to the deck.** Make sure the white plastic pinch valves are attached to each piece of tubing and in the open position. If you need to, attach a cable tie around the tube so the tygon doesn't slip off the copper on the outlet side.

5. When you are ready to start sampling, begin with the out flow end of the tube raised high enough to prevent water flowing through the tube. Slowly lower it to waist level as water starts filling the tube from the bottom up. This is done to reduce the number of air bubbles trapped within the sample chamber and to ensure that the sample chamber is filled slowly.

6. Gently rap on the sides of the copper with the 'thumper' starting toward the bottom and working your way up. Keep watching the Tygon tube for bubbles that are dislodged. Repeat the rapping until you are satisfied that no bubbles remain, close the pinch valve on the top drain tube, then close the pinch valve on the fill tube.

7. Close the niskin spigot and remove the sampling assembly. **Remember, you will always crimp the end of Tube A first, then the middle seal, then the top of Tube B.** With the Tygon tubing still connected, insert the copper tube through the jaws of the crimper and line it up with the first mark at 3". Step on the pedal to begin sealing the sample. The crimping tends to cause a recoil with the copper tube as the dowel pins meet and the shoulder force the copper out of the way. Make sure you have a good grip on the copper and watch out for the sharp copper seals. You should feel and hear the final compression of the copper forming the seal as the compressor slows to a ticking sound.

8. Push the pedal the other direction to open the jaws. The bottom piece and tubing should simply fall to the bucket. If it doesn't you may have to gently wiggle it to come free from the rest of the copper. Be careful of the seals, they are razor sharp and can be compromised if they are mistreated. Repeat until you have your two samples. **Immediately** use the re-rounder to create a head-space inside each copper tube. **Failure to re-round promptly will cause the seals to leak.** Retrieve the Tygon tubing and repeat until all samples are taken.

9. After you have finished the cast, liberally rinse each sample off with fresh water. Dry the samples thoroughly and double-check that each tube is labelled with Cruise-Station-Cast-Niskin and an 'A' or 'B' to distinguish the lower sample from the upper sample. Store the sample tubing in the bucket filled with fresh or saltwater. Change the water every few days to prevent the tubing from getting slimy. Inspect both ends of the dowel-pin's sealing surface to see if they have started flattening after repeated use on a long cruise and check the stainless steel holder for "spreading." If you can see daylight between the dowel-pin and the holder, the arms are probably bending and will need to be replaced.

10. After the samples are rinsed and dried, they should be packaged carefully into a suitable box. Pick a watertight box that will hold a maximum of 150 tubes, anything bigger will be too heavy. Put a few larger pieces of bubble-wrap on the bottom and fold them up to cover all four sides of the box. Space the tubes roughly 3 inches apart for each row, as shown in Figure 6. Put one sheet of bubble-wrap over this layer and then put this layer of tubes in the gaps between the first row of tubes. This creates the effect of weaving the bubble-wrap between each sample, so they don't bump into each other during shipment. Keep repeating this layering until the box is full. Fill the remaining gap with more bubble-wrap and cable tie the lid into place. Note the Stations/Casts on the outside of each box.

There is a short video showing the equipment and demonstrating the above sampling procedure that should be watched. This should clear up any questions after reading the above sampling description.

MAINTENANCE

With the compressed air turned off and the hydraulic pressure relieved, wipe the seawater off the jaws using a damp (fresh water) paper towel. Spray the crimper (The Jaws) with WD-40 after sampling to minimize corrosion. If the foot pedal is getting salt-water on it, carefully wipe it down with a damp paper towel (fresh water) after the cast and spray the moving parts with a little WD-40.

Change the water in the bucket every few days to prevent the tubing from getting slimy.

Like any air tool, the foot pump needs to be lubricated between uses. With the airline detached place the foot pump in the vertical position and **add a few drops of hydraulic oil into the brass Swagelok air intake fitting, before each sampling station.** It's probably best to shut off the compressed air supply to the crimper when not in use.

If there are remaining questions, feel free to email us.

