The Keuffel & Esser Logarithmic Dividing Engine

Michael P. O'Leary

Image 1 - The K&E Dividing Engine. The big guy behind it is the author, holding the hand crank used for setting the engine at its starting point. The dividing engine is mounted on a steel framework table.

Having explained the concept of the dividing engine and how it works in my previous article, I am going to share with you all the experience I had this summer. Ed Chamberlain, a fellow member of the Oughtred Society, and a great friend of mine, wrote me an email early this summer that he was going to be putting up a slide rule display at the American Precision Museum (APM), in Windsor, Vermont. While he was setting up his display (which was quite impressive, by the way), he mentioned that we collectors were seeking a dividing engine to study. As many of you know, there is one at the factory at Faber-Castell, but no one seemed to know where a K&E dividing engine was.

That changed. As it turns out, the staff at the museum took Ed up into the storage area above the displays, and introduced him to the K&E Logarithmic Dividing Engine, Serial Number 2 (of that model). When Ed got home, he fired me an email about it. The APM was also starting an "Adopt a Machine" program, where a volunteer could adopt a machine for restoration purposes. I volunteered! I went up to the APM with Ed, was introduced, and wrote up a proposal to adopt the dividing engine. I was approved for the project, and set about cleaning the machine.

Here is the history of the machine, as we have it at present. When K&E's machinery was being liquidated, Theo Alteneder, of drafting tool fame, bought this engine and stored it away. Ed Battison, founder of the APM and a former curator of one of the Smithsonian Institution's museums, met Mr. Alteneder, and was given the dividing engine for his museum. It sat in storage for a good long while, and at one time in its storage was exposed to rain. Whoever prepared it for storage at the K&E plant did a masterful job, because there was very little evidence of rust anywhere on the machine. It had been properly coated with grease or Cosmolene, making my clean-up efforts much easier.

I am presenting the pictures of this machine in the same order the items are described in the companion article, so you can see how K&E implemented the concepts described.

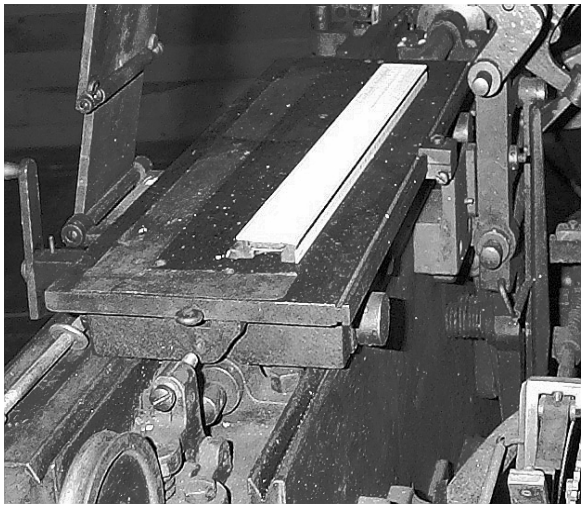


Image 2 - The Carriage. I have placed a K&E 4053-3 on the top of the carriage, to give an idea of size and orientations. In this image, you can see a knob-like object on the right front of the carriage, which is the wheel mount described in the "Concepts" article. The wheel is ground to match the V-groove in the base. Halfway back on the right edge of the carriage is the feed stop which trips the trip release.

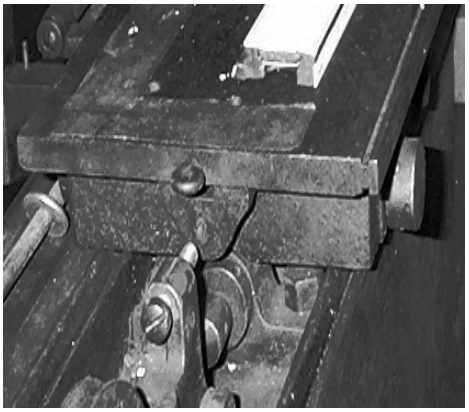


Image 3 - The Starting Carriage Stop. The screw that touches the carriage in the center of the image is set to stop the carriage at the starting position for the dividing run.

