A GEM CUTTER'S HANDBOOK

Specialized Gem Cutting

By JACK R. COX

A Gem Cutters Handbook —

SPECIALIZED GEM CUTTING

By Jack R. Cox

And the Staff of

GEMS and MINERALS Magazine

This is the second in the *Gem Cutters Handbook* series. The chapters originally appeared as monthly features in GEMS AND MINERALS Magazine. The first book of the series is *Cabochon Cutting* which covers the type work with which many rock hobbyists start. After the hobbyist has learned to cut cabochons proficiently, he often wishes to go onto more specialized work such as that covered in this book.

Also included are three chapters on tumbling which is a favorite with both beginners and advanced rockhounds. For the hobbyist who wishes to make his work more efficient and convenient, there is some up-to-date information in the chapter on the use of diamond abrasives.

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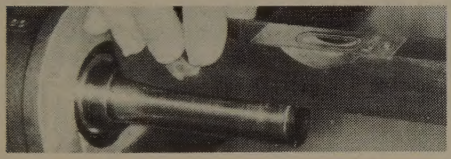
GEM CUTTER'S HANDBOOK

SPECIAL SLAB SAW TECHNIQUES

In addition to cutting slices from rough gem material, the slab saw may be used for special purposes such as cutting blocks for book ends or cubes from which spheres may be made. Sawing cubes and blocks involves right angle cuts. It's not difficult if you use the techniques that advanced hobbyists and professional cutters have developed. In some cases, you can make simple jigs that will greatly facilitate the process.

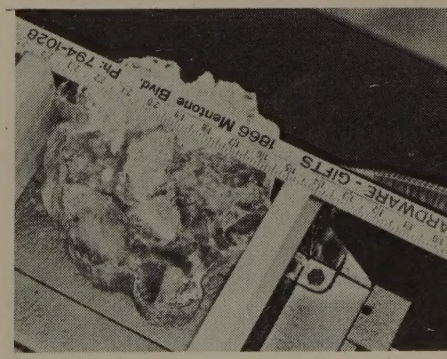
Cutting Book Ends

An excellent professional method of cutting blocks for book ends involves the use of a carpenter's level and a straight edge. The prime prerequisite for this technique is that the *saw arbor must be level.* This may require that you place shims under some of the machine's legs. When you are sure that the arbor is absolutely level, you have a basis for making perpendicular cuts.

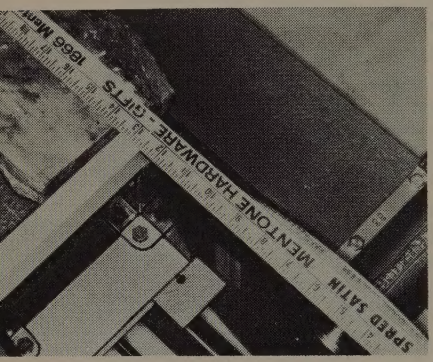


The first step in cutting a book end is to select the side that will produce the most attractive pattern. Study the material for desirable patterns and markings. When you have made your selection, lay a carpenter's square on the chosen side. Then make an "L" shaped mark that indicates where to make the cuts for (1) the bases of the book ends, (2) the sides that will face the books.

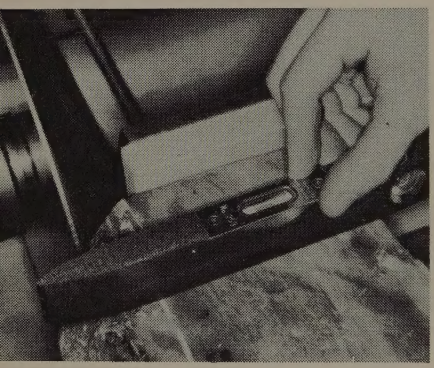
Clamp the rock in the slab saw vise so that the mark for the base cut runs parallel to the path of the blade. To make sure the mark is aligned, crossfeed the vise to the correct position. Then lay a straight edge along the mark and the blade. If it is not correctly aligned, loosen the vise, twist the stone until properly adjusted, and reclamp. Turn on the saw and make the first cut.



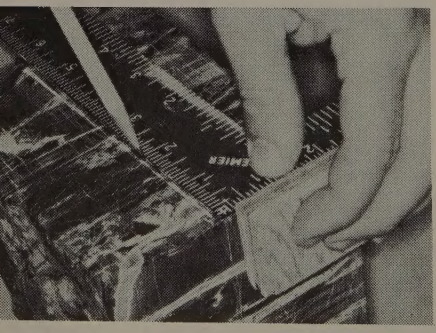
After the base cut has been made, remove the stone from the vise. With a straight edge, extend the remaining mark around the corner and across the newly sawn surface. You will saw along this new line.



Place the stone in the vise with the flat surface at the top. Again, the line across the top should run parallel to the path of the blade. Adjust the cross-feed and check the alignment of the blade and mark with a straight edge. Position the stone for correct alignment, and tighten the vise jaws just slightly.

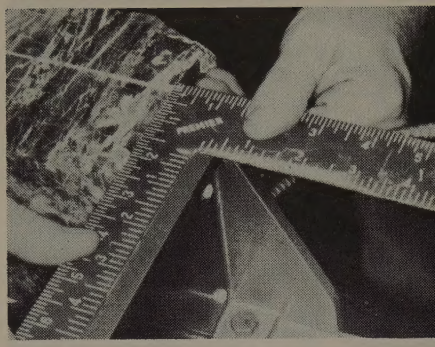


To make sure the second cut will be perpendicular to the first, place a level on the stone's flat surface, with the sides of the level parallel to the saw's arbor. Push or tap the stone until it is perfectly leveled. Then, tighten the vise and make the second cut.

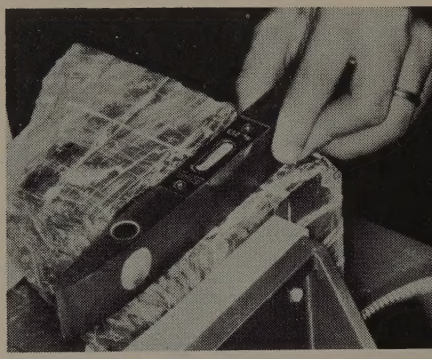


You are now ready to make the cut that will split the block into two matching pieces. Remove the stone from the vise and, with a square, make a mark, along one of the flat surfaces, that divides the block into halves.

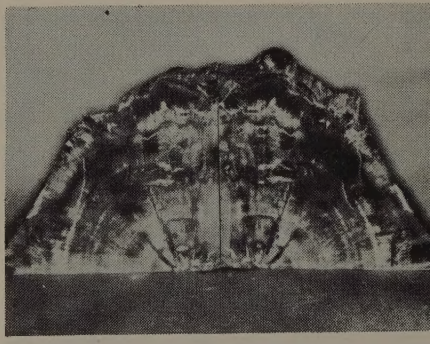
Position the stone in the vise so that the marked flat surface is against the leading vise jaw. Clamp it lightly. If the vise jaws are true, the leading flat surface will be perpendicular to the blade. Check this with a square. If the surface and the blade are not perpendicular, you can insert shims between the stone and vise jaws to make it so.



Place the level on the block once more. Level the stone by pushing or tapping, and then clamp the vise jaws securely. The combination of leveling and making the leading flat surface perpendicular to the blade will assure that the final cut will be at right angles to the first two. Adjust the crossfeed if necessary, and make the cut.

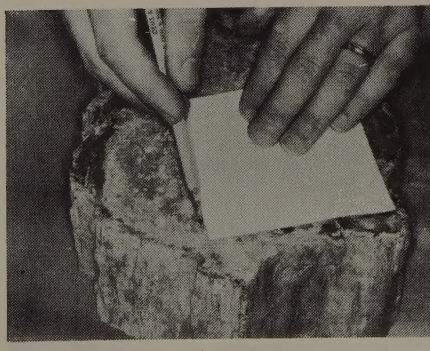


This technique will yield a pair of perfectly matched book ends. When the flat surfaces are polished (finishing flat surfaces will be covered in a subsequent section) they make very attractive ornaments.

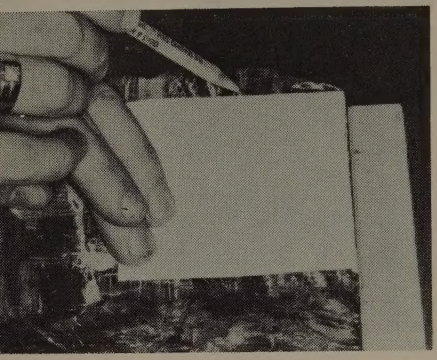


Sawing Cubes

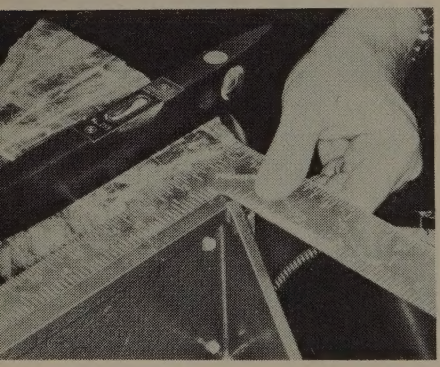
A stone cube makes an attractive ornament or paperweight. Cutting a cube is also the first step in making a preform for a sphere. The sawing procedure is similar to that used in making book ends. The first step is to study and measure the rough stone to determine the size cube you will cut. Make a template of the correct size in the form of a perfect square. Use this template to draw an "L" shaped mark on the stone.



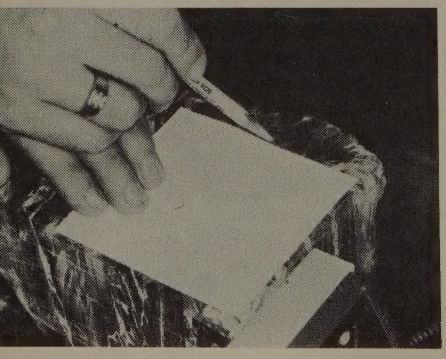
Make the first two cuts just as you would in sawing book ends. Line up the leg of the "L" with the blade and saw. Remove the stone from the vise and extend the other leg of the "L" around the corner and across the freshly cut flat surface. Reclamp the stone in the vise, line it up with the blade, level and make the second cut.



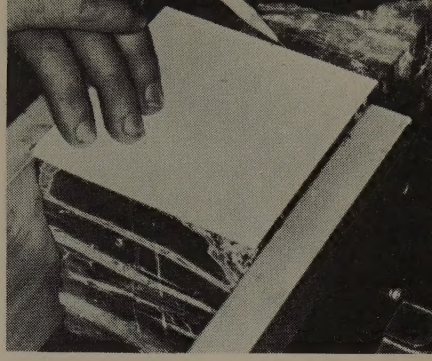
The third cut is made the same as the splitting cut on book ends except that it runs along the edge of the block instead of through the middle. Remove the stone from the vise and clamp it lightly with one flat face against the leading vise jaw and the other surface at the top. Lay the template on the top with one edge against the leading vise jaw. Position the template so that all corners are within the surface of the stone. Check to make sure that there is enough room for the square to be cut and then mark around the template. Use a square to make sure the stone's leading edge is perpendicular to the blade. Level the top surface and tighten the vise securely. Adjust the crossfeed and make the third cut.



After the third cut, loosen the vise jaws just enough to make the stone movable. Do not remove the stone, but rotate it 90 degrees. Lay the template on the top surface with one edge against the leading vise jaw and an intersecting edge flush with the edge of the stone farthest from the blade. Make a mark perpendicular to the vise jaws along the template edge nearest the blade. Make sure the block is level and perpendicular to the blade. Clamp tightly and make the fourth cut. Repeat this process and make the fifth cut.

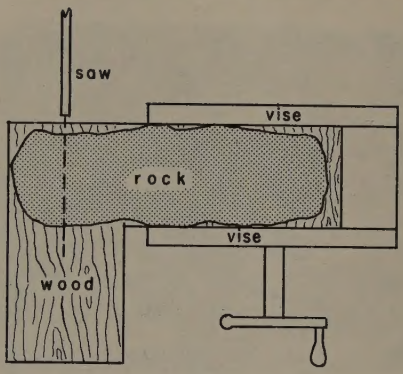


Remove the stone from the vise and turn it so that the one remaining rough side faces the blade. Place it back in the vise and clamp lightly. Again, place the template on the top surface with two sides against the jaws and one side flush with the edge of the stone farthest from the blade. Make a mark along the rough side. Position the stone so that it is perpendicular to the blade and level. Clamp tightly and turn on the saw to make the last cut. You will now have a perfect cube with all faces intersecting at right angles.

