A Universal ore-polishing machine.

(With Plate XXI.)

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AVAILABLE methods of grinding and polishing ore-minerals, in preparation for their examination with the ore-microscope in reflected light, fall into two categories. The more usual procedure, adapted from the corresponding methods in metallography, involves the use of high-speed laps faced with soft materials and supplied with relatively large quantities of abrasive mixed with water.[1] The advantages of this method are its rapidity (about ten minutes will usually suffice for the whole series of processes), the possibility of using unmounted chips, and the simplicity of the necessary equipment. Amongst its chief disadvantages are the high relief developed between hard and soft minerals in the same specimen and the dirtiness of the process owing to the large amounts of wet sludge produced.

A different kind of process was developed at Harvard University,[2] which dispenses with the use of coarse abrasives and of soft facings on the laps. Instead of a chip, a surface is cut with a diamond saw, and the laps are faced with copper or lead. The disadvantages include the necessity of mounting every specimen, the much greater time involved by the whole process, and the more elaborate apparatus. The advantages, however, to a large extent outweigh these drawbacks; the surfaces prepared are vastly superior for microscopic study, especially in the lack of relief; the mounted specimens are convenient to handle, examine, and store, and are practically indestructible, and the whole process is much cleaner owing to the very small amounts of abrasive employed and to the use of oil instead of

[1] M. N. Short, Bull. U.S. Geol. Survey, 1931, no. 825, pp. 10–17. H. Schneiderhöhn and P. Ramdohr, Lehrbuch der Erzmikroskopie, 1934, vol. 1, pp. 68–84.

[2] J. W. Vanderwilt, Econ. Geol., 1928, vol. 23, p. 292. L. C. Graton, Amer. Min., 1937, vol. 22, p. 491.

water as a lubricant. Moreover, the polishing is to a large extent automatic, so that in a small laboratory the machines can be left running with a minimum of attention on the part of the operator.

In building the machine to be described the main consideration was one of economy, both in initial outlay and in flexibility of use of the complete equipment—the one outfit was required to serve for any kind of polishing process likely to be undertaken. (It may be observed that even material transparent in thin section may sometimes be advantageously examined in polished and etched surfaces; considerable use of this method has lately been made in the study of Portland cement clinker.[1]) The general arrangement is shown in pl. XXI, fig. 1.

Cloth-faced laps for rapid polishing require to be driven at speeds of the order of 1000 r.p.m., whilst the metal laps must revolve at about one-tenth of this speed. A $\frac{3}{4}$ h.p. 3-phase motor, running at 700 r.p.m., is fitted with a double pulley of 3 and 6 inches diameter. The drive is taken to a similar double pulley mounted on the input shaft of a motor-bicycle gear-box, and the output is taken from another 3-inch pulley over jockeys on the bench to a 4-inch pulley beneath the left-hand lap. On a direct drive, a lap speed in excess of 1000 r.p.m. is thus available, whilst reduction by changing the belt in conjunction with a 3 to 1 ratio in the box gives a lap speed of less than 100 r.p.m. A number of intermediate speeds can be obtained by different arrangements of the belt in combination with intermediate gear ratios. The general design of each lap is readily understood from text-fig. 1. The $\frac{7}{8}$-inch steel spindle runs in two ball-races, the upper of which is a combination journal- and thrust-bearing; the laps, $7\frac{1}{2}$ inches diameter, are held by a $\frac{7}{16}$-inch bolt running through the spindle and furnished below the driving pulley with a large knurled knob. This arrangement has been found in practice to be much more convenient than any of the usual coned bearings and similar devices—the laps are firmly held, yet instantly detachable. The pan is an aluminium casting 9 inches diameter bolted to a $\frac{3}{8}$-inch steel plate, and is furnished with an aluminium guard-ring and a drain for the removal of sludge. A brass collar brought up just to clear the lower surface of the lap affords adequate protection to the bearings.

[1] B. Tavasci, Giornale di Chim. Indust. ed Appl., 1934, vol. 16, pp. 538–552. (Abstract in Zeiss Nachrichten, 1936, 2 Folge, Heft 1, p. 32.) H. Insley, Journ. Research Nat. Bureau of Standards, U.S.A., 1936, vol. 17, pp. 353–361.