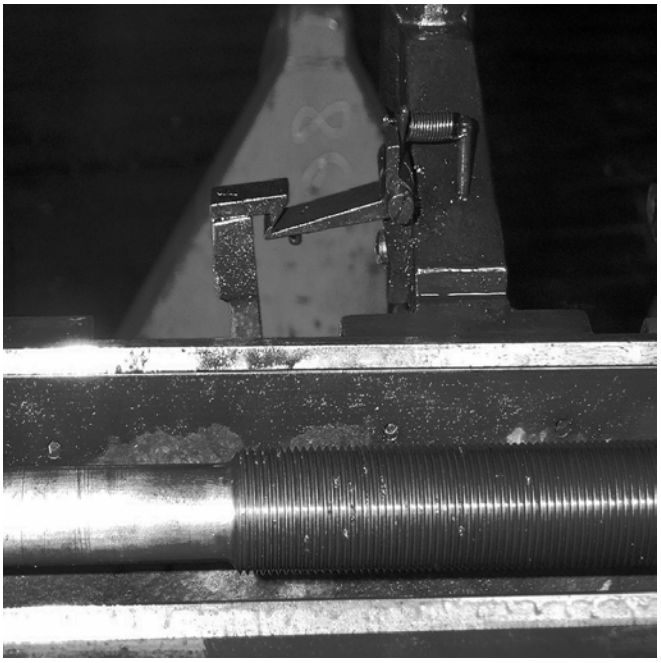


Image 4 - The Trip Release and Feedscrew. The trip release is the pair of clips in the center of the image. Below it you can see one end of the feedscrew. Note that the thread, which is ground into the metal for the highest accuracy, is raised above the surface of the rest of the shaft.

Image 4a - The Trip Release - Back Side View. When the carriage stop pushes on the top of the left lever, it releases the right lever, which disengages the clutch on the shaft below and stops the dividing engine.

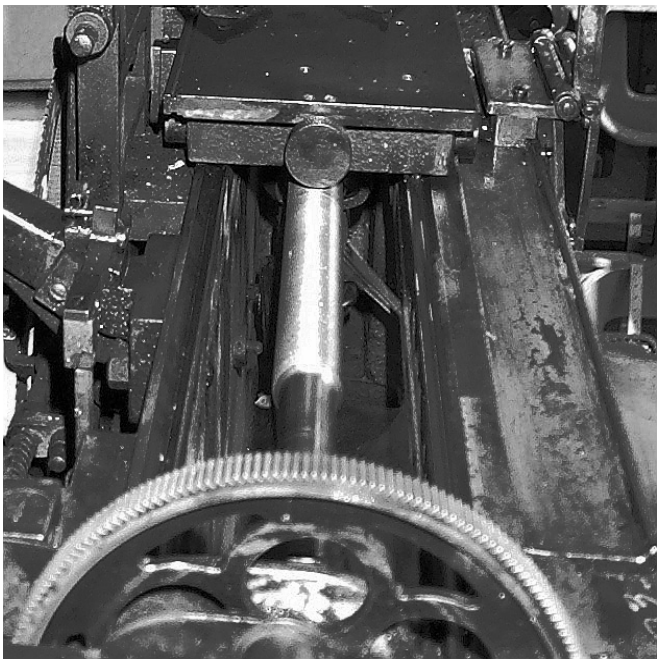


Image 5 - Another view of the feedscrew. In this view, you can see the feedscrew centered between the V-rails the carriage travels on. The big gear at the bottom of the image is a step-down gear that works in conjunction with the logarithmic cam.

Image 6 - The Feed Half-Nut Mechanism. Shown is the mechanism that engages the feed half-nut. With the lever in, as shown, the feed half-nut is engaged with the feedscrew. When the lever is pulled left to the horizontal position, it releases the feedscrew, and allows the carriage to be positioned manually.

Note that the bottom of the lever assembly has a roller on it. This roller makes contact with the bar to the right of it. This bar is a very important feature of the dividing engine. It allows the master tool and die maker to adjust the feedscrew's pitch so it can be calibrated precisely with all the other dividing engines in the factory, making it possible to dedicate each machine to a single set of scales, and allow the blanks to move from machine to machine, and maintain K&E's legendary accuracy. This bar is sure to be one of the trade secrets to K&E's production.