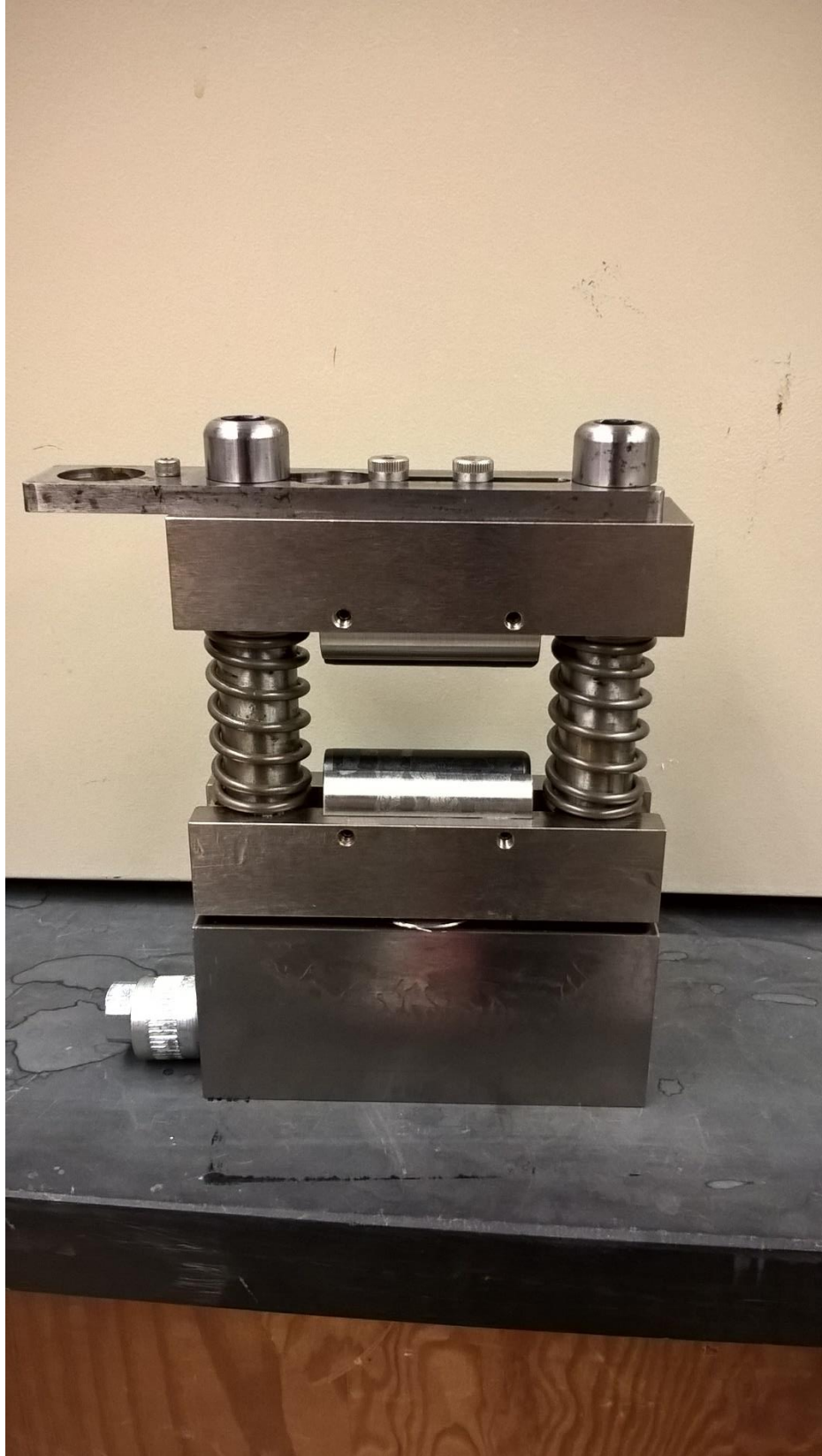


Figure 1: The Cold Weld Device or Jaws



Figure 2: The Foot Pump