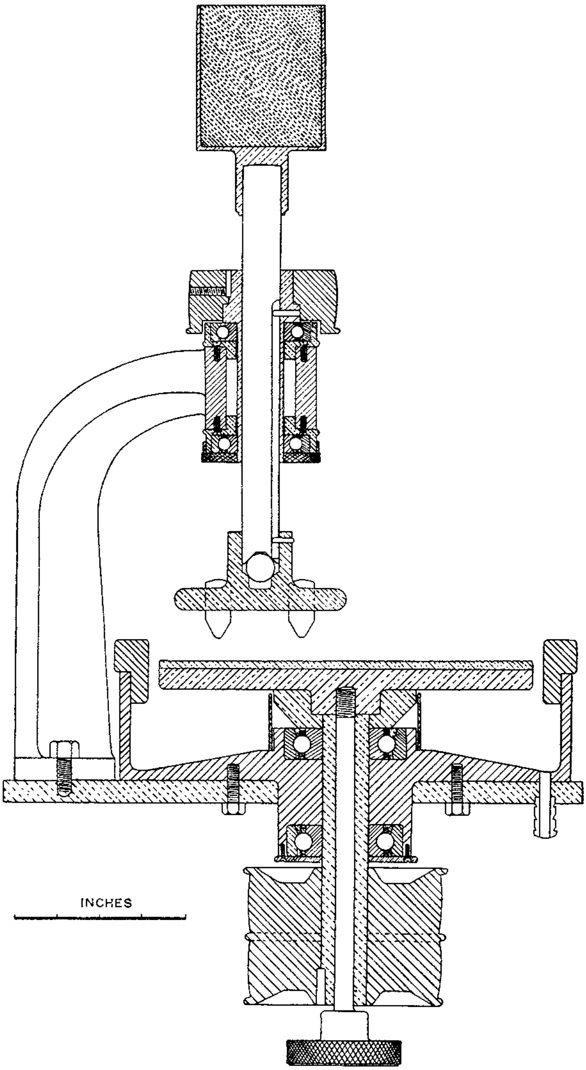

Fig. 1. Universal ore-polishing machine. Part-sectional elevation of lap and head for automatic polishing.

The heads for automatic polishing are carried on cast aluminium brackets bolted to the steel plates. A ¾-inch steel shaft is keyed to slide in a steel sleeve to which the driving pulley is attached, and ball-races are again used here. After some experimenting with different methods of holding and driving the specimens, it was found that the best results were obtained with a simple arrangement closely resembling that originally described by Vanderwilt. A brass plate carries three driving pins, adjustable to the heights of the individual specimens, and these rest in conical depressions moulded directly in the backs of the mounts. The lower end of the driving shaft rests on a steel ball above this plate, the drive being effected through a second key. The specimens are thus left free to bed individually on the laps and also to revolve about their own axes, and completely satisfactory results have been obtained without the added complications necessary to impart a positive axial spin to each specimen. The sliding shaft is loaded by lead weights fitted over its upper end; an added weight of about 12 lb. has proved generally satisfactory. The heads are driven from an intermediate shaft bolted to the wall, which is itself driven from a pulley beneath the right-hand lap; a belt beneath the table conveys the drive from one head to the other. The diameters of the pulleys are such as to impart a final speed to the heads of about twice that of the laps, the rotations of the head and lap in opposite senses being secured by twisting the intermediate belt. Driving throughout is by 1-inch flat belt, and to avoid unnecessary vibration all the belts are sewn and fitted with tensioning pressers contrived from ball-bearing bicycle hubs.

Four laps are in general use, one faced with copper (thick sheet copper soldered to the gun-metal casting) and three with lead (cast directly in the lap tinned to receive it). On the copper lap graded alumina averaging 0·02 mm. diameter is used, on the first lead lap 0·01 mm. alumina, and on the second lead lap prepared Dujardin alumina. The third lead lap is used for magnesia or rouge, though it has frequently been found possible to dispense with this final stage, the specimens coming off the second lead lap with a completely satisfactory polish. The method of charging the laps and the use of the oil lubricant have been fully described by Vanderwilt. The graded alumina is prepared from the commercial product by grinding and subsequent elutriation in a series of syphons;[1] experience has shown that the precise grade of abrasive used on the first lead lap

[1] J. W. Vanderwilt, Econ. Geol., 1929, vol. 24, p. 853.

is specially important; if too coarse, the subsequent polishing is rendered unduly difficult, whereas too fine an abrasive at this stage will begin to polish projecting parts of the surface without removing the deeper pits left after treatment on the copper lap. The motor which drives the stirrer of the elutriator is conveniently fitted with a light lap faced with billiard cloth and running directly at 1400 r.p.m., for use in quick polishing by hand.