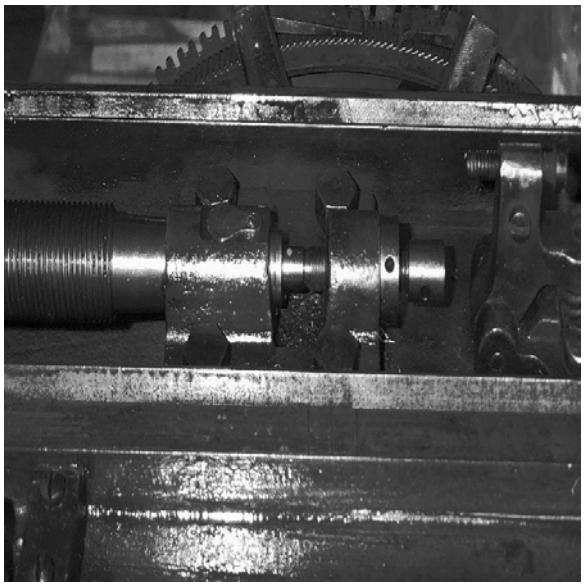


Image 7 - The Feedscrew Mount and Center. This is the right end of the feedscrew, showing the mount at left center in the image, and the adjustable center to the right of it. Above and to the right of the adjustable center is another view of the starting carriage stop. Note the cover on the oil hole. Each day and several times during the shift, the operator would open the cover and put in a few drops of oil.

Note also that the center has a pin hole in the center nut, and in the center end itself. The master tool and die maker that made this engine used this type of fitting throughout the machine, where fine adjustments would be necessary during the maintenance of the machine. Some of the pin holes had been elongated by apprentices using punches instead of the proper pin wrench. In other locations on the engine, a number of modifications had been done, which are obvious because the toolmaker making the modification used screws and bolts instead of machinist-made fasteners that are shown in this image.

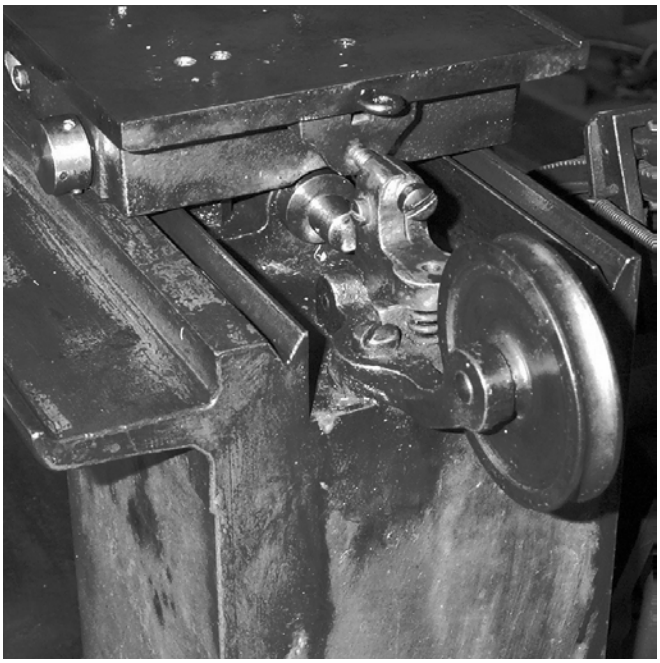


Image 8 - The Feed Tensioning Weight. Located on the center edge of the carriage is a loop. A weight was suspended from this loop by means of a rope, over the top of the pulley, and down the side of the machine. This weight placed tension on the feedscrew and feed half-nut to eliminate play in the travel of the carriage. Note the carriage wheel mount, and the ground V-grooves in the engine bed.

Image 9 - The Base of the Dividing Engine. The base of the dividing engine is actually two pieces. The main piece is the large rectangular part in the picture, to which all other parts of the engine are mounted. The second piece is the curved arm on the left, which is the left side centering mechanism for the feedscrew. The left feedscrew mount is located next to the step-down gear shown in Image 5. The large brass pieces to right of center, and above the carriage, are the mounts used to hold the cutter table. They are shown in the "Up" position, which allows access to the carriage during setup and removal of the blanks, and maintenance of the cutters.