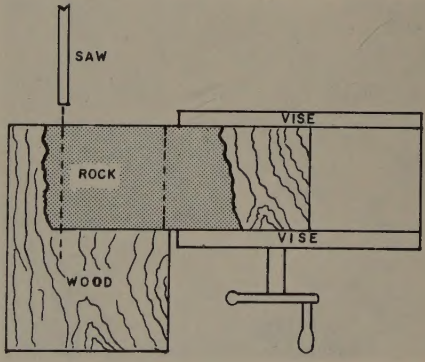


A Helpful Jig

Just before a cut is finished, the stone usually breaks off leaving a small projection on one of the sawed surfaces and a pit on the other. If the pit is in a surface to be finished, it forms an unsightly blemish. This problem can be solved by placing an L shaped piece of ½ inch plywood in the vise beneath the stone. Make the projecting leg of the "L" longer than the stone's width. Saw through the stone and plywood. As the cut is completed, the plywood supports the stone so that it does not break off.

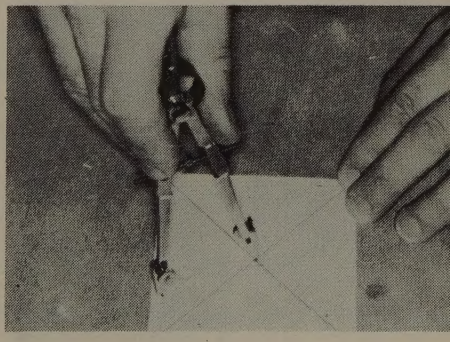


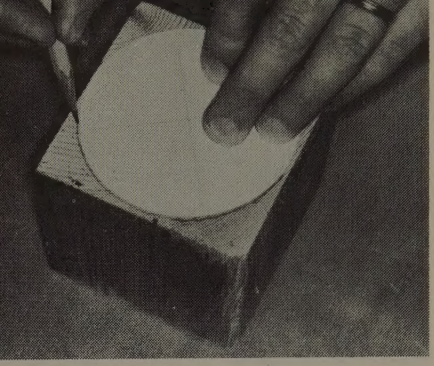
The drawing above also illustrates an alternate method of cutting book ends or cubes. If the stone is long enough, you can saw two parallel faces. After these two cuts you can clamp the stone in the vise with the flat face perpendicular to the blade. Another cut will be at right angles to the first. You can then rotate the stone 90 degrees and follow the usual proceedure of making it perpendicular and level.



Preforms for Spheres

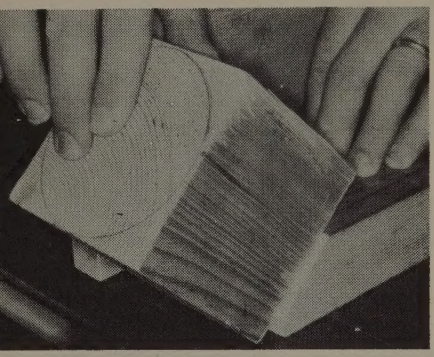
A cube for a sphere preform does not have to be perfect. Try to cut the sides at right angles, but squaring and leveling are not absolutely necessary. When the cube is cut, check it with the square template. If any side of the cube is smaller than the template, reduce the size of the cardboard square until it fits the smallest stone surface. Then draw cross lines from the corners of the square.



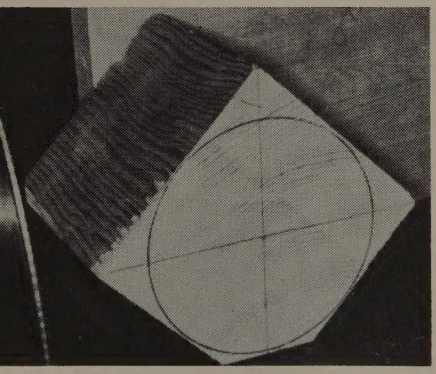


Where the cross lines intersect, place the point of a compass and scribe a circle with a diameter the same as the width of the square. Cut out the circle and lay it on a face of the cube. Mark off the corners that are to be sawed away. (In lieu of the cardboard template, some sphere makers use circular objects such as jar lids.)

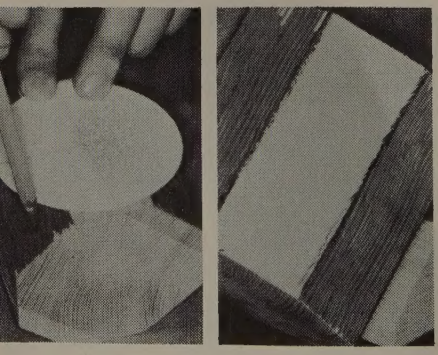
Note: For the sake of clarity, wooden blocks were used as models for the photographs of sphere preforms.



Make a wooden wedge with one side at 45 degrees to the other. Lay this wedge in the bottom of the saw vise. Place the cube in the vise with one side resting on the wedge and the marked side against the leading jaw. Make sure the corner projects far enough from the vise for the blade to cut it off. Clamp the vise and adjust the crossfeed to align the mark with the blade. Saw off the corner. Cut a little outside the mark; if you saw to the inside, your block will be cut too small.

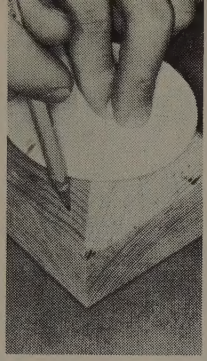


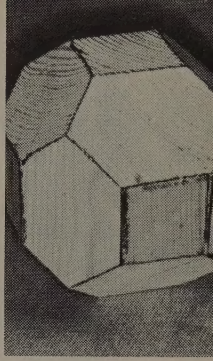
Loosen the vise and rotate the cube counter-clockwise 90 degrees. The sawn corner now rests on the floor of the vise; the wedge is no longer needed. Make the necessary adjustments, clamp the vise and cut off the next corner. Repeat this process two more times, and the four corners will be removed.



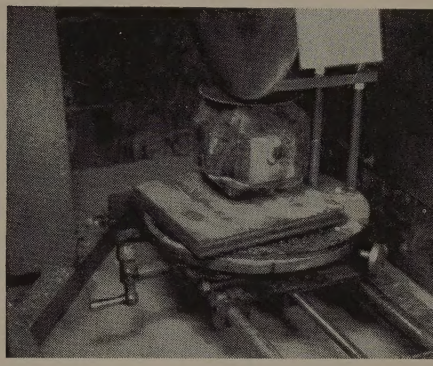
There are now two more planes from which corners must be cut. Remove the block from the vise and mark off the corners of the next plane. Place the wedge and the stone in the vise and saw off the four corners as before. Be sure the marks and cuts are not inside the area of the circle.

Remove the stone from the vise and mark off four corners on the remaining plane. Saw off these corners in the same manner. When finished, you will have an eighteen sided block. In a subsequent chapter we will describe how this block is made into a sphere.



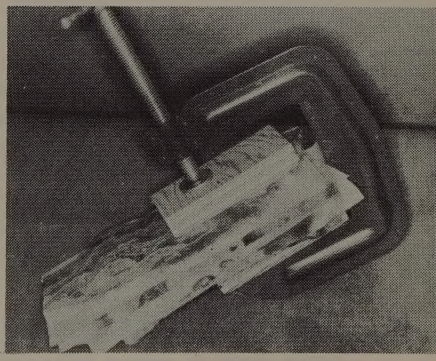


Some advanced sphere makers use overhead saws to cut preform blocks. This saw has an indexed vise carriage. With this device five successive cuts may be made without removing the rock from the vise.

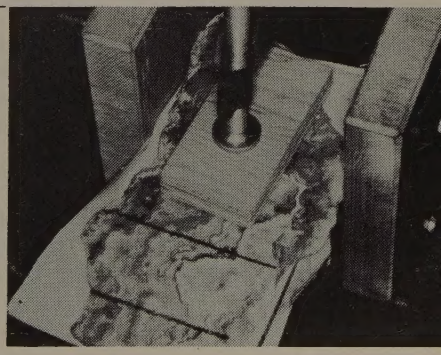


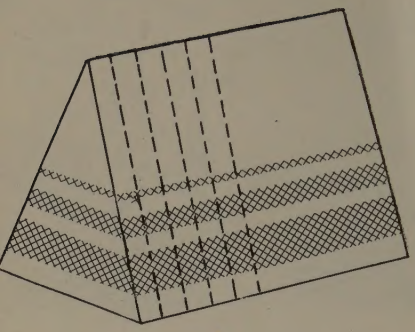
Gemstone Preforms

It is sometimes desirable to cut a quantity of preforms of the same size. Some cutters saw various geometric shapes which they then finish in a tumbler. One method of making preforms is to lay up a stack of slabs with a piece of paper between each slab. The paper acts as a cushion. Place strips of wood on each side of the stack and clamp them all together with a C clamp.

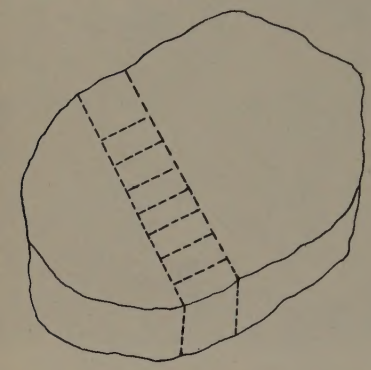


Place the stack in the vise and clamp. You can make a series of horizontal cuts which will yield strips of the same width. These strips can be clamped in the vise and sawed in the other direction to yield identical rectangles. *Note: if the slabs are too small for the vise to grip, the stack can be clamped between pieces of hardwood that extend beyond the edges of the slabs. Then grip the hardwood in the vise jaw.*





A triangular block of stone will make preforms for earrings, pendants, etc. For accurate angles you can use a wooden wedge as you would in cutting the corners from the sphere preform. When the block is cut, clamp it in the vise so that you can cut triangular slices from it. If you are cutting banded material, try sawing it with the bands running across the lower portion of the triangle. It's more attractive that way.



Rectangular preforms may be sawed from thick slabs. Clamp a stone in the vise so that you can saw a slab with two parallel sides. From this slab you can saw a strip with a square or other rectangular cross section. Slice uniform preforms from this strip.

Orienting The Saw Cut

Much gem material has patterns and inclusions that enhance the beauty of the stone. In many instances it is necessary to orient the material so that the cut will display these patterns to best advantage. Before you clamp a stone in the vise, study it to determine which direction you should cut to bring out the pattern. If the material has a rind or the patterns do not come to the surface, you will have to grind off some of the outside or make an exploratory cut. To save material, remove only a thin slice. This cut may indicate that the material must be clamped at another angle for the best pattern display.

Petrified wood is often cut with the grain. However, certain petrified limb sections that show ring growth are best cut across the grain. Banded stones such as calcite onyx should be cut across the bands or diagonally across the banding. Materials such as Montana and Texas agates have inclusions that resemble trees, ferns or plumes. Saw parallel to these patterns. If the surrounding agate is clear, try to leave a thin layer over the inclusions. This prevents the softer inclusions from undercutting when the material is polished. When sawing tigereye for cat's-eye gems, cut parallel to the band of chatoyant fibers; for different effects, try sawing across the bands on a bias.

Caution

In sawing the corners off sphere preforms and similar operations, the blade must start into an angling surface. Feed the carriage very slowly at first to make sure the blade will not be deflected and damaged.

GEM CUTTER'S HANDBOOK

FINISHING FLAT SURFACES

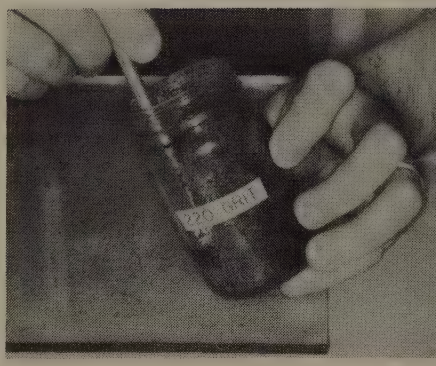
Stone book ends, pen stands, and flat specimens for display are popular items with rock hobbyists. Finishing a perfectly flat surface on a piece of stone is not quite as easy as finishing the domed surface of a cabochon. However, with patience and practice, the technique can be mastered without difficulty. If you wish to eliminate a blemish in the stone, the entire surface must be ground away to the bottom of the blemish.

Flats are finished on a hard surface with loose silicon carbide grit, or on sanders covered with abrasive cloth. The loose grit method, known as *lapping*, is the most common. It can be done by hand, or there are power driven machines for the purpose. A check through manufacturers' ads reveals various types of lapping equipment — horizontal lap units, slab polishers, and automatic vibrating and oscillating machines.

Flats are usually finished from stones that have been slab sawed. It's much easier if they are cut on a true running saw. If the saw leaves marks, these must be ground away.

