

AN INEXPENSIVE TABLE FOR POLISHING ORES

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Increasing interest in polished section technique has created a need for a suitable machine for polishing ore specimens. Up to the present most of the polishing wheels used in metallographic and mineragraphic laboratories have been of the Sauveur-Boylston type.¹ This consists of two disks approximately 6 inches in diameter which are attached to the projecting ends of the armature shaft of an electric motor. The disks thus revolve in vertical planes. Cloths of different types are fastened to the disks by means of brass hoops. The cloths usually employed are sheeting for coarser polishing powders, such as the finer grades of carborundum or alundum, chromic oxide, and rouge, and billiard cloth for magnesia or "black magnetic rouge." The disadvantages of this type of polishing wheel are:

1. The abrasive tends to fly off the wheel.
2. The effort of holding the specimen against the vertical disk is much greater than with a horizontal wheel.

On the other hand, with the horizontal wheel gravity tends to retain the abrasive and aids the operator in maintaining a steady pressure of the specimen against the cloth.

Horizontal laps are in use in a number of institutions and in most places have been constructed locally.

Machines for polishing specimens are manufactured by a few companies. These are highly satisfactory but are too expensive for most institutions to permit their purchase.

An inexpensive and effective machine was designed and constructed by Professor A. J. Eardley in the Department of Geology of the University of Michigan. This design was modified somewhat by the present writer, and a polishing table was constructed by him in the Department of Geology of the University of Arizona in September, 1935. It has been in use for more than six months and has proved very satisfactory. The present paper describes this polishing table.

The details of the table are shown in Plates I and II and in Figs. 1 and 2 and are largely self-explanatory. The cost of the table completely equipped is about \$110, depending on the cost of labor. As shown in the plans, the table supports two horizontally revolving laps, but a third lap can be installed at an additional expense of about \$30 by increasing the length of the table 12 inches.

¹ Described in Murdoch, J.: *Microscopical determination of the opaque minerals*, p. 19, New York, 1916.

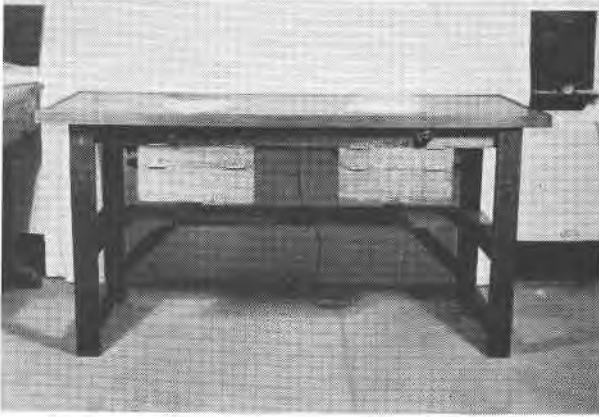


FIG. 1. Eardley-Hatton Polishing Table.

The table proper is of simple wood construction (Plate I) and is made unusually rugged in order to minimize vibration. The table is first constructed and the outside is stained brown and then varnished. The shaft and bearings of each lap are then mounted on two boards $1\frac{1}{2}'' \times 6'' \times 17''$. Details of this mounting are shown in Plate II, Fig. 1b.