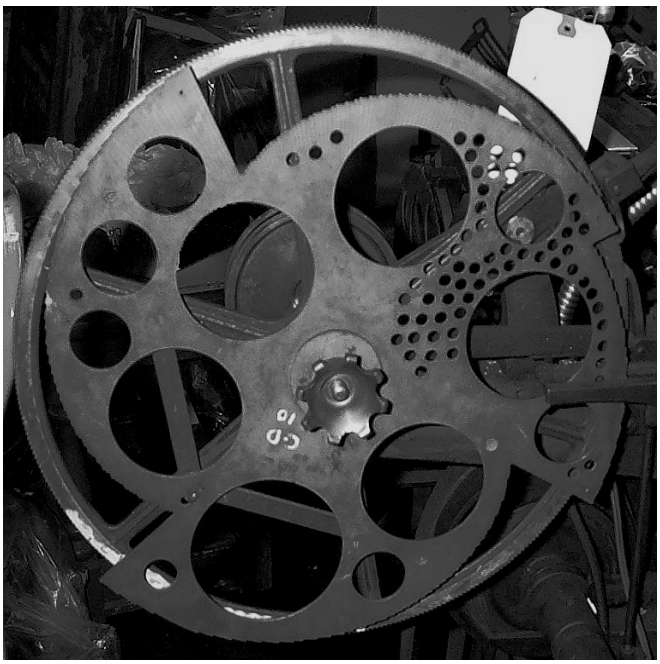


Image 10 - The Logarithmic Cam. Here is the logarithmic cam, which sets the position of the feedscrew before each cut is made. Note at 3 o'clock is a small arm. This is one side of the bed for the cam stop, not shown. The cam is mounted on a large gear.

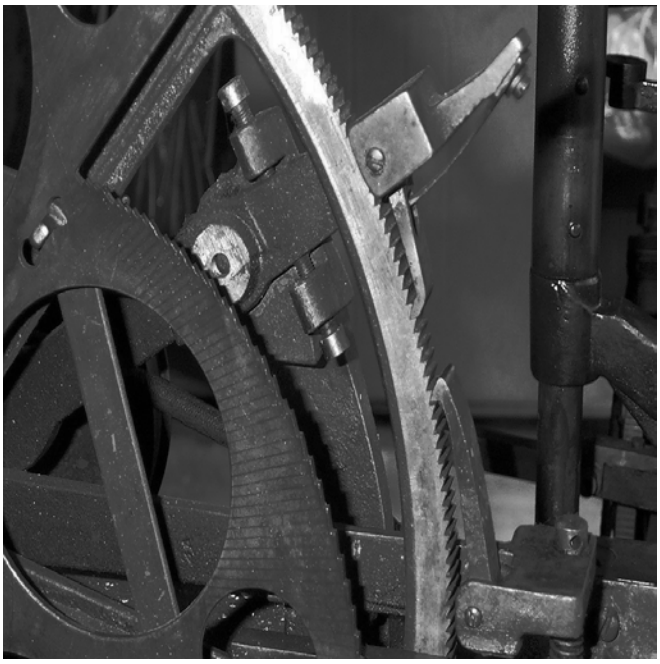


Image 11 - The Logarithmic Cam - Detail 1. Now we get to see the way the machine really works! The large gear is moved downward a very small amount by the upper entry pallet. It has an adjustable travel that is set by the master tool and diemaker, so it always engages the gear properly with each stroke. The lower escape pallet stops the cam from rotating counterclockwise, just like the escapement mechanism in a mechanical clock.

Image 12 - The Logarithmic Cam - Detail 2. This is just another image of the cam showing the differing lengths of the steps in the cam. Note the lines drawn by the master tool and die maker, which were used to lay out the notches on the edge of the cam.