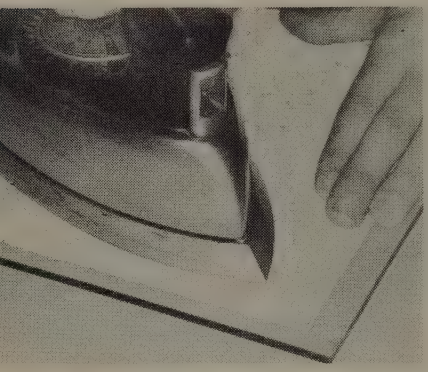
Hand Finishing

Mix silicon carbide grit with an equal volume of water in a jar or glass. The grit is available in grain sizes of 46, 60, 80, 100, 120, 220, 320, 400, 600, 800, 1200, and 1600. The larger the number, the finer the grit. Many hobbyists begin with a coarse grit such as 80 or 100. Experts advise starting with 220 or 320. It takes longer, but the abrasion is not so harsh, making it easier to get a good finish.

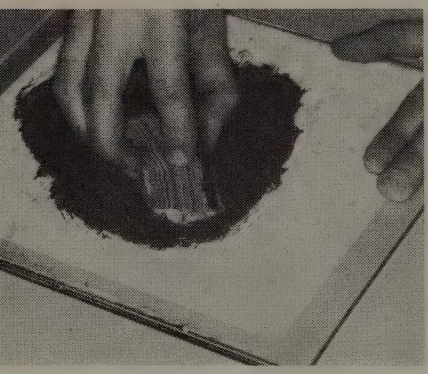


Brush some of the grit mixture on a piece of plate glass, and rub the stone on it vigorously with a circular motion. Rub for several revolutions clockwise, then the same amount counterclockwise. Work across the entire surface of the glass to avoid grooving it. Allow about 5 to 10 minutes for each square inch of stone. When this step is finished, any saw marks, bumps or grooves should be eliminated. The surface should have an even, smooth texture.

Before proceeding to the next grit, everything must be scrupulously cleaned. Keep a bucket of water and detergent for this purpose. Scrub the stone, the glass, and your hands to remove every particle of grit. Be sure to clean under your finger nails. A piece of coarse grit carried to the next lapping step can cause scratches. It is best to use separate pieces of glass for each grit. Be sure to use separate jars and brushes. When everything is clean, repeat the lapping process using 600 grit, clean, and lap again with 1200 grit. Allow at least 15 to 20 minutes per square inch.

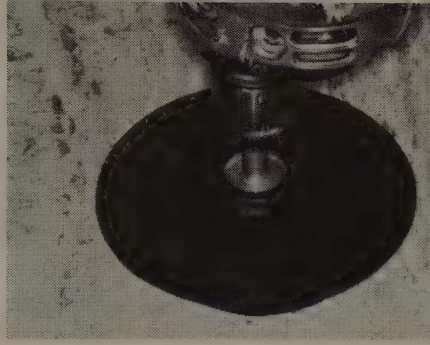


A power driven buff is best for polishing the flat surface (see polishing section). If this is not available, a buff can be made by nailing material, such as leather, felt, canvas, carpeting, or corduroy to a board. A more satisfactory polishing surface can be made from vinyl floor tile. Rough up the *smooth* surface of the tile with sand paper. Apply waterproof tile cement to a piece of glass and press on the tile, freshly roughened surface next to the glass. The tile has a serrated back which will be the polishing surface. Press down the tile with a electric iron set on moderate temperature. Set aside for three or four days until the cement is completely dry. To polish, wet the serrated surface thoroughly with a detergent and water solution. Allow to dry. Moisten once more and sprinkle with Linde A, tin oxide, or cerium oxide. If you are using one of the oxides, try mixing a little Linde A with it. Let dry. Then moisten slightly, and rub the stone vigorously on the tile. When a good polish appears, wash the stone. From time to time, rough up the surface of the tile with a knife or hack saw blade.



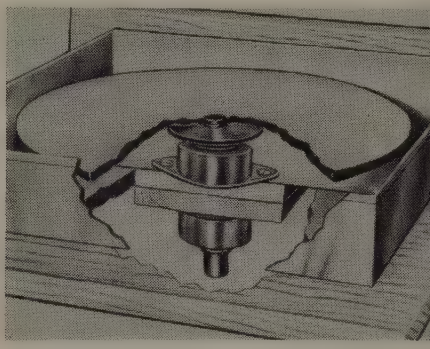
Flat surfaces may also be finished using silicon carbide abrasive cloth tacked to a block of wood. The handle of a used scrub brush works well for the block.

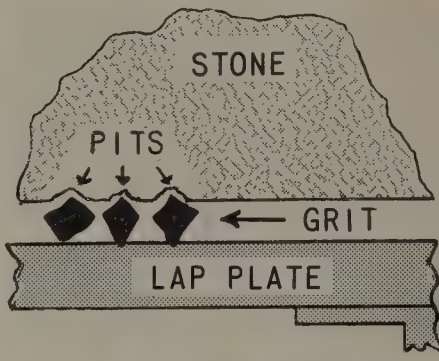
Carpenter's electric vibrator or rotary sanders may also be used for flats. Use lapidary silicon carbide cloth. Work across the entire surface of the stone. It is almost impossible to get a perfectly flat surface this way, but for general display purposes, the surface will be flat enough. For polishing, a buffing material such as leather, felt or canvas can be used with the sander.



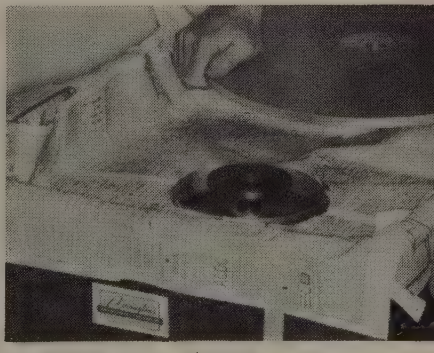
Horizontal Lap Units

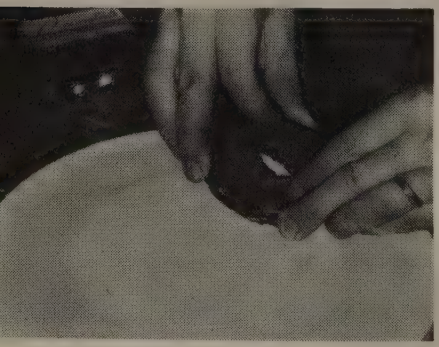
A horizontal lap unit is basically a vertical shaft, shaft bearings, a circular metal disc, known as a lap plate, and a pan or tub. These components are available mounted in a chassis or as kits which may be assembled on a bench. The lap plate is most often made of cast iron or mild steel. These metals are preferred because the grit can imbed itself in them. Plates are available with perfectly flat surfaces or slightly tapered from center to periphery. The theory behind the tapered plate is that the vacuum created by the paste of thin grit is eliminated. Some cutters feel that it is easier to get a flat surface with a tapered lap. Mixtures of equal parts of silicon carbide grit and water are used on the lap. The grit does not scratch or plane away material. As shown in the drawing, it actually digs minute pits all over the stone's surface. A progression of finer grits is used to wear away material and smooth the surface.





Again, absolute cleanliness is necessary. Coarse grit must not be carried to finer lapping procedures. To eliminate a lot of cleaning labor, line the pan of the lap unit with several layers of newspaper. When you have finished using one grit, peel away a layer of newspaper, and you will have a clean surface for the next step.





Saw marks, if any, and blemishes should be ground away in the first lapping. For hard stones, such as agate, 80 or 100 grit may be used. This large size grit digs fairly deep pits; therefore, experts who work for mirror-like surfaces advise starting with 220 grit. Soft stones should not be lapped on grit coarser than 220. The unit should be run at approximately 250 revolutions per minute (rpm). Start the motor and brush some of the grit and water mixture on the revolving plate. Grip the stone securely and apply it to the plate. To avoid grooving the plate, sweep the stone from the periphery to the center of the plate, continually rotating it. With flat plates, you can sweep the stone from edge to edge with 220 or coarser grit. Scratches often result when the plate becomes dry, producing friction which can cause bits of stone to chip off and scrape across the surface of the rock. This is eliminated by keeping plenty of the grit and water mixture on the plate at all times. To help the grit get under the stone, you can apply more pressure on the stone's trailing edge. When marks on the stone are ground away and there is a smooth surface, clean the plate, stone, and hands thoroughly. Repeat the lapping process with 400, 600, and 1200 grit. Be sure to keep the plate moist at all times.

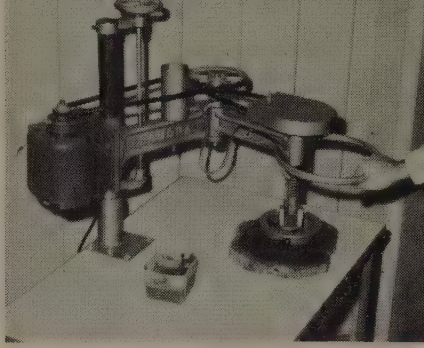
Flat surfaces may be polished on hard felt wheels, muslin, disc, or drum buffs. Discs are available that thread on lap unit shafts. Canvas, felt, leather, and carpeting are favorites for flats. The plastic material, Pellon, is said to give a lustrous finish.

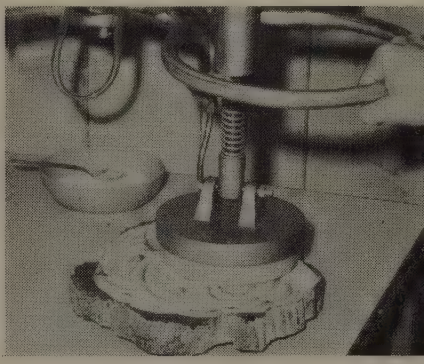
Mix some polishing compound and water to the consistency of cream and brush it on the buff. Polish the stone using plenty of pressure. Apply more pressure on the trailing edge so that the leading edge does not dig into the buff.

Overarm Slab Polishers

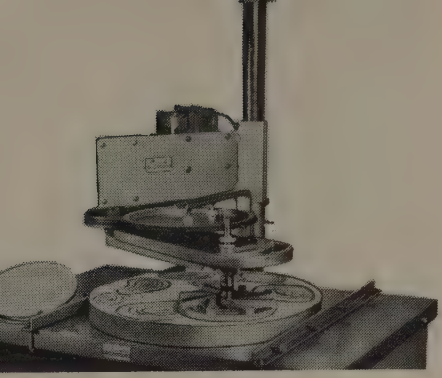
The arbor on this slab polisher is mounted on a jointed arm. For grinding, a plate is attached to the arbor. Grit and water are mixed and spread across the slab's surface. The arm is lowered with an adjusting device until the plate rests on the stone. Then the motor is turned on and the rotating plate is swept back and forth across the slab. The entire surface must be covered, including the edges. Use the same progression of grits as in regular lapping. Make sure the marks from the previous grit are completely removed before advancing to the next grit. After each grit, clean everything thoroughly. Some lapidary experts favor this machine because considerable pressure can be applied for faster cutting.

When the surface is completely lapped, remove the grinding plate and clean off every bit of grit. Attach the polishing head. Mix polishing compound and water and spread over the stone. Turn on the motor and polish. When a gloss appears, let the polish mix get almost dry so that heat will develop for a final glassy polish.

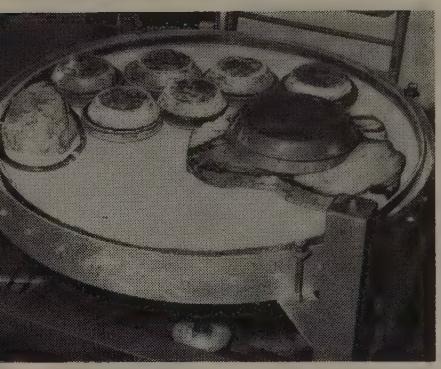




Several smaller stones can be finished together on a slab polisher. A metal ring or wooden frame is needed. Lay the ring on a sheet of glass, formica or other surface (not wood). Arrange the stones in the ring so that they are at least ¼ inch apart. Mix casting plaster and water to the consistency of thin cake batter. With a large spoon, carefully ladle plaster into the spaces between the stones. Mix more plaster and smooth gently onto a stone in the center. It will flow out to the ring's edges. Do not pour the plaster; it will flow under the stones. Use a straight edge to level the plaster, and let set until completely dry. Then turn over the casting, and grind and polish the stones as you would a single large slab.



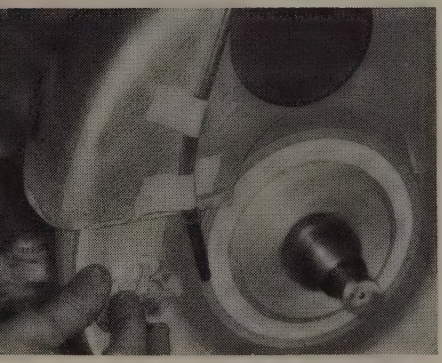
This slab polisher will automatically polish a ring of stones set in plaster. It can also be used manually to lap and polish large slabs. To remove stones from plaster, allow it to dry. Then tap gently on the reverse side until one stone breaks loose. The rest can then be freed easily. To remove delicate stones, cut notches in the plaster. Soaking in hot water will loosen the plaster that clings to the stones.