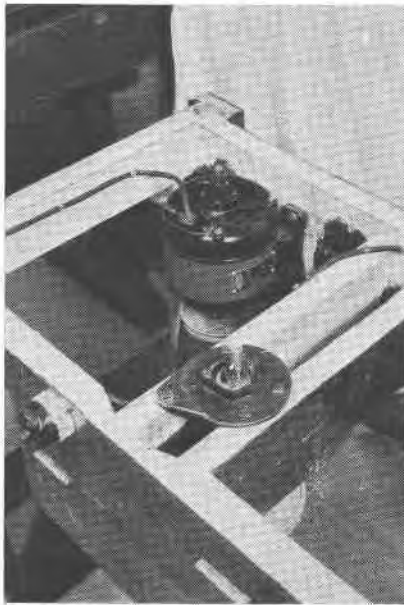
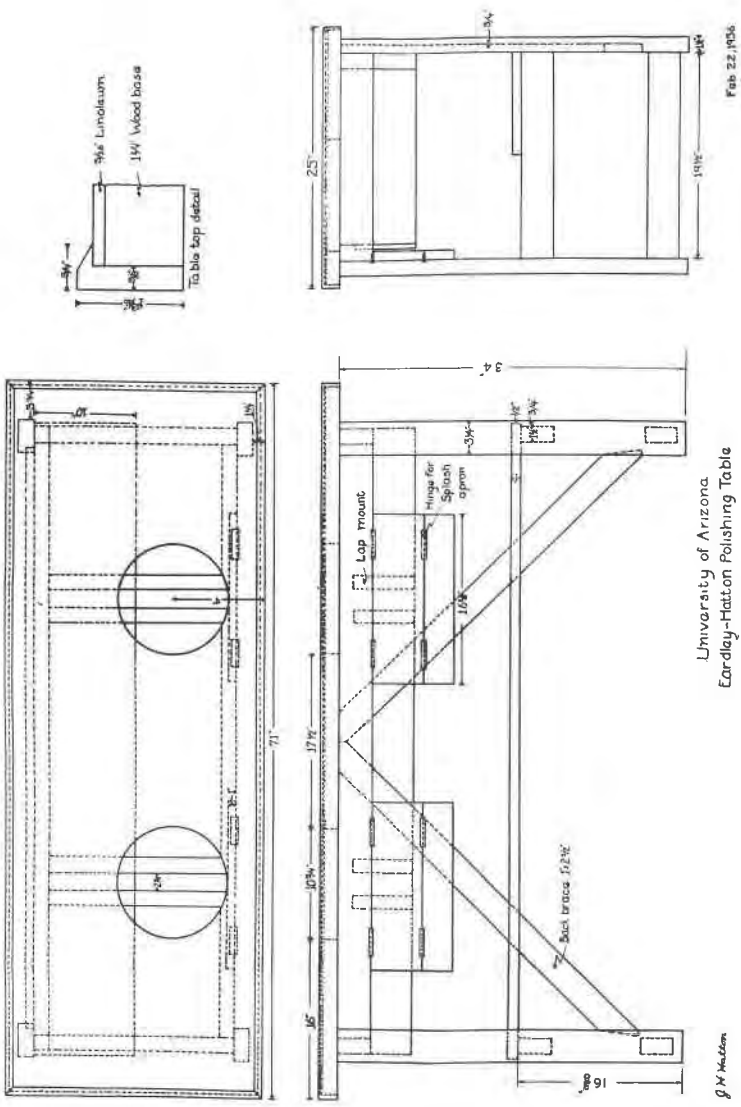


FIG. 2. Details of Mounting



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Eardley-Hatton Polishing Table

PLATE I. Construction of the table.

J. M. Hatton

The bearings are Delco-Remy generator bearings and were designed for the generators of Plymouth automobiles. Only the end plates and bearings of the generator are used. The lower bearing of the table is a simple ball bearing.

The bearing hole into which the shaft fits is made of special hard steel and can be reamed only with much trouble, hence the shaft must be turned so as to fit snugly in the bearing; this has an inside diameter of $43/64$ inches. It was found advisable to knurl that portion of the shaft which fits in the bearing. The upper thrust bearing acts merely as a guide. The bushing is slightly smaller than is necessary for the $\frac{1}{2}$ -inch shaft and must be reamed to fit the shaft.

The catalogue number of the Delco-Remy ball (lower) bearing is 817223; that of the thrust (upper) bearing is 1853830. It will be found necessary to have $5/16$ " holes drilled in the bearing plates in order that they may be readily attached. The holes already present are not suitably located for immediate use.

The bearings are attached to the $1\frac{1}{2} \times 6 \times 17$ " boards by means of $\frac{1}{4} \times 2\frac{1}{2}$ " lag screws. The upper bearing is first screwed onto the boards, the shaft inserted and allowed to hang freely. The lower plate and bearing is centered and attached by similar screws. It is necessary at this stage to have the bearings exactly at right angles to the axis of the shaft, otherwise the shaft will bind, causing wear with attendant vibration of the lap. The life of the bearings will be considerably lessened by any unnecessary wear. After the end plates have been attached, the shaft will bind and the screws must be manipulated. The use of shims may be necessary if it is found that the plates have been slightly misplaced. To test the freeness of the shaft, the lower pulley should be attached and rotated slowly by hand. Tight places will readily be "felt." The shaft, upon being rotated rapidly, should continue its rotation for several revolutions by inertia.

