antimony, elements not easily excited, were found only in spark spectra.

The author, in concluding, wishes to acknowledge the helpful suggestions of Dr. G. R. Harrison and Dr. W. H. Newhouse.

NOTES AND NEWS

A ROCK SAW

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Many laboratories are equipped with either a diamond saw or a thin carborundum wheel for cutting small specimens of minerals or rocks but very few are equipped to cut specimens 3 inches or more across. Believing that this subject may be of interest to mineralogists and petrologists I shall describe an inexpensive and mechanically simple rock saw adapted from the "gang saw" used extensively in the marble industry. In the field office, of the Section of Metalliferous Deposits of the U. S. Geological Survey, at Golden, Colorado, this saw has proved itself very useful for cutting both large and small specimens.

The following does not imply that the power bandsaw used in larger laboratories is not an effecitve tool for sawing rock. The fundamental principle, that is the use of loose abrasive and a moving smooth blade of metal, is similar to that of the "gang saw" and even the hardest kind of rock can be cut. Undesirable features of a power band saw are that its cost is too high for many small laboratories, readjustment of specimen against saw blade is necessary every half hour or so, and that it scatters abrasives about the room. None of these objections can be made against the saw described.

Cutting with a "gang saw" is effected by loose abrasive dragged back and forth across a rock under the edges of a series of soft metal blades with the motion of a hack saw or hand wood-saw. In a single operation a "gang saw" cuts blocks of marble several feet across into a series of slabs. For our purposes only a single cut is necessary and therefore only a single metal blade is used, otherwise the operation is essentially the same. The principle employed is quite simple and can be applied in a number of mechan-

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ical ways. The particular set-up which I used is described in some detail in order to bring out the results obtained as well as the difficulties encountered. The mechanical arrangement can be made more elaborate or simple to suit one's desires for convenience of operation and expense of construction.

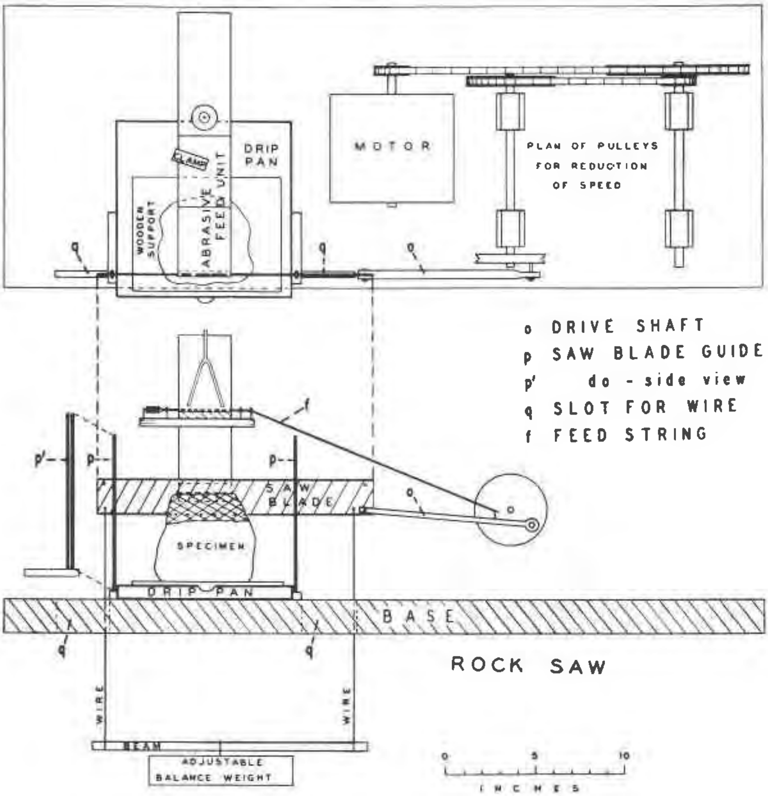

FIG. 1. *Above:*—Ground plan of motor, pulleys, shaft for driving saw blade, and position of specimen. *Below:*—Side view showing position of saw blade held in guides with respect to specimen, and the unit above the saw blade for feeding the abrasive.