The mounts are 1½ inches diameter, and are moulded in a small electrically heated press, the plunger of which is turned with a conical projection to form the depression in the back of the specimen in which the driving pin rests. The moulding material employed is Black Rhodoid Powder, 4016 R.K.B.,[1] a plastic material made from cellulose acetate. The press is turned in brass throughout, and has given entirely satisfactory results, thus avoiding the more difficult mechanical work involved in grinding and case-hardening steel.[2] It is wound with about 30 ohms of resistance wire laid between layers of asbestos paper, and passes 3·5 amps. when run off a 200-volt main through an intermediate variable resistance. Pl. XXI, figs. 2 and 3, show the assembled press and the component parts. In use, the cut chip is placed face down on the brass base of the press and the body of the press is fitted above. A measured amount of the moulding material is poured in, and lightly tamped down; the plunger is inserted and the press is lightly screwed home until resistance is felt. The current is then switched on for five minutes, after which the press is screwed further until a strong resistance is again felt. The current is cut off and the whole apparatus allowed to become quite cold. The specimen can then be ejected without difficulty by mounting the press on an auxiliary ring;[3] a slight smearing of talc on the inside surfaces before each mount is made makes ejection still easier.[4] If the chip is friable or porous it is impregnated with Bakelite resin R. 0014[5] and cured before moulding.

It is a pleasure to acknowledge my indebtedness on many points of design to Mr. A. N. Lanham, who is also entirely responsible for the construction of the machine.

1 Supplied by Messrs. May & Baker Ltd., Dagenham, London.
2 P. Krieger and P. H. Bird, Econ. Geol., 1932, vol. 27, p. 675.
3 H. C. Fuller, Econ. Geol., 1933, vol. 28, p. 393.
4 P. B. Myers, Econ. Geol., 1934, vol. 29, p. 502.
5 Supplied by Bakelite Ltd., Tyseley, Birmingham.

EXPLANATION OF PLATE XXI.

A Universal ore-polishing machine.

FIG. 1. General view of the machine. The motor is on the floor behind the table, and the gear-box on the left.

FIG. 2. The mounting press.

FIG. 3. The parts of the press, showing the electrically heated body, plunger with conical projection, plunger cap, a mounted specimen, base of press, and ejecting ring.

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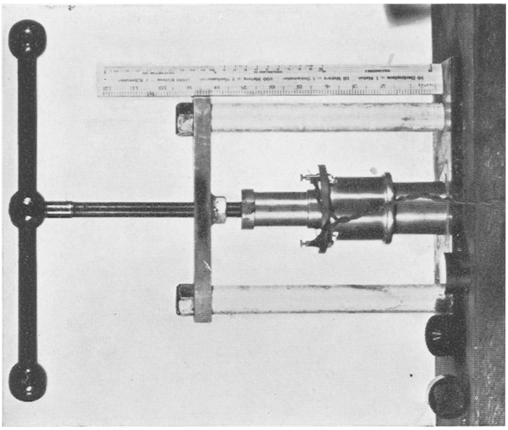

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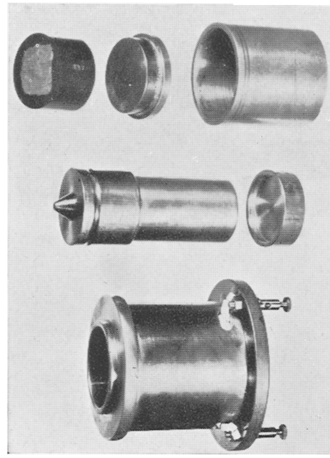

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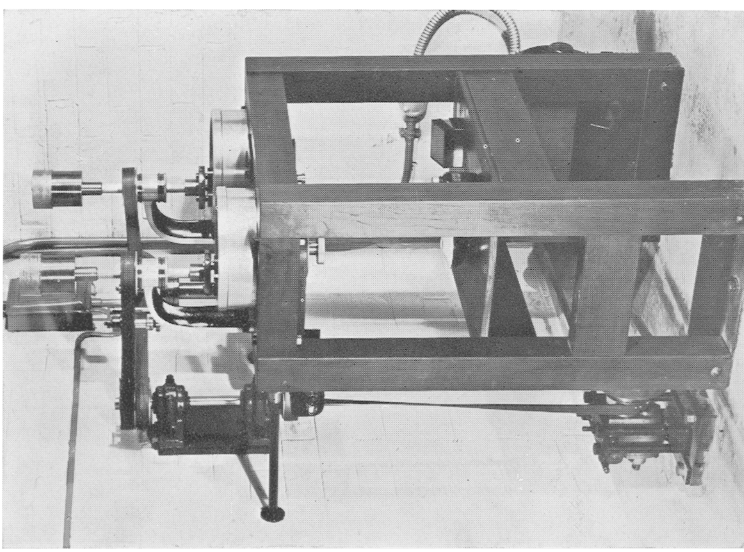

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