The lap assembly should then be mounted into the table by wood screws at the front and by lag screws at the back. It will be found that the laps have again been thrown out of line and that a "freeing" is again necessary. This may be accomplished by again manipulating the screws which hold the bearing plates. The same tests for freeness should again be applied.

The shafts are provided with a cut-away portion to allow the set screw of the driven pulley to be well seated. At the top of the shaft a cross head pin is placed which fits into the lap. This serves as a safety to prevent all possible slippage.

Individual motors are used to permit independent operation of each lap. The motors are $\frac{1}{4}$ h.p. Kenmore 110-volt A.C. with 1750 R.P.M. and

are supplied by Sears, Roebuck and Co. The driver pulley is 5 inches in diameter and the driven pulley $6\frac{1}{2}$ inches in diameter, the latter turns the shaft 1350 R.P.M. This speed of revolution has been found by trial to be the most satisfactory for a 5-inch lap. A faster speed tends to pull the specimen from the hands and to cause too much abrasive to fly off the wheel, whereas excessively slow speeds prolong the time of polishing. The belts are 42-inch V-shaped fan belts. Pulleys and belts were likewise obtained from Sears, Roebuck and Co. The motor is mounted onto the back of the table in such a position that the slack of the belt is taken up. The belts should not be too tight as centrifugal force would soon cause excessive wear in the motor and lap bearings.

The laps are shown in Plate II, Fig. 5. They are brass castings machined on the upper surface. They can be obtained from the Metallurgical Laboratory of the University of Michigan, Ann Arbor, for approximately \$2.00 each. The laps do not screw onto the shaft but have tapered sockets which fit onto the tapered upper end of the shaft. As all of the laps of this type made at the University of Michigan have the same size of internal taper, the shaft must be turned to fit this socket. Hence it is advisable to obtain one of the laps before having the shafts made, so that the machinist can fit them properly. With a close fit between the taper of the shaft and the socket of the lap, the latter is held sufficiently firm during the polishing to prevent slipping. On stopping the wheel, the lap can be removed almost instantaneously with a moderate upward jerk. The ease of changing laps makes it advisable to keep a lap for each type of abrasive thus eliminating the need for frequent changing of cloths.

Laps of greater diameter than 5 inches are likewise made at the University of Michigan and have the same size of socket as the 5-inch lap and can therefore be used in this machine. However, a larger sized lap necessitates a slowing down of the motor, otherwise the peripheral speed would be greater than that of the 5-inch lap. Larger sized laps are also unnecessarily wasteful of cloth as the cloth must be replaced upon the appearance of the smallest hole or tear.

The splash pan (Plate II, Fig. 3a) is made of sheet metal and can be constructed locally by a tinsmith. It has a drain to facilitate the cleaning of the lap pans. Hoses need not be attached at all times as the operations are not particularly wet. If such is the case rubber stoppers should be used to plug the holes.

Splash pan covers may or may not be provided (see Plate II, Fig. 4). If the laps are not detached from the shafts, they should be covered; but if they are placed in a cabinet when not in use the covers are not

necessary. If the grinding machine is in the same room as the polisher, the covers are an absolute necessity.

A heavy 3/16" linoleum is cemented to the table top and is kept highly waxed. Thus any splashing may be wiped off very easily and this feature contributes much to the appearance of the laboratory.

The top is placed on the table after all other work has been completed and is attached by four 4-inch wood screws, one in each corner post. This allows the top to be removed in a few minutes time to facilitate the oiling of the motors and lap bearings. This should be done once every two weeks at least. Caution must be used so that one does not apply an excessive amount of lubricant as this merely flows into the motor and down on the pulleys. From here it is thrown off to smear the wall or the operator. The splash aprons in front of the table catch most of this excess oil.

The cloth may be attached to the lap in several ways. The first is by use of elastic bands, which fit into the groove at the periphery of the lap. This is a satisfactory method if the bands are tight. However, the cloth may pull loose upon the fatiguing of the bands.

The second method tried is that of the use of a solid spring steel bar which has been bent to fit the lap. If the ring does not fit snugly, small loose places will appear in the cloth. These cause excessive wear and rips, and often pull the specimen from the hand.

The third and best method yet devised is by the use of a 3/16" coiled spring made of No. 20 wire. The spring must be strong but naturally can be considerably weaker than that indicated by the second method. The spring is cut and the ends joined either by wiring, welding, or by the use of a hook and eye. The cloth is easily put on and the wrinkles removed by this method.