Figure 3: Aluminum Mounting Bracket for the Jaws

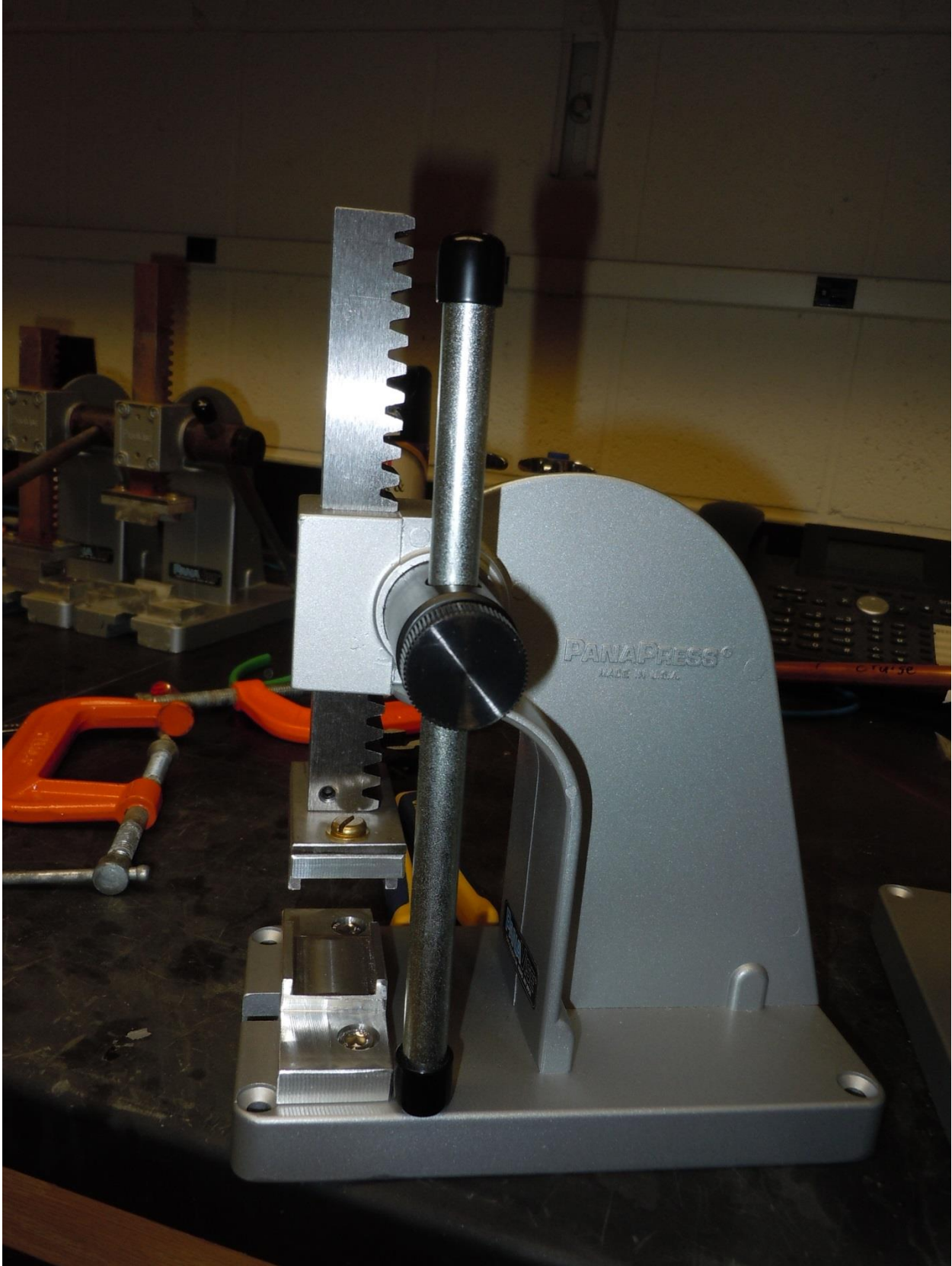


Figure 4: The Flattener