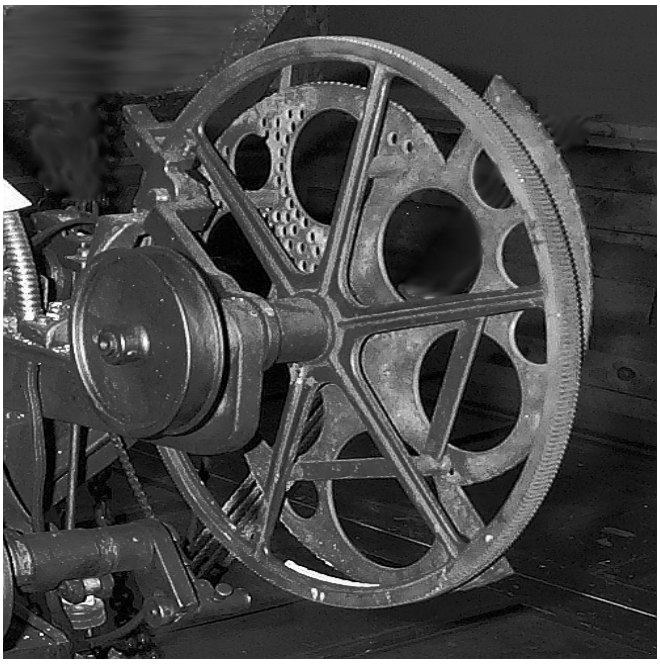


Image 12a - The Logarithmic Cam - Mount. The logarithmic cam and its gear are mounted on an arm that extends behind the base. On the other end of the shaft is a pulley, used to apply braking pressure on the shaft. There is a loop on the back of the dividing engine base, where a belt is attached and the belt goes over the pulley to a hanging weight. This keeps the cam in position when the feedscrew has been turned to the next stop.

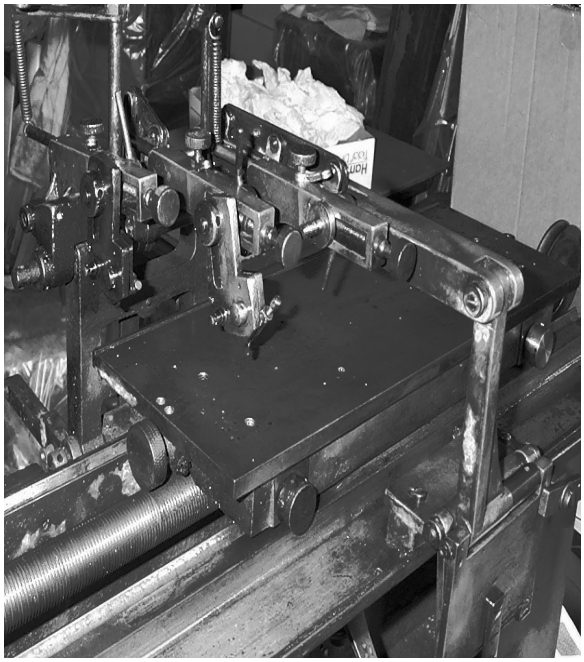


Image 13 - The Cutter Table. The cutter table consists of the pair of brass rectangles at the bottom right

of the image, the arm that rises vertically from the rectangles, and the horizontal arm that goes to the back of the base. There are three cutter mounts shown, two with cutter holders. At the top center of the cutter table, in the rear of the image, is an arm that lifts the cutters for the return stroke. Tension on the cutters is applied by a spring, shown in the far left top corner of the image. Each cutter has this spring setup.

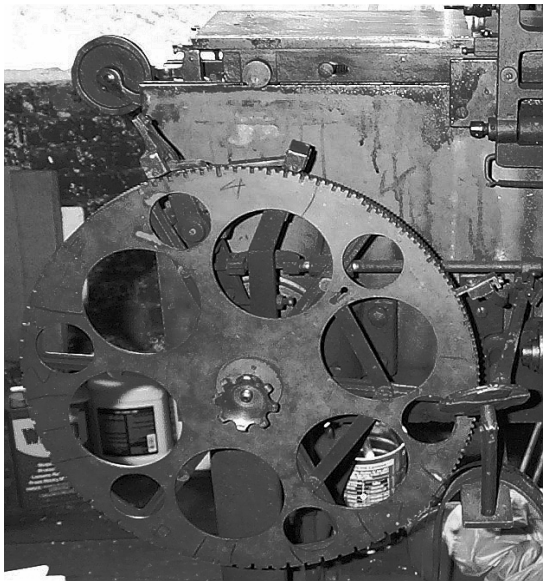


Image 14 - The Engraving Length Cam. This cam has three levels of cuts. First is the surface of the cam, followed by two progressively deeper cuts in the edge. This cam does not drive the cutters. It simply moves the cam follower on the cutter cam to the proper lobe for the cut.