Stones are also lapped and polished automatically on machines sold under names such as Vi-Bro-Lap, Exy-Lap, Vibrating Flat Lap, Rociprolap, Orbit-Lap, etc. Here, the stones are placed in a vibrating or oscillating tray. They are lapped with grit on a plate, and polished on a pad. Each manufacturer supplies instructions for the grits and polish compounds to use, length of time for each step, etc.

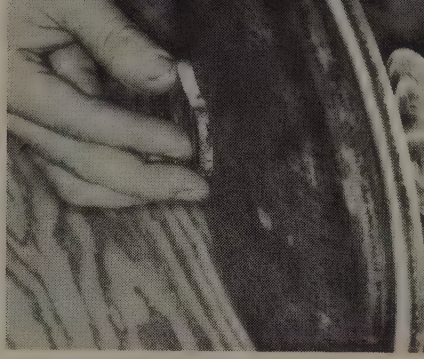
Alternate Methods

Small flat surfaces may be ground on the sides of grinding wheels. An adequate supply of water is necessary to keep the stone from cracking. If your grinding equipment does not supply enough water, a tube may be attached to the side of the splash shield so that it will direct a stream against the wheel. Attach the other end of the tube to a circulating pump or to a can for a gravity flow. If the stone is quite rough, first grind it as flat as possible on the periphery of the wheel and finish up on the side.

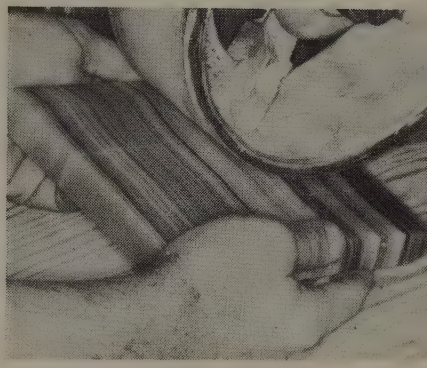


The small flat can be smoothed on a drum sander. Start with 220 grit, then use 320 or 400 and 600 grit cloth. Some professional cutters sand on fairly new, dry, 220 grit cloth, and then on a well worn 220 dry cloth. Medium pressure is used. It is easier to keep the surface flat with a large diameter sander because the sander's curvature is not so pronounced. Be careful that the stone's leading edge does not dig into the sanding cloth. It will flip the stone out of your hand.

A disc sander may also be used to sand small flats. Although it has been done, it is very difficult to sand flats on flat discs; the paper on the cushion tends to sand only the edges. A convex disc reduces this problem. When the stone has been smoothed to a glossy surface, polish it on the buff you use for cabochons. In polishing, apply pressure to the trailing edge so that the leading edge does not snag the buff.

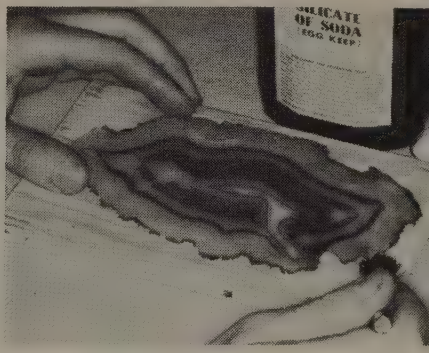


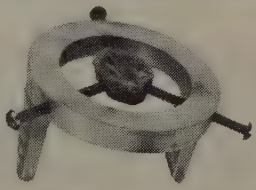
A leading professional cutter sands large flats on drum sanders. He first laps the stone with 220 grit on a lap plate or slab polisher. He sands it on new 220 grit dry cloth, then sands again on well worn 220 grit dry cloth. Wet cloth may also be used (220, 400 and 600 grit). The stones may be polished on your favorite buff. With this method it is virtually impossible to obtain a *perfectly* flat surface, but it is hard to detect the imperfection. It's speedier than lapping.



Helpful Hints

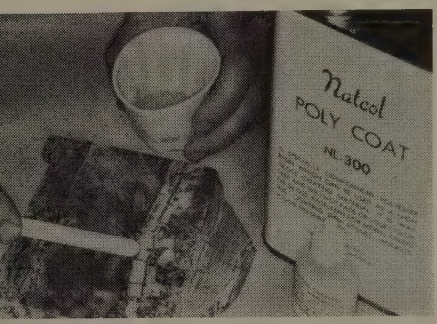
Thin slabs are difficult to hold for lapping. The problem increases with smaller grits because the fine mixture creates a vacuum between stone and lap. It's helpful to attach the slabs to a larger object. A block of wood works well, or you can use a large piece of stone on which a flat surface has been sawed. The larger stone dissipates some of the heat which might cause the thin stone to crack. The slabs can be attached with sodium silicate (water glass) or some water soluble adhesive. To remove, soak in warm water. Dop wax may also be used. First heat the stones by placing them in warm water and bringing it to a boil; then dop.





For holding nodules or slabs, there is a variety of grippers and clamps on the market. Slabs of regular thickness can also be handled and manipulated with greater ease if wooden drawer pulls are cemented to them.

It is often difficult to determine if a flat has been lapped enough with one grit, especially the first. Before lapping, try marking the entire surface with a piece of aluminum or brass. Make sure the marks get into all crevices, saw marks, and other blemishes. When the stone is thoroughly lapped, all the marks will have disappeared.



Many stones, especially large ones, have pits, some of them quite deep. To lap the entire surface down far enough to eliminate these pits is a long process. Instead of grinding them away, the pits can be filled with plastic resin. Heat the stone by setting it in the sun or under a heat lamp. Then catalyze the resin per the manufacturer's instructions and brush it onto the stone. As the stone cools, it will draw the resin into the pits. The stone's surface, with the filled pits, can be lapped and polished.

For two reasons, the lap plate should be kept moist: (1) If it becomes dry, friction generates heat which can pop out pieces of stone, The pieces of stone will scratch the surface of the flat. (2) As the mixture dries, a vacuum is created that "grabs" at the rock.

As more water is added to the grit mixture, it tends to sling off the plate. Some cutters add cornstarch, soap chips, bentonite, or one of the commercial preparations such as Covington "Old Miser" to the grit mixture. The additive and grit are mixed to a thick paste which adheres to the plate. Other cutters apply a thin coat of warm beeswax to the plate for holding the grit.

Geodes and stones with crystal cavities make attractive specimens when lapped. To protect the crystals, pack the cavity with damp soap powder or cornstarch. Allow the powder to set and then lap and polish. To remove cornstarch, soak the stone in water. Soap powder can be removed by boiling in water.

Soft stones such as calcite onyx are difficult to polish because they scratch easily. After lapping with 600 grit on power equipment, hand lap them on a piece of plate glass with 1200 grit.

Eventually grit may become imbedded in the lap plate which can cause scratches. It can be removed by scraping the plate with a razor blade.

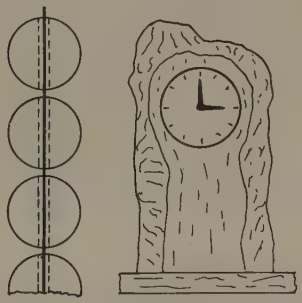
Heat speeds up the polishing of a flat. Try setting the stone under a 100-watt bulb for five minutes, and then polish.

GEM CUTTER'S HANDBOOK

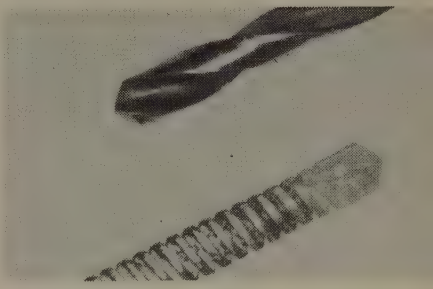
DRILLING GEMSTONES

A machine for drilling gemstones is a handy piece of equipment. With it you can put holes in pendant stones so that a pegged bail or eye mounting can be attached. A hole can be cut into the face of a cabochon to mount an emblem or smaller stone. A drill is needed for bead-making. With large tube drills you can cut preforms for rings, bracelets, circular buttons and other shapes. Drills are required for making stone clock cases, circular paperweights, and a multitude of other uses.

Gems can be drilled on machinists' drill presses or with special drilling units produced by lapidary equipment manufacturers. One form of drilling employs metal drill tubes and abrasive grits. For faster drilling, diamond impregnated drills are used.

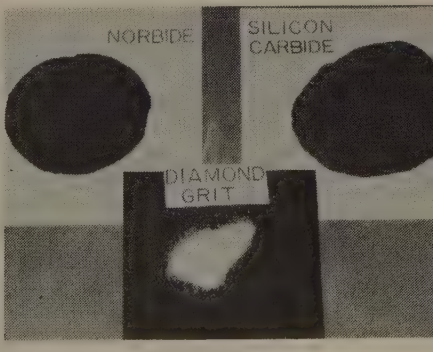


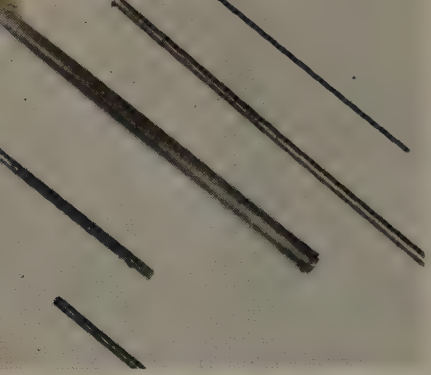
Very soft stones such as howlite and alabaster can be drilled with regular steel twist drills. Use a coolant such as soluble oil, or if the stone will stain, use copious quantities of water. For larger holes, masonry drills may be used. These are available in varying sizes, qualities, and prices. They should not be used on small fragile stones because they chip their way through the material.



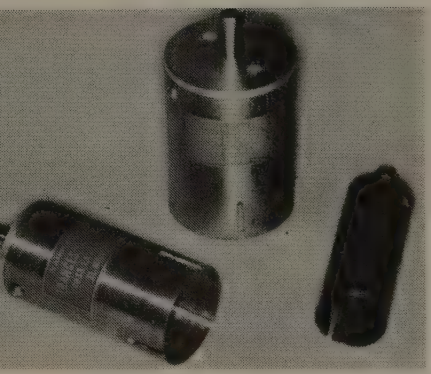
Abrasive Drilling

For this type of drilling, the most efficient abrasive is diamond grit. However, it is costly. Commonly used abrasives are silicon carbide and boron carbide (Norbide). The best grain size to use is 200 or 220. Various grit mixtures sold under proprietary names are also available. For a coolant and flushing agent water, turpentine, or light oil is used.

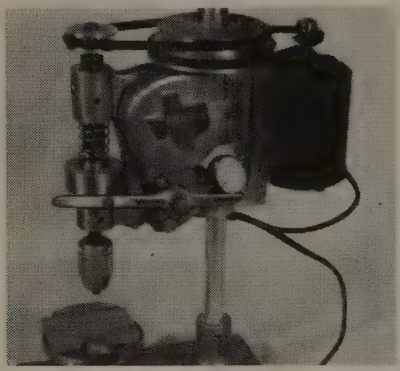




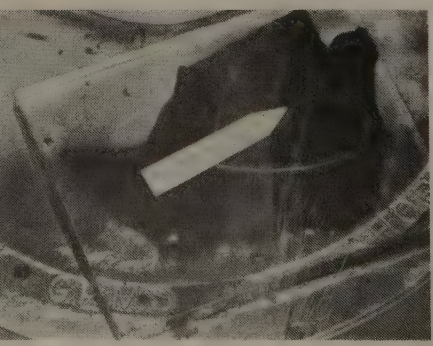
Needles and nails may be used for drilling with abrasive grit. However, tubes make better drills. Tubes of bronze, brass, stainless steel, ordinary steel, sterling silver, and gold-filled metal can be used. Many hobbyists use the tubes from ball-point pens. Tube ends should be square and true. To help the tube pick up and retain the abrasive, the end can be nicked with a sharp knife.



Large tubes are used to cut gemstone rings, circular gem preforms, bracelets, paperweights, holes in stone clock cases, and for a multitude of other purposes. These tubes are made of tough steel. Note the notches for catching grit. Drilling with large tubes is known as core drilling. Some hobbyists make core drills from tin cans, copper and steel tubing, and carpenter's hole saws.