The arrangement of the various parts of the saw is shown in figure 1 drawn approximately to scale. The plan and dimensions shown can readily cut specimens of any size up to 7 inches across and 5 inches high. It is evident that by enlarging certain obvious parts of the machine specimens of a larger size can be cut.

The saw blade moves with a horizontal 3 inch stroke at the rate of 100 to 150 per minute and is driven by a $\frac{1}{4}$ h.p. motor. The relatively low speed was chosen because with it, if anything should go wrong, less damage would occur and there would be no tendency for the abrasive to be scattered about the room. It is also believed that a slow rate of cutting is offset by the corresponding small amount of personal attention that is required. Experimental work was not done with different speeds or lengths of strokes. The

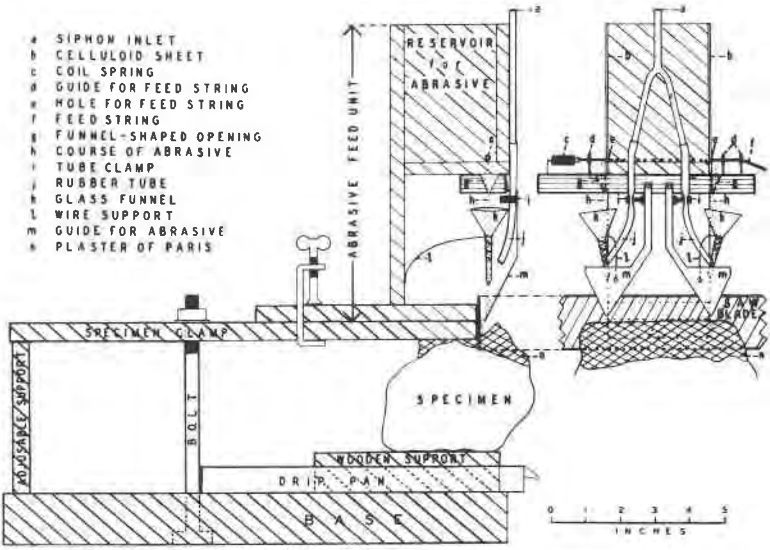

FIG. 2. Front view—*right*—and side view—*left*—of feed unit for abrasive and water showing its position with respect to the specimen, specimen clamp, and saw blade. The continuation of the feed string *f* is shown in fig. 1.

approximate rates for making saw-cuts 7 inches long does not seem to be materially greater than for cuts 2 or 3 inches shorter. The approximate speed of cutting is:

	Per Hour
Silicified wood and beryl	$\frac{1}{4}$ inch
Basalt and granite	$\frac{1}{2}$
Calcite and fluorite	1
Sandstone	1 to 2
Sulphide ores (depending on gangue)	$\frac{1}{2}$ to 1

Since the saw will operate all day with little or no attention these rates of cutting are considered very satisfactory.

The saw blade is a strip of 16 gauge sheet iron, 17 inches long and cut about 2 inches wide to give it stiffness. After one side of the blade has worn enough to cause the blade to ride unevenly, it can be turned and the other side used. The saw blade must be straight and it is essential to hold it in line with guides. Each guide is made with two $\frac{1}{4}$ inch rods, spaced the width of the blade, and set in a metal stand which is bolted to the base. The connecting rod is a stick of wood with a slot at one end in which the saw blade is held by a small bolt, and the other end of the connecting rod is attached to an eccentric fitted with a small ball bearing (from an old generator of an automobile). The connecting rod must move in line with the saw blade and, if the bearing does not hold it so, it will be necessary to add guides for this purpose.

Some pressure on the saw blade is necessary for effective cutting. This is obtained by means of a weight (2 to 5 lbs.) suspended from a beam held by wires attached to each end of the saw blade (see fig. 1). The weight is shifted to a position that will cause the saw blade to cut down evenly and to maintain it in an approximately horizontal position or one sloping slightly away from the eccentric; otherwise the blade will begin to ride unevenly and eventually stick. This adjustment of the weight ordinarily requires a little attention at the beginning of a "cut" before the saw blade has had time to seat itself. The difficulty in starting the "cut" can be overcome if, instead of using weights to hold the saw blade, it is held in tension by means of a coil spring attached to a standard (spring and standard not shown in diagram) at the end of the saw opposite the connecting rod. A rigid frame could no doubt be devised to apply pressure to the saw in a manner similar to that of a power hacksaw which would require little or no personal attention.