Both motors are driven from a central 2-plug base plate. The base plate is fed by a single electrical line thus eliminating one unnecessary lamp cord.

If the laps develop static electricity they should be grounded by a fine copper wire.

COST SHEET

Table (construction and wood).....	\$17.00
2 Kenmore motors, 1750 R.P.M., ¼ h.p. @ \$6.95.....	13.90
2 5" V-type pulleys @ \$.60.....	1.20
2 6½" V-type pulleys @ \$.75.....	1.50
2 42" V-type belts @ \$.60.....	1.20
4 5" laps @ \$2.00.....	8.00
2 switches @ \$.25.....	.50
2 shafts (made to order) @ \$6.00.....	12.00
2 splash pans @ \$2.50.....	5.00

2 generator end plates @ \$1.00.....	2.00
2 generator end plate assemblies (ball-bearing) @ \$5.00.....	10.00
1 base plate—two hole @ \$.50.....	.50
1 plug, electrical.....	.10
15' wire @ \$.10 per ft.....	1.50
10' rubber hose @ \$.10 per ft.....	1.00
2 splash pan covers @ \$1.50.....	3.00
linoleum, 72"×25", 3/16" heavy.....	5.00
1 pt. paste to cement linoleum.....	.25
6' of $\frac{1}{8}$ coiled spring @ \$.20 (for lap cloth retainer).....	1.20
Miscellaneous (nuts, bolts, etc.).....	2.00
Labor for installation, etc.....	20.00
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Total approximate cost.....	\$107.85

The polishing machine is kept in the same laboratory as the microscopes and opaque sections, thus allowing frequent polishings during identification of the mineral.

SUGGESTIONS FOR CONSTRUCTION OF A GRINDING TABLE

A grinding table may be constructed according to the same design as that of the above described polishing table. The grinding laps are usually 10 inches in diameter, hence wider holes must be provided on the table top. If a three-lap table is desired, the entire table should be lengthened 15 inches. This would allow for a distance of $78\frac{1}{2}$ inches outside dimensions between supporting posts and an overall table top length of 86 inches. The lap holes should be cut with their centers $11\frac{1}{2}$ inches from the edge of the table and the holes should be 15 inches in diameter. The centers of the holes should be 25 inches apart.

The grinding laps are metal disks of 1-inch thickness. Brass laps like those used in the polishing machine are used as bases for the disks. The disks are attached to the brass laps by means of lag bolts $\frac{3}{8}$ " in diameter and $7/16$ " long. Four holes are drilled through the brass laps to accommodate four holes similarly placed in the disks. The holes in the brass laps are not threaded but the holes in the disks have threads which fit similar threads at the ends of the bolts. The holes in the disks should not be over $\frac{3}{8}$ " deep so that the life of the disks may be prolonged as much as possible.

Care must be taken that the center of the disk coincides with the center of the shaft, otherwise vibration and undue wear on the bearings will result.

The advantages of this type of grinding machine are:

1. Metal disks are less expensive than large-sized laps which are provided with screw threads or other methods of attachment.

2. Worn or uneven disks may be machined easily.

If only two laps are provided, cast iron is preferable for coarse grinding and wrought iron for fine grinding. The cast iron lap is made by casting a disk of the requisite diameter and thickness, followed by machining of one surface and the periphery. The wrought iron laps are cut from a 1-inch sheet of boiler plate, usually by means of an acetylene torch, followed by machining of the periphery. If the surfaces are not sufficiently smooth, one of them must be machined.

The third lap, if provided, is made of copper and is used for the finest grinding abrasives. Copper laps are used for this purpose at Columbia University and at the California Institute of Technology. Concentric grooves are cut on the surface of the copper to prevent grabbing of the specimen.²

The laps on the grinding table should not be run faster than 750 R.P.M., otherwise the abrasive will not remain on the lap. The best set of pulleys which could be used with the Kenmore motor above described is a 3" driver pulley and a 7" driven pulley.

The writer wishes to express his thanks to Professor M. N. Short of the University of Arizona for encouragement and criticism.

² Directions for cutting such grooves are given by J. W. Vanderwilt: Improvements in the polishing of ores: *Econ. Geol.*, vol. 23, p. 307, 1928.