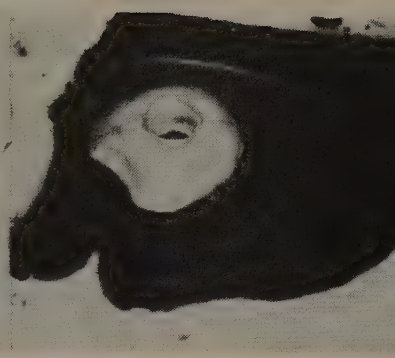


If a machinist's drill press is used for abrasive drilling, the drill tube must be manually raised every few seconds so that fresh grit can flow into the hole. Automatic lapidary drills feature mechanisms for this purpose. On this drill, the cam mechanism on the side raises and lowers the drill while the spindle revolves at high speed. Drills of different manufacture employ a variety of automatic mechanisms. Lapidary manufacturers produce their drills with proper speeds. If you are using a machinist's drill press, speeds from 2,000 to 3,000 rpm are recommended for small tubes and less than 2,000 rpm for large tubes.



It is easiest to drill through a stone with flat sides. If at all possible, drill the slab before you shape the gem. Mark the gem's outline and select and mark the spot for the hole. Then attach the stone to a piece of plate glass, steel or wood. Use dop or sealing wax. To prevent chipping on the underside, make sure there is plenty of support under the location of the hole.

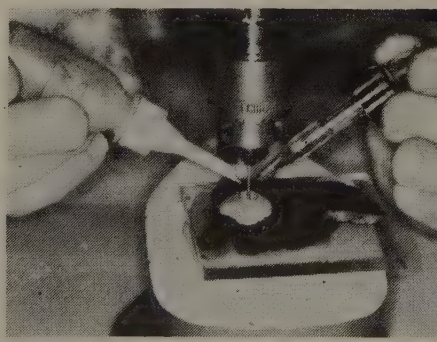
When the stone is attached to some kind of backing, make a well of modeling clay around the spot where the hole is to be drilled. Ferrules, pieces of metal tubing, machine nuts, etc., may be surrounded by clay to make convenient wells. Be sure the well is large enough to hold a sufficient amount of grit and coolant.

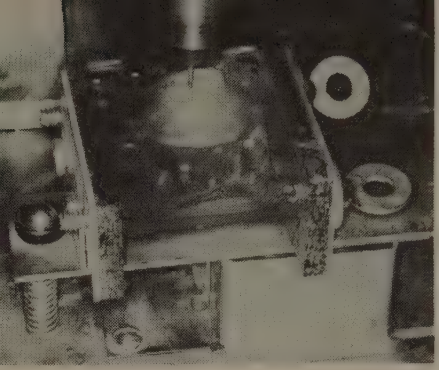


The tables on gem drills can be adjusted so that the mark for the hole is centered under the drill tube. Some drills are supplied with vises for clamping the stone and its backing. If the drill does not have a vise, attach the assembly to the table with a C clamp.

A simple method of attaching the stone to the drill table is to use strips of modeling clay. Lay the strips on the table, and press the stone into the clay. If the machine's drilling action is gentle, it may not be necessary to back the stone.

Chuck a tube of the right size in the drill. With an automatic drill, work the mechanism by hand until the chuck is at the top of its stroke. Then adjust the table until the stone is about 1/32 inch below the tube. Place a little grit and coolant in the well and start the motor. The machine will do the rest. With the machinist's drill press, adjust the spindle and chuck so that the drill will penetrate the stone. After applying the grit, lower the revolving tube gently onto the stone. Raise the chuck at intervals of a few seconds so that the grit will flow into the hole. You will have to add grit periodically and perhaps some more coolant. Boron carbide is tougher than silicon carbide and does not have to be added quite so often. Handy containers for grit are small oil cans or empty plastic containers in which medicines for innoculations are stored. Coolant is conveniently added with an eyedropper.

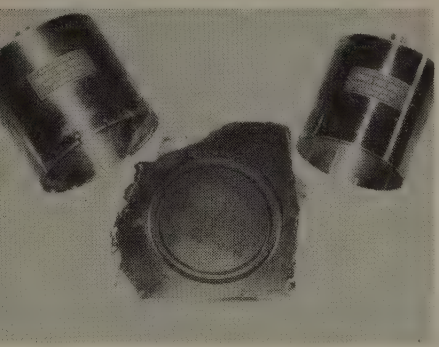




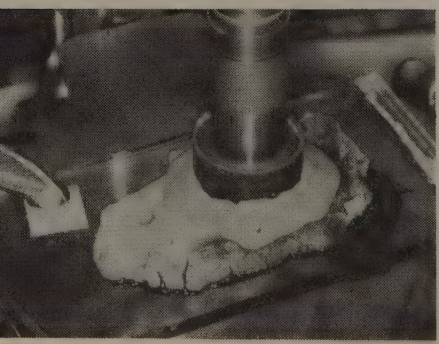
Instead of raising and lowering the chuck, this type of drill has a spindle which floats. The stone is clamped into a vise which is attached to a vibrator. When the motor and vibrator are turned on, the drill tube revolves rapidly and the stone is vibrated in an up-and-down motion. The vibration enables fresh grit to flow under the tube. The floating spindle permits the tube to proceed downward until the hole is drilled.

As the tube cuts a hole, a rock core is produced which works up into the tube. After the hole is drilled, this core should be pushed out of the tube with a stiff wire. Occasionally the core breaks off before the hole is completed. This clogs the tube and drilling action halts. In this case, it is necessary to remove the tube from the hole and push out the core. Sometimes the core is jammed, and the section of the tubing containing it must be cut off. Roll the tube under a sharp knife blade. The tube must be re-centered in the hole and drilling continued.

Use of Large Core Drills



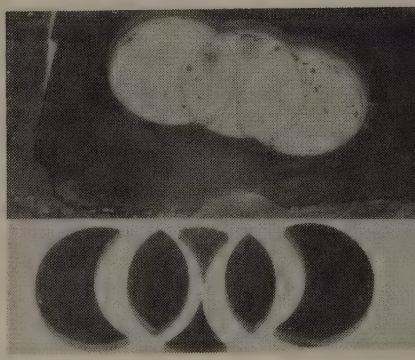
In selecting a large core drill, first determine whether the diameter of the hole or the diameter of the core is the important dimension. If you are drilling a hole in a stone to hold a clock, the diameter of the hole is important. In this case, specify this size as the outside diameter of the tube. If you wish to cut some button preforms of a particular size, specify that the inside diameter of the tube is to be that size. In making a ring or bracelet you will need two tubes, one with a specific outside diameter to cut out the center, and one with the correct inside diameter to cut the outside of the ring or bracelet.



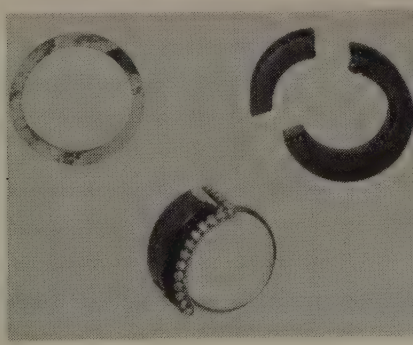
Some automatic gem drills are designed to use core drills as well as small tubes. Core drills up to about 1¼ inch in diameter can be handled. The drilling procedure is the same as with small tubes.

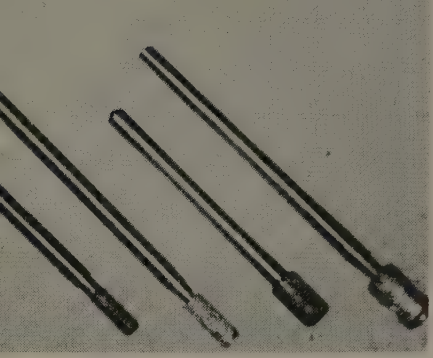
To cut a bracelet preform requires a machinist's drill press. Select good tough gem material that is free of fractures and flaws. Jade is a favorite material. Slabs should be $\frac{3}{8}$ inch or thicker. Follow the regular procedure of attaching to glass or some other backing, and center under the chucked tube. Some experts advise cutting the inner hole first because most of the grit tends to flow into the outer hole if it is drilled first. Use light pressure, and raise the drill frequently so that fresh grit may flow into the cut. You can tell if the tube is cutting by the sound. When the grit is fresh you can hear the abrasive action. As grit breaks down the abrasive sound diminishes. Usually you can tell when the tube penetrates the stone and contacts the backing because there is a change in sound. After drilling one hole, insert the other tube in the chuck and drill the second hole. Be sure to leave the stone clamped to the table so that the holes will be aligned to each other. The finished product will be a band of stone which can be ground, smoothed and polished. The procedure for finger rings is the same.

A variety of shapes can be made with core drills. By drilling this stone in three places, crescents, navettes, and other decorative forms are produced. These shapes and stone discs cut with a core drill can be made into attractive cabochons. The stone preforms can also be tumble polished.



Circles of stone can be used for preforms for shapes such as hearts, stones, etc. (see section on preparing stones for grinding). If a gemstone ring is sliced into thirds, a contoured stone for a ring setting is produced.

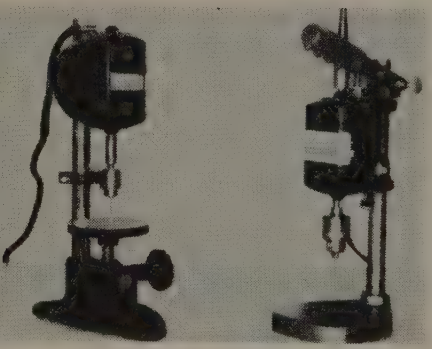




Diamond Drills

Two types of diamond drills are available. Solid diamond impregnated drills are made by fusing diamond particles together with a bonding agent. This mixture is bonded to a steel shank. Diamond coated drills are made by fusing a single layer of diamond grit to a metal shape. Solid impregnated diamond drills are more expensive, but they last much longer. The thin, solid drills are delicate and must be used with care. The coated drills will stand more punishment and cost less, but they have much shorter cutting lives. Diamond drills are available in solid forms and as tube drills.

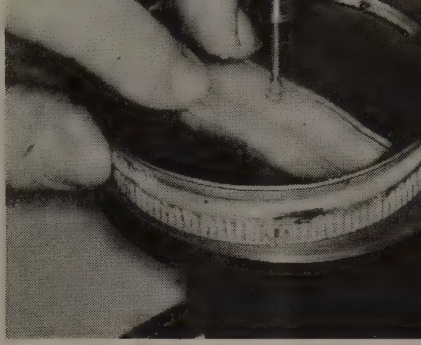
Diamond core drills from Felker Manufacturing Co. come with pressure coolant heads to supply a constant stream of water to the cut. The water flushes out the cuttings and keeps the work cool for fast cutting.



On many machines for diamond drilling, the table is raised to the drill. All parts must be true. There must be no wobble in the table or the chuck; this can easily snap a drill. Many of the drills available are supplied with rheostats so that the speed at which the drill runs can be varied. Several diamond drilling machines have heads which can be tilted for carving gemstones.

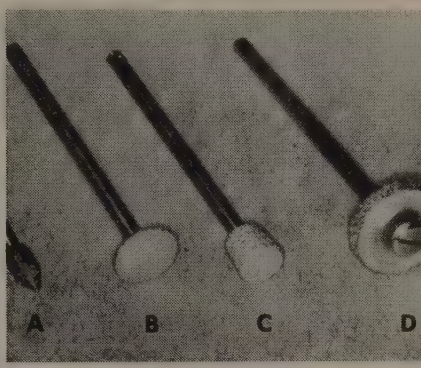
The stone and drill must be kept cool. Immerse the stone in a pan of water. Some cutters hold the pan and stone on the drill table by hand. For absolute steadiness, a clamp can be used to hold the gem and pan. Diamond drills tend to chip the underside of the stone as they come through. This can be prevented by cementing the stone to a piece of glass.

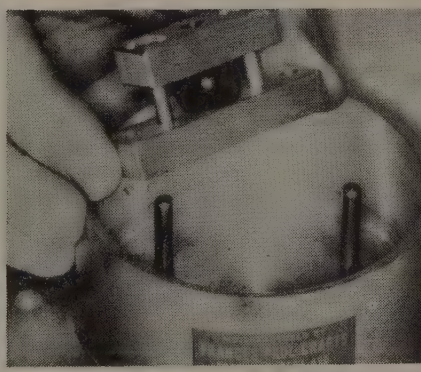
Turn on the drill and place your foot on the rheostat. To start, run the drill at low speed. Gently raise the table until the drill contacts the gem. Apply very little pressure until the drill has cut into the surface of the stone. This is especially important if you are drilling a gem with a curved surface. After the hole is started, you can increase the pressure. The speed can also be increased with the rheostat. At short intervals, lower the table slightly so that fresh water can flow into the cut. Until you learn how to use a diamond drill, be very careful with pressure. Reduce the pressure considerably when the hole is almost through.