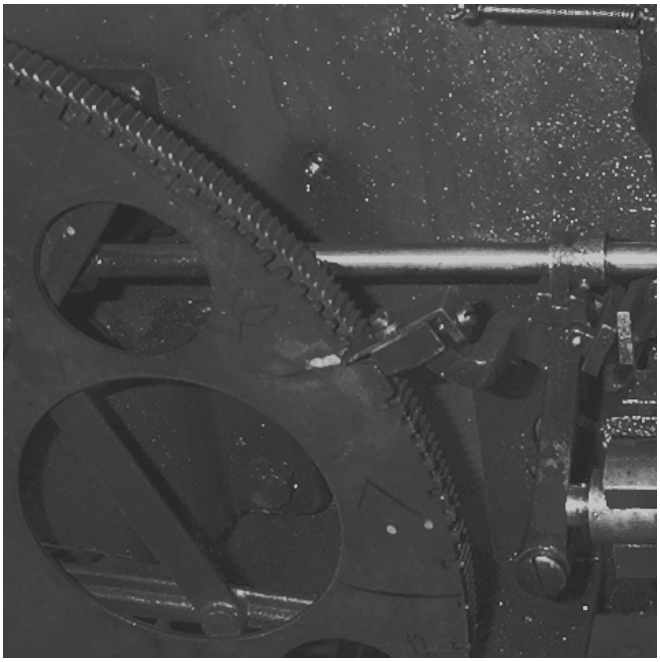


Image 15 - The Engraving Length Cam - Detail. Shown here are the two depths of cuts in the cam, and the cam follower (center of the image) in one of the cuts.

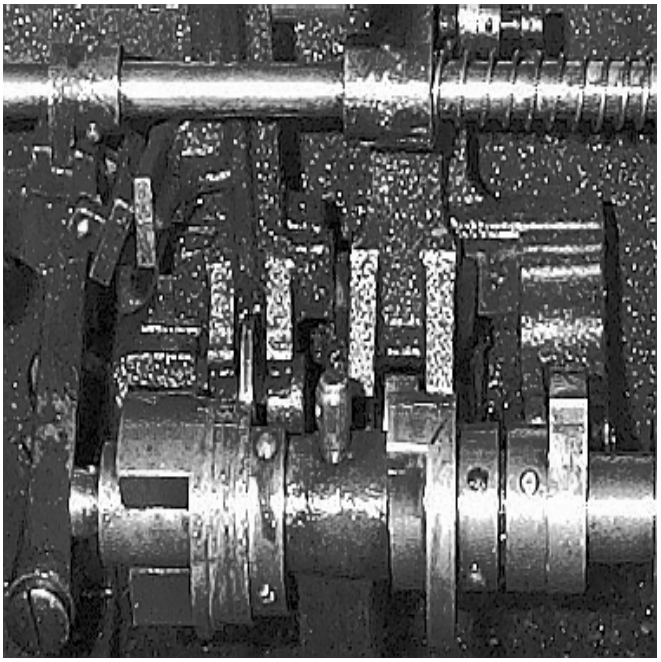


Image 16 - The Engraving Cutter and Return Cams. This image shows the cutter cam, the return cam, and the cutter lifter cam. Can you guess which is which?