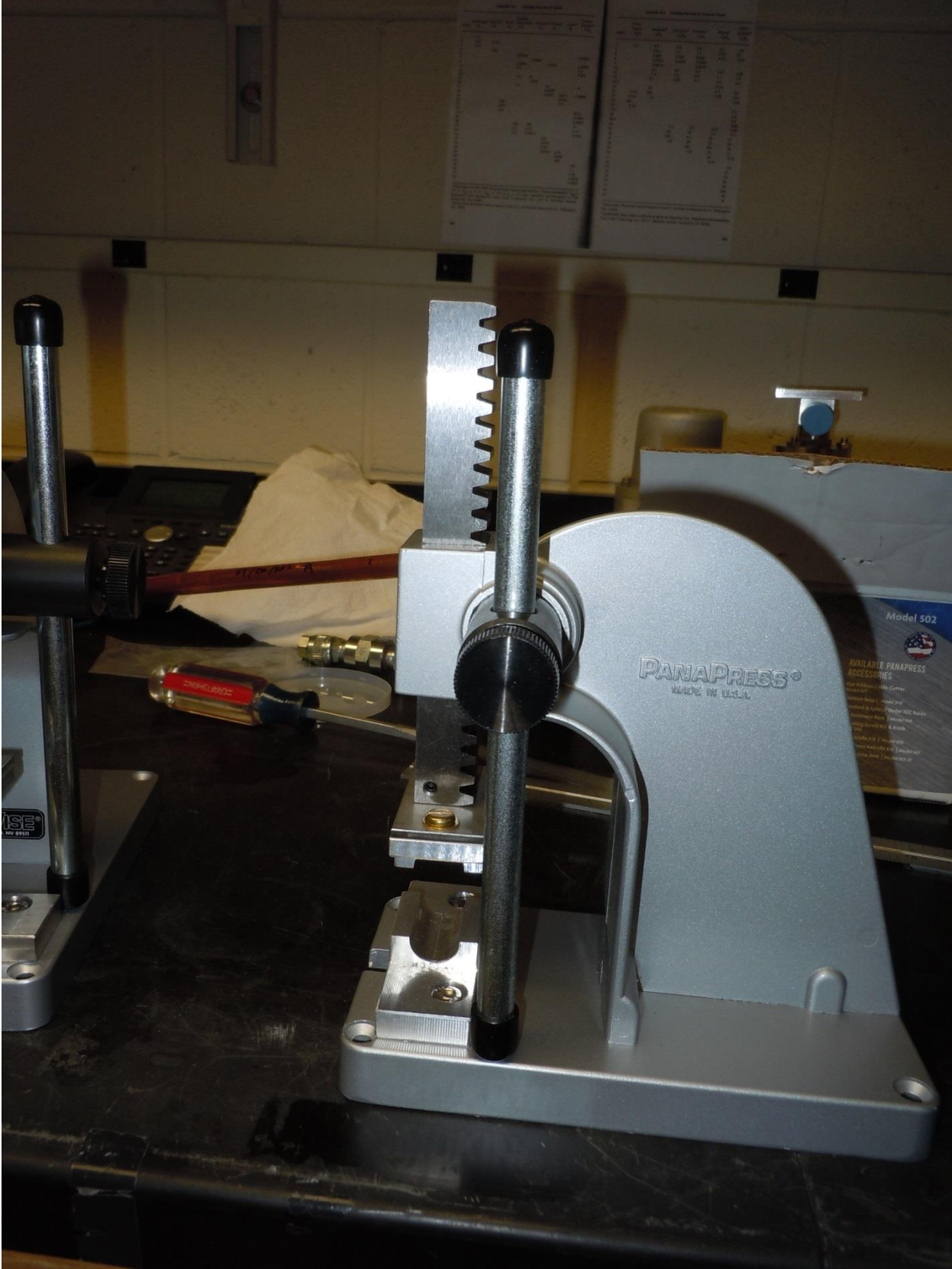


Figure 5: The Re-Rounder



Figure 6: Packing the Samples