Other Diamond Tools

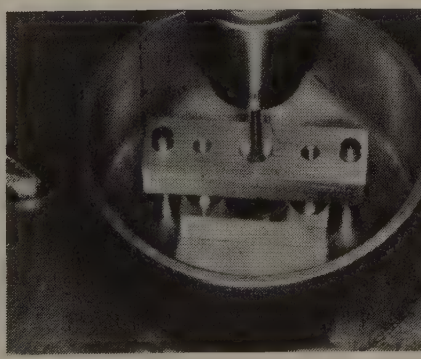
If the edges of the hole are chipped by the drill, they can be smoothed with a hole beveler (A). It is often desirable to bevel the sharp edges of holes in beads so that the bead strings will not be worn. Sometimes emblems (available from rock shops and suppliers) are mounted in holes drilled in stones. To prevent the emblems from twisting, the holes can be slotted with a diamond hole slotter (B). Diamond carving tools (C & D) are also available.

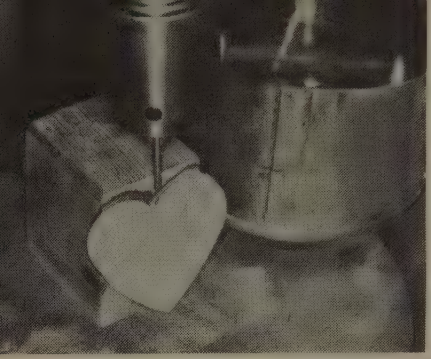




Drilling Jigs

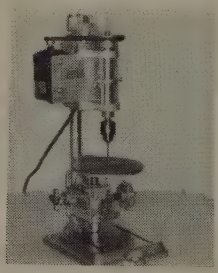
This jig makes it possible to drill round beads and other domed stones. The jig is first clamped on the drill table so that the drill centers in the hole in the bottom. Then the clamp containing the bead is slid onto the vertical pins. The drill enters the bead through the hole at the top of the clamp. When the hole is halfway through the stone, remove the drill and lift the clamp off the pins. Turn it over and replace it on the pins. This automatically centers the bead so that the hole can be completed from the other side. Chipped edges on the stone's surface are avoided.



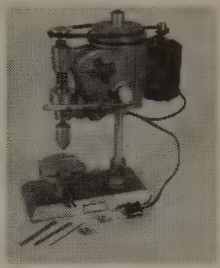


To drill into the end of a stone such as a teardrop or heart, first dop the stone on a block of wood. Clamp the block in the pan of water so that the top of the stone is perpendicular to the drill. The points of stones like teardrops must be flattened. If you wish to drill several stones, you can cast them in a pan of plaster of Paris. If you are using a diamond drill, be sure the pan is deep enough to contain a sufficient amount of water.

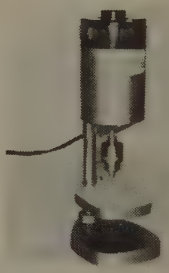
Always be careful of pressure in diamond drilling. A fair amount of pressure is sometimes needed, but remember to release the pressure periodically. Never use a diamond drill dry. It's a good idea to put a rubber pad (cut from an old inner tube) in the bottom of the pan used in diamond drilling.



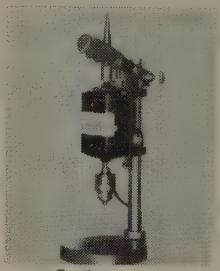
Frances Paul
Pro Carva



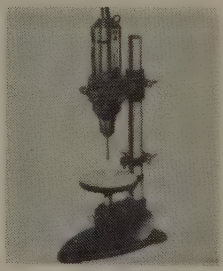
Rock's Lapidary
Equipment
Automatic Drill



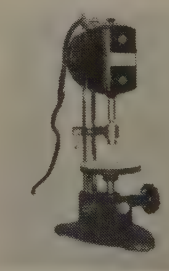
Covington
Automatic
Drill



Covington
Diamond Drill
and Gem Carver



Dremel
Moto-Tool
On Drill Press Stand



Frances Paul
Pronto Diamond
Drill and Gem Carver

DRILLING EQUIPMENT MANUFACTURERS

DRILLING MACHINES
Covington Lapidary Eng. Corp., Box 35, Redlands G, Calif. 92373
Dremel Mfg. Co., P.O. Box 518, Racine, Wisc. 53401
Frances Paul Crafts, 3033 La Madera Ave., El Monte, Calif. 91732
Highland Park Mfg. Co., 1009-1011 Mission St., South Pasadena, Calif. 91030
Rock's Lapidary Equipment, P.O. Box 10075, San Antonio, Texas 78210

DIAMOND DRILLS
Felker Mfg. Co., 1900 S. Crenshaw, Torrance, Calif. 90509
Metro Diamond Drill Co., 845 Masselin Ave., Los Angeles, Calif. 90036
Rohde's Lapidary, Box 351, Bayfield, Colo. 81122

GEM CUTTER'S HANDBOOK

GEMSTONE SPHERES

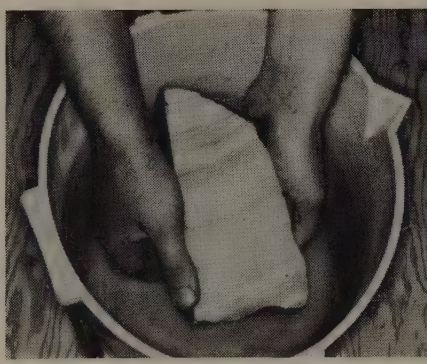
Shaping a sphere of solid stone and bringing it to a gleaming polish is a challenge. Sphere cutting enthusiasts claim it is the most interesting phase of the gem cutting hobby. At a gem and mineral show, a display of spheres never fails to draw a crowd.

Spheres are made from a great variety of gem materials. They are cut in sizes small enough to be mounted in rings and up to 450 pounds and more. Small spheres can be drilled to make attractive beads.

Learning to cut a sphere is not particularly difficult, but it does require time and patience. It may be done on quite simple equipment or on special machines designed for the purpose. There are even machines which will cut several beads at the same time.

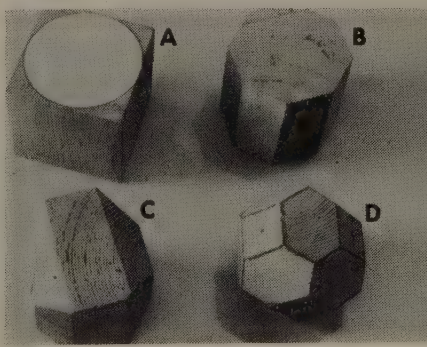
Material

Select a good stone for cutting a sphere. The material should have attractive patterns and color, and be free of fractures and cracks. Avoid using material that chips easily. To check for fractures that may not be easily detected, soak the stone in water for a few hours. Then remove the stone from the water, dry it and check with a magnifying glass for any discolored areas where water has entered cracks. You can also soak the stone in oil, wash it in detergent, and allow it to set. The oil will seep out of cracks it has entered. Do not do this with stones that are discolored by oil.

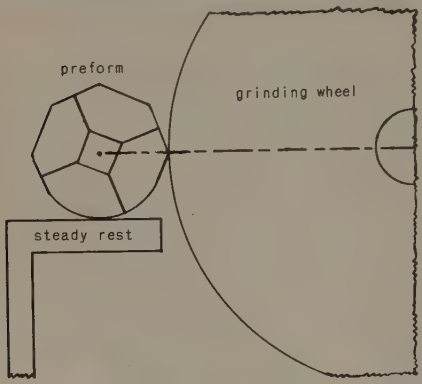


Preforming

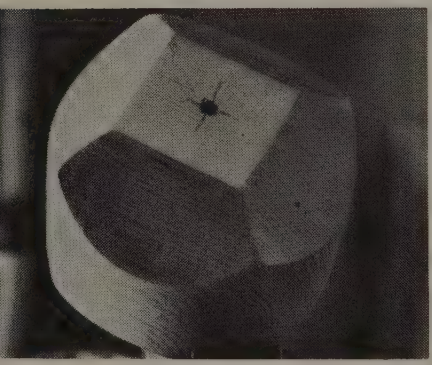
The complete procedure of sawing a sphere preform is covered in the section, *Special Slab Saw Techniques*. First a cubic block (A) is cut. Then a round template which will fit the smallest side of the cube is used to mark the profile of the sphere. In steps B, C, and D, the edges of the cube are sawed off to form an 18-sided block. Wood blocks are used here for clarity of illustration.



Preforms may also be cut with an abrasive core drill. First cut a cylinder from a block of gem material. Lay the cylinder on its side and cut another core at right angles to the first. Then turn the preform to other angles and cut off more corners. The preform will either have to be dopped to a block or cast in plaster of Paris. Grit can be contained in a clay ring or the preform can be clamped into a container filled with grit and water. This method is slower than sawing, but cuts a nice preform.



After the preform is sawed, it must be ground as close to a spherical shape as possible. Up to 4-inch spheres can be ground on standard arbors with good bearings. Larger spheres require arbors with shafts at least 1½ inches in diameter. Spheres 2 inches or smaller in diameter can be ground on 6- or 8-inch wheels. For larger spheres use wheels 10 inches or more in diameter. Use a steady rest adjusted so that the center of the sphere lines up with the center of the grinding wheel. The grinding wheel should be well balanced. Do not jamb the preform into the wheel or let it bump.

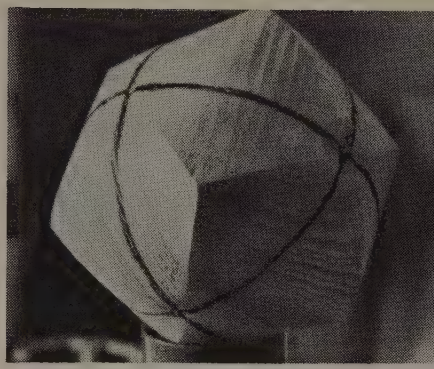


Before grinding, mark the center of each of the *squares* on the block. These remain from the surface of the original cube. Do not grind off these dots. They are guides to keep you from grinding inside the sphere's diameter. The first step is to turn the preform in one direction and grind off a complete set of parallel edges, rounding off the faces almost to the dots. This will form a cylindrical surface around the central portion of the preform.

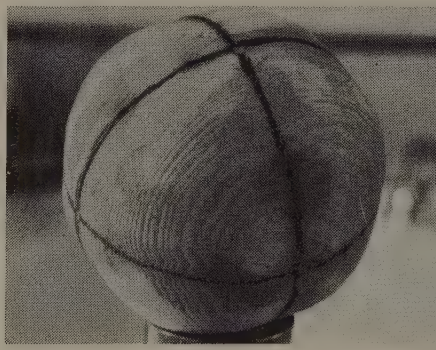
Turn the preform 90 degrees, and again grind off a set of parallel edges. This will form two cylindrical surfaces intersecting at 90 degrees. The preform will now look like the picture. Remember not to grind through the dots in the centers of the squares.

Four flat surfaces now remain. Turn the preform 45 degrees and round off these flats to form the third cylindrical surface. The preform is now in a rough spherical shape. It is actually three intersecting cylindrical surfaces from which eight points project. These points must now be ground off.

Before grinding away the points, use a wax pencil or crayon to mark three lines around the circumference of the three cylindrical surfaces. The lines should follow the center lines of the cylinders and will intersect each other at 90 degrees. These lines are your guides to keep you from grinding too far. They form eight segments, with a point projecting from each segment.

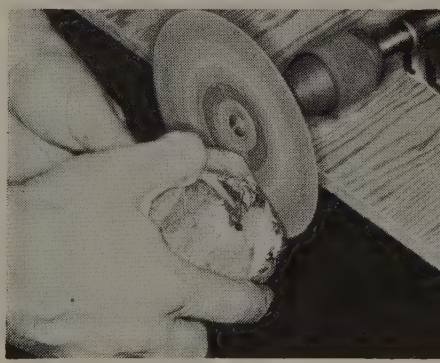


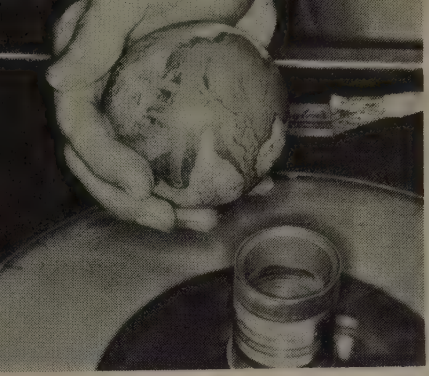
Grind the segments separately. Rock the preform back and forth across the surface of the wheel, forming it as closely as possible into a sphere. Grind close to the lines, but not into them. The more spherical you make the preform, the easier the final shaping will be. The grinding wheel shapes the stone much faster than subsequent steps.