Number 80 mesh carborundum is used. As stated in the opening paragraph cutting is effected by an abrasive which is dragged across the rock under the edge of the saw blade. In addition to the abrasive a small amount of water must be added which acts as a lubricant and also washes out the fine powder that forms during the cutting of a rock. Cutting is most efficient when the abrasive and water are added at a controlled and even rate. This proved more difficult to accomplish and caused more trouble than any other feature connected with the saw. Too much abrasive and too little water permit the abrasive and rock powder to pack and clog under the saw blade with an inevitable decrease in the rate of cutting. Similarly an excess of water, since it tends to flush the abrasive out too fast, retards the rate of cutting. After a certain amount of experimenting, a feed unit was developed as shown in figure 2. It is not as complicated as it may appear in the diagram. The unit is fastened to the clamp holding the specimen in order that its relative position to large or small specimens may be the same. The sides of the reservoir for the abrasive are sheets of celluloid about 2 mm. thick. A string about 1 mm. in diameter is passed through two holes (*e* hole for feed string—size exaggerated in the diagram) opposite each other and through the celluloid. The holes are slightly larger than the string and as the string is pulled through them abrasives will be dragged out. One end of the string is fastened to the connecting rod (fig. 1) which at each stroke pulls the string in one direction. The other end of the string is attached to a small coil spring, fig. 2, which returns the string after each pull given by the shaft. The to-and-fro motion of the string pulls abrasive through the holes first from one side and then from the other. Guides (*d*) are necessary to hold the string in line in order to prevent the holes in the celluloid from being enlarged by wear. The abrasive passes through the funnel-shaped opening and glass funnels, falling on the guide for the abrasive. The glass funnels can be adjusted by means of their flexible wire supports and the guides of thin sheet iron can be bent to direct the abrasive where it may be needed. Water drips on the guide and washes the abrasive onto the saw blade. The amount of abrasive used is regulated by adjusting the length of the feed string, and the flow of water (generally a slow drip) is controlled by means of the clamps on the rubber tube.

The position of the specimen and the manner in which it is clamped in place is shown in fig. 2. The clamp is a soft board held by a bolt. It is necessary to have the clamp nearly horizontal since the feed unit rests on it, and this can be readily done by matching the adjustable support to the height of the specimen. A drip pan or some means to confine the water and abrasive is necessary for cleanliness and a pan fitted with a lip to drain off the overflow was found to be very convenient.

The saw blade wears most directly over the center of the specimen and for this reason it is necessary to have a wooden support to hold the specimen well up in order that the edges of the drip pan may remain clear of the saw blade. In fig. 2, plaster of Paris as shown is not always essential but is convenient for making a drain to direct the abrasive and water towards the saw blade. Without such a drain the abrasive is just as apt to spread away from as to move under the edge of the blade. Plaster of Paris is also very convenient to fix a specimen of irregular and uneven shape in a desired position. It is also very satisfactory for mounting several small specimens so they can all be cut in one operation.

The cost of the equipment used for the saw amounted to about $17.50 which includes: a $\frac{1}{4}$ h.p. reconditioned motor, $6.00; 2 power bench-grinder shafts, $5.50; and the V-pulleys with belts, $3.50. All these items can be ordered from mail order houses or establishments dealing in machine shop supplies. The drip pan and guides for the saw blade, made to order in a tin shop, cost $2.50. The saw blades of 14 to 16 gauge sheet iron cost 4 to 6 cents each. Several other small items used are odds and ends that were available in the laboratory and their cost if they had to be purchased would add relatively little to the expense. The time required to assemble the saw if calculated as hired labor would add materially to the cost of the machine. The expense of operation is not great. With proper adjustment about one pound of abrasive and about 5 kilowatts of electricity are used during a 10 hour period, which brings the cost to about 5 cents per hour. It is practical to wash and clean the abrasive, thus reducing the cost of operation.