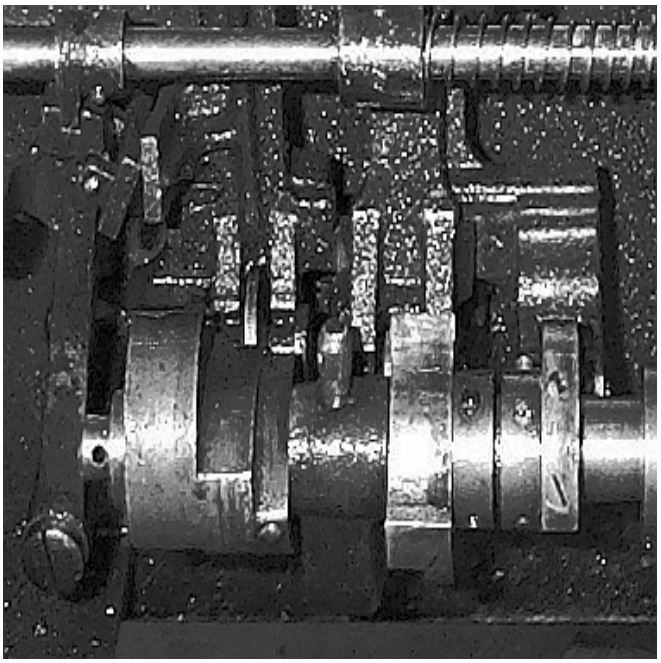


Image 16a - The Engraving Cutter and Return Cams - Another Setting. Here is another setting of the cams to help you figure them out.

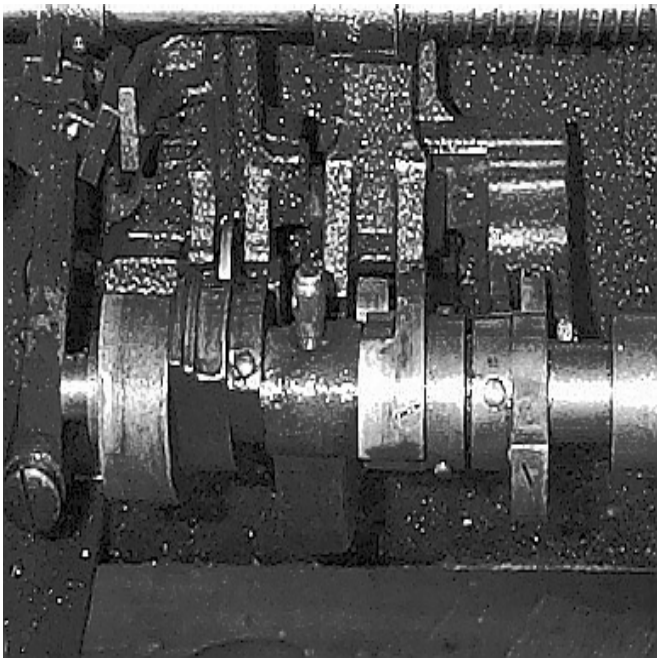
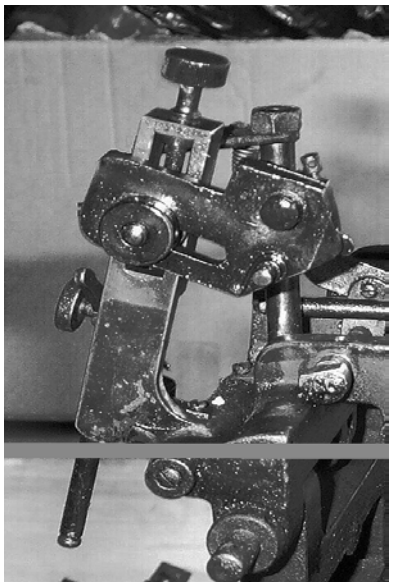


Image 16b - The Engraving Cutter and Return Cams - A Third Setting. By now you should be an expert!

Image 17 - The Cutter Mount - Positioned for Maintenance. At 9 o'clock on the arm is a setscrew used to adjust the depth of the cut. At 12 o'clock is a setscrew to fine-adjust the position of the cutter over the slide rule blank. At 7 o'clock is the spring mount arm, used to attach the tensioning spring. The odd-shaped block attached to the almost vertical arm is the cutter mount itself. It holds the cutter, and the tiny knob at 3 o'clock on the mount keeps the cutter from cutting too deeply into the celluloid.



At this point, the grand tour of this machine is at an end. At some point in the near future, the Keuffel & Esser Logarithmic Dividing Engine will be placed on display near the Browne and Sharpe Linear Dividing Engine in the American Precision Museum in Windsor, Vermont. It is my hope that all who visit New England will make a stop there to look at the machine "in the flesh".