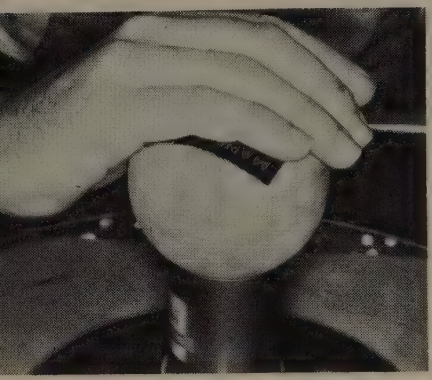


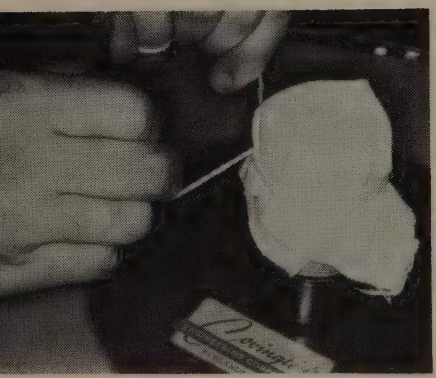
Fast Grinding of Soft Materials

Preforms of soft material such as calcite onyx can be ground much faster with the very coarse grade of *Tri-M-ite* sanding cloth discs (available at hardware stores). The discs should be attached to a rubber disc mounted on a steel mandrel. These disc and mandrel combinations are sold at hardware stores. The mandrel can be held in a chuck on a motor shaft or drill press. It should be turned at 3,000 rpm or more. Some sort of collecting system should be devised to carry away the large amount of dust that is generated. A vacuum cleaner with a hose attachment can be adapted.









Final Shaping With A Sphere Tube

Sphere tubes are usually made from iron or brass pipe. They may be used on a machine with a horizontal or vertical shaft. Several manufacturers supply tubes for their vertical shaft machines. The tube should be run at about 150 rpm. Mix coarse (80 or 100) grit with water to the consistency of paste. Brush some of the grit mixture on the tube and sphere, place the sphere on the tube, and hold it there with your hand. Start the motor. As the tube spins, rotate the sphere in all possible directions with your hand. When all the bumps and grinding wheel scratches have been lapped away by the grit, wash the stone, hands and equipment thoroughly. Next use 220 grit. For hard stones and obsidian, proceed through 400 and 1200 grits. With soft stones such as onyx, lap only through 220 grit. Then, after washing, place the stone on the sphere tube and sand it with pieces of 220, 320, and 400 grit wet or dry sanding cloth held by hand. Work across the top of the stone covering about ¼ of the surface; stop; turn the stone, and sand another quarter of the surface. Keep the sanding cloth wet by dipping it in water.

When a dull gloss appears on the sphere, it is ready to polish. Wash everything thoroughly. Then form a piece of clean canvas, felt, or leather over the end of the sphere tube. Tie the cloth or leather buff to the tube with several wrappings or heavy twine. Mix polishing compound and water to the consistency of cream and brush it onto the buffing material. Place the sphere on the tube and start the motor. Rock the sphere in every direction as it turns. Add a little water from a squeeze bottle if the polish compound becomes dry. Soon a mirror-like polish should appear. Some cutters prefer to place the sphere on the tube and hold the buffing material in their hands, rubbing it back and forth across the sphere. When about ¼ of the sphere is polished, they turn it and polish the next section.

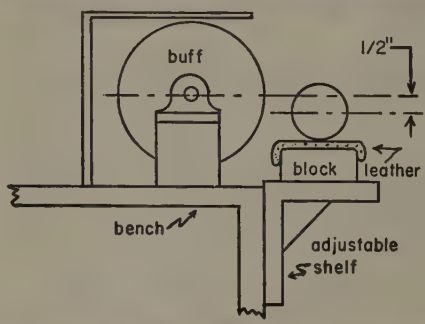
Instead of holding the sphere by hand on a sphere tube, some cutters apply a second tube, held by hand, to the top of the sphere. The hand held tube is rocked back and forth to generate a perfect sphere.

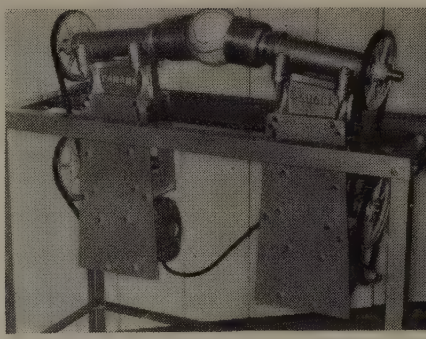
Some experts prefer to polish spheres on muslin buffs; 10x1½-inch buffs work very well. A steady rest covered with leather should be adjusted so that the centerline of the sphere will be just a little below the centerline of the buff. Apply a mixture of polishing compound to the buff and sphere and start the motor. Hold the sphere on the rest with the fingers on either side and the thumbs at the back. Push it lightly against the buff. At first you will have to turn the sphere by hand. As the buff dries it will spin the sphere. Use light thumb pressure for a brake. Rotate the sphere to polish the entire surface, and add polishing compound as needed.

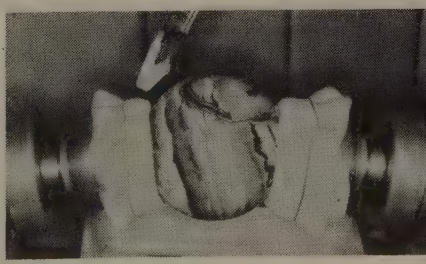
Sphere Cutting Machines

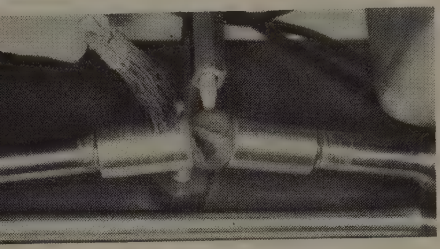
Machines for cutting spheres come with two cups mounted on shafts which are set at an angle and turn in opposite directions. The preform is ground in the regular way. It is then placed between the cups. The cups are moved horizontally by cranking a threaded rod until they hold the sphere securely, but not too tightly. A mixture of coarse grit and water is brushed on the sphere and the motors turned on. If the cups have been adjusted properly, the sphere will turn in every direction, grinding away high spots and blemishes. If it does not turn freely, adjust the cups slightly until it does. When the sphere is completely rounded and smoothed, it should be lapped with 220, 400, and 1200 grit. Wash everything thoroughly between grits.

When the lapping is completed, wash away all grit, and tie pieces of canvas, felt, or leather on the cups. Brush on a polishing mixture and place the sphere in the cups, adjusting for proper fit. Start the motors. Add water with a squirt bottle occasionally and when needed, brush on some polishing compound.



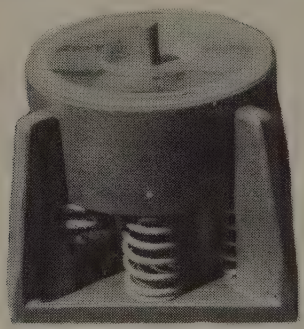




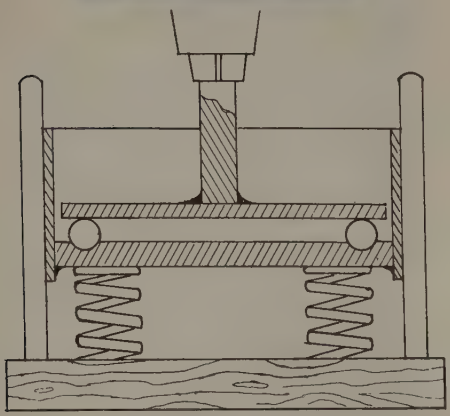


Small Spheres and Beads

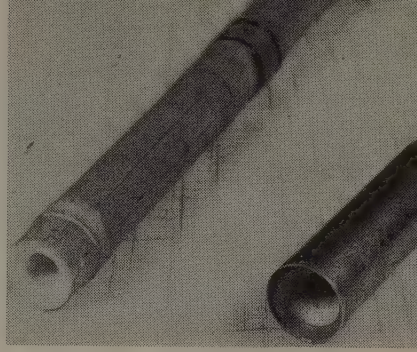
To make beads and tiny spheres, special equipment is needed. Machines are available that will cut spheres from ¼- to 1-inch in diameter. Preforms are made the same as with larger spheres by sawing and grinding. The preform is then placed in the cups and the cups adjusted so that the preform is held loosely, but not too loose. The stick at the back is adjusted so that it touches the sphere. A mixture of 220 grit and water is brushed on, and the machine is started. When the sphere is round and smooth, everything is washed and 600 grit is used. The easiest way to polish these spheres is to dop them on a regular dop stick and apply to a buff, the same as you would a cabochon. When a little over half of the sphere is polished, remove it from the stick and re-dop to polish the other side.



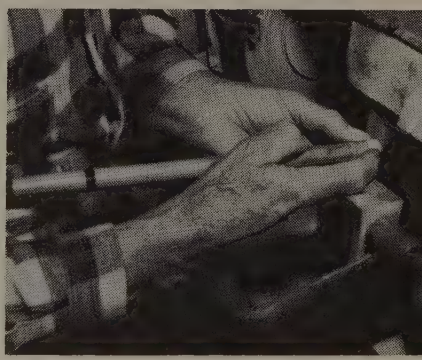
A bead mill will produce a quantity of beads of uniform size. As the drawing shows, the mill consists of a base, a tub mounted on springs, and a runner (a steel disc to which a short shaft is attached). The Crown mill in the picture also features a splash shield at the top. The bottom of the tub is grooved to receive the bead preforms. The base of the mill is attached to a drill press table, and the shaft on the runner locked into the chuck of the press. A quantity of preforms is sawed and ground as close as possible to a spherical shape, the same as for all spheres. These preforms are then placed around the groove at the bottom of the tub. A mixture of grit and water is added. Then the drill press chuck is lowered until the runner rests on the beads. The drill press is adjusted to run at slow speed and turned on. The mill will shape the beads into perfect spheres. Finer grits can be used for smoothing. The beads must be polished by hand on a buff. They can be dopped for easier handling. *Note: Refer to the section on Special Slab Saw Techniques for methods of sawing a quantity of preforms.*



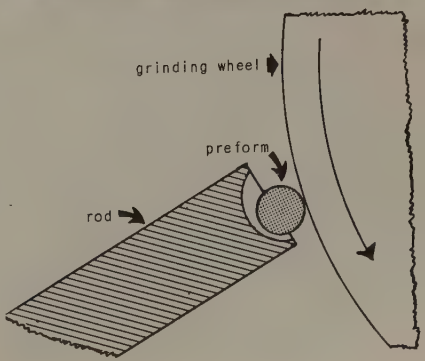
Beads may be ground to spherical shape on a grinding wheel using tubes you can make yourself. The tube at the left of the picture is made of bamboo; the one to the right is a piece of copper tubing pressed onto a piece of hardwood dowel. Both tubes have inside diameters of about ½-inch for forming spheres around ⅝-inch in diameter. The inside of the bamboo tube is beveled to about 45 degrees.

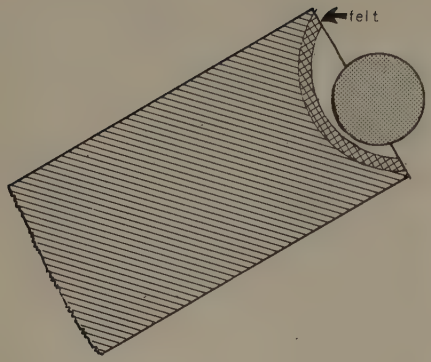


The bead preforms are sawed and ground by hand as usual. Then a preform is placed in the end of a tube. The picture shows how the preform is held and manipulated by the fingers. Note that the tube should be slightly smaller than the preform. The tube, or stick to which the tube is attached, should be long enough to tuck under your arm. Rest the end of the tube on the steady rest in front of the 100 grit grinding wheel. *Always work below the centerline of the wheel.* The wheel should be true with a flat periphery and the edges slightly rounded; sharp edges can cut your fingers. Move the tube forward until the bead touches the wheel. Use light pressure. Turn the bead in all directions with your fingers. Do not turn the tube. With practice you should be able to turn out a nearly perfect spherical bead. You can use the tube to sand the bead on a drum sander and polish it on a buff. Another method to finish the beads is to abrade and polish them in a tumbler. Follow the tumbler manufacturer's instructions, but eliminate the coarse grind. Start with 400 or 600 grit.



A technique similar to the tube method uses a rod of wood, metal, or some tough plastic. A spherical depression is made in the end of a rod *at least twice the diameter of the preform.* The preform is placed in the depression. A 220 grit grinding wheel is used, running at slow speed (500 rpm or less for an 8-inch wheel). The preform is applied to the wheel with *a very light touch.* The wheel will spin the preform in the





rod, grinding away the high spots. Constantly sweep the rod back and forth across the wheel. As the preform is ground away, it may be desirable to use a smaller rod, but always use a rod that has twice the diameter of the stone. As the preform is shaped you can apply a *little* more pressure, but keep it light. Hard materials can be smoothed with the rod on a drum sander. For soft materials, line the depression in the rod with felt, saturate the felt with fine grit and spin the bead against a smooth rubber or leather disc. To polish, use another felt-lined rod saturated with polishing compound.

Helpful Hints

Small spheres may be mounted in jewelry by cementing on bell caps or up-eyes. Beads must be drilled. This procedure is reviewed in the section, **Drilling Gemstones.** Larger spheres may be displayed by setting them in drainpipe wall flanges or the rings that car manufacturers place around doorhandles and window lifts (escutcheon plates).

There are cup-shaped silicon carbide grinding wheels available from machinery suppliers which work very well for shaping a sphere preform. Whatever type of grinding wheel you use, never let the preform bump against it. Apply the preform with light pressure.

Spheres of hard material may be sanded on drum sanders after they have been shaped on a sphere tube or sphere cutting machine. One expert sphere cutter advises that quartz, obsidian, and glass should be worked on a sphere tube with 220, 400, 600, and 1200 grits, then polished. He sands stones over 6 Mohs in hardness on two drum sanders, one with new 320 grit dry cloth, one with well-worn 320 dry. He sands calcite onyx with sanding cloth held in the hand as the sphere rotates on a tube. For a good prepolish, sphere cups or tubes can be covered with cloth, and fine grit applied.

As a sphere rotates on a sphere tube, it will grind a perfect seat. The edges of the tube will eventually become sharp. To protect your hands, round off these edges with a grinder. You can protect your hand from grit when using a sphere tube by wearing a rubber glove. Sphere tubes should be about 2/3 the diameter of the sphere. For clarity of illustration, a larger sphere was used in this article.

To polish calcite onyx, try brushing some oxalic acid on the polishing cloth and then apply polishing compound to the sphere.

SPHERE AND BEAD EQUIPMENT MANUFACTURERS

SPHERE TUBES AND SPHERE CUTTING MACHINES

Covington Lapidary Eng. Corp., First & Highway 99, Redlands G, Calif.
Pomona Lapidary, 355 North Clark, Pomona, Calif.
Scott Lapidary Equipment Co., 1426 Houser Lane, Modesto, Calif.
Terry's Lapidary, 3616 E. Gage Avenue, Bell, Calif.

BEAD MILLS

Crown Lapidary Equipment, 11021 So. Vermont Ave., Los Angeles 44, Calif.

GEM CUTTER'S HANDBOOK

TUMBLING GEMSTONES

Tumbling is the process of abrading and polishing stones in a drum. Perhaps it should more correctly be called rolling. The process is quite similar to that in which pebbles are smoothed by sand as they roll down streambeds.

Several years ago a prominent figure in the gem cutting industry said tumbling was on the way out. To the contrary, it is now more popular than ever. Many cutters start in the hobby with the purchase of a tumbler. Literally thousands of tumblers are sold each year and the styles offered are too numerous to list. For sources of tumblers refer to the advertisements in current gem and mineral hobby magazines.

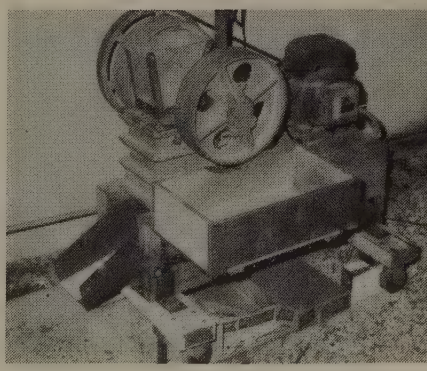
Gem Material for Tumbling

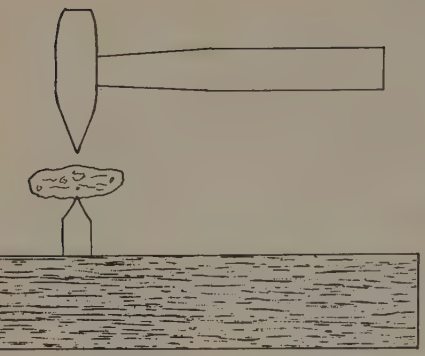
If you want beautiful tumbled gems (baroques) you must start with rough gem material of good quality. Many cutters have started with poor material (commonly referred to as "junkite") believing that tumbling would improve the appearance. They are usually disappointed. Tumbling will not improve color and it cannot make good stones out of badly fractured material. Colorful pebbles of agate, jasper, and other materials that have been smoothed by nature make good material. Cabochon cutters often collect trimmings of good material that are too small to cut. These scraps are excellent for tumbling. If you are unable to collect your own material, many dealers offer gem material that has been crushed to sizes suitable for tumbling.

Generally, gemstones of different hardness and toughness should not be tumbled together. Obsidian should not be tumbled with quartz gems; the obsidian abrades much faster. Although they are all quartz gems, agate or jasper should not be tumbled with crystalline quartz such as amethyst or rose quartz. Agate is tougher than the crystalline varieties and requires more time for abrasion. Even the same type of stone may vary. For instance petrified woods from different areas may react differently. There are special exceptions to the rule but the beginner is advised to tumble only one type of material.

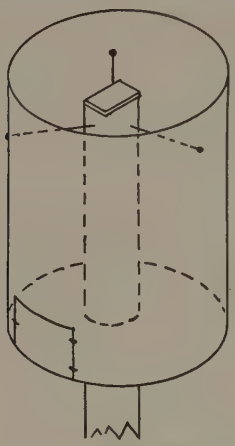
Crushing

Pebbles of the desired size can sometimes be found. In most cases, however, material for the tumbler must be broken up. The most efficient way is with a commercial crusher like the one shown in the picture. These crushers break up the rocks without shattering them. They are used by professional tumblers, but are too expensive for most hobbyists. Hobbyists usually crush





the stone by hand. It may be necessary to crush large stones by laying them on a hard surface and striking them with a sledge hammer. Smaller pieces should be handled more gently. Lay small pieces on a hard surface and use a cold chisel and hammer to break them. Place the point of the chisel along cleavage planes, cracks, or fractures for easy breaking. One cutter drilled a hole in a log and drove a cold chisel into the hole with the point protruding. He places a stone on the chisel point and strikes it with a chisel-edged rock hammer. It is also sometimes possible to hold stones in a gloved hand and break them with a hammer. *Caution: whatever method you use, be sure to wear safety goggles and heavy gloves.* You can keep rock chips from flying by placing the stone in a section of inner tube and clamping the ends of the tube. However, you cannot use a chisel with this system. An arrangement to avoid flying chips is shown in the drawing. Here a post capped with heavy iron is set in the ground. A grease drum is attached to the post with bolts. The stones are crushed on the iron and the pieces fall into the drum.



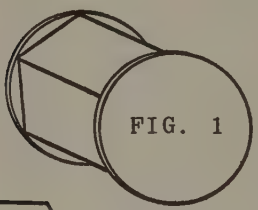


FIG. 1

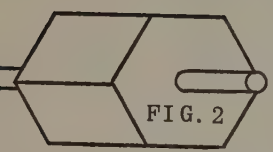


FIG. 2

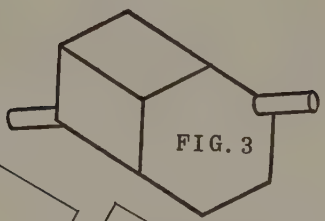


FIG. 3

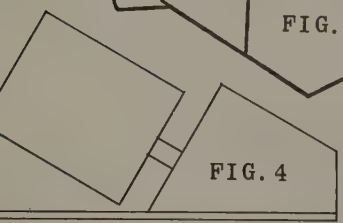


FIG. 4

Tumbling Equipment

You need only look through tumbler manufacturers' advertisements and catalogs to get an idea of the variety of tumblers available. For hobbyists there are machines with barrel capacities ranging from one to fifty or more pounds. The two general categories of machines are those on which the drums rotate on horizontal rollers or shafts (Figs. 1, 2, and 3) and those with open-end drums which rotate on a shaft at an angle, similar to a cement mixer (Fig. 4).

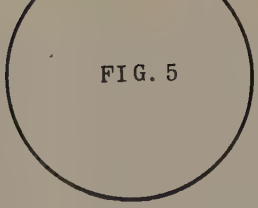
Drum shapes also vary. Circular (Fig. 5), hexagonal (Fig. 6), modified hexagonal (Fig. 7), octagonal, and square drums are used. The general concensus of experts is that the shape is not nearly so important as the speed at which the tumbler is run and the

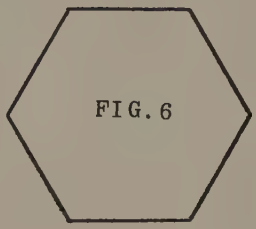
thickness of the slurry. Hexagonal and round drums seem to be the most popular.

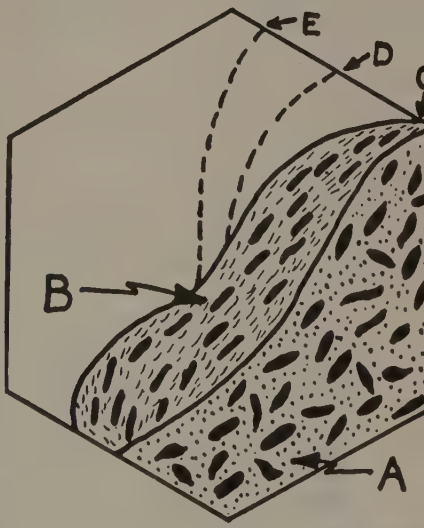
Manufacturers make drums from a variety of materials including steel plate and polyvinyl plastic. For small tumblers they frequently use paint cans and polyethelene jars. Do-it-yourself hobbyists have used all these materials as well as a host of others such as glass jars, wooden kegs, and rubber tires. The abrasive will wear through tin cans and polyethylene jars fairly soon and they must be replaced. Steel plate drums also wear, but slowly. To eliminate wear on the steel, some manufacturers supply rubber or plastic liners. It is also believed by some experts that the liners increase tumbling efficiency and protect the stones. Other experts disagree. Hobbyists sometimes line drums with rubber matting or with a plastic material, known as Tumblelife (available from Paul Pearson Lapidary, West Alton, Missouri 63386).

What Happens Inside the Tumbler?

The object of tumbling is to first grind away sharp edges and projections until a pleasing round baroque stone is produced. Then finer abrasive is used to smooth the stone and finally it is polished. To accomplish this the stones must tumble through the abrasive and roll against each other. When the proper load, slurry consistency, and speed are set, the stones travel partially up the side of the revolving drum and then roll or slide down to the opposite side. If the tumbler is running too slow, the mass merely slides back down the side of the drum and there is no tumbling action; flat sided baroques are produced. If the tumbler runs too fast the stones travel too far up the side of the drum and then fall to the opposite side. When this happens they do not abrade and often break from the impact of the fall. The diagram at the bottom of this page illustrates tumbling action.







How a tumbler works. A — nearly stati
ary material. B — Sliding layer where gri
ing or polishing takes place. Assuming
correct speed for a certain tumbler to
15 rpm, the sliding will start at about
At 25 rpm, the sliding will start at D;
35 rpm, at E. The last two are too
as the stones will tend to fall instead
slide.

Tumbler Speeds

Many of the tumblers supplied to hobbyists come with pulleys and belts installed that will deliver the manufacturer's prescribed speed. Since some tumbler manufacturers also tumble commercially, these set speeds are the result of their experience. Speeds can be changed on most tumblers by installing different sizes of pulleys, jack shafts, or gear boxes. On some motorized models, this is impossible.

According to some experts, hexagonal drums should run slower than round drums. Their reasoning is that a hexagonal drum running at the same speed as a round drum will carry the stones to a higher point than the round drum and let them drop and fracture instead of rolling. Their recommended speeds for tumbling drums in revolutions per minute (rpm) would be:

Drum Size	6"	8"	10"	12"	14"	18"	24"
Hexagonal Drum RPM	32	29	25	23	21	19	16
Round Drum RPM	54	48	42	38	35	31	27

A Professional Tumbler's Speed Recommendations

One professional tumbler who turns out beautiful baroques with a mirror-like polish uses both round and hexagonal drums. He does not advise different drum speeds. His drums all run at 100 surface feet per minute (sfm). To convert sfm into rpm: (1) Determine the circumference of the drum by multiplying the diameter by pi (3.14). (2) Divide this figure by 12 to convert the circumference into feet. (3) Divide the circumference footage into 100.

As an example, if you wish to find the rpm for a drum 20 inches in diameter:

$$20 \times 3.14 = 62.80 \qquad \frac{62.80}{12} = 5.23 \qquad \frac{100}{5.23} = 19.2 = 19 \text{ rpm}$$

With the drums traveling at a set speed, any variations of the travel rate of the stones can be accomplished by changing the consistency of the slurry. This technique will be discussed later.

Successful Tumbling Requires Experimentation

There are many ways in which gems can be tumbled successfully. It is necessary for you to work out the system that best fits your needs. The factors that affect the success of tumbling vary with the composition of the stones, the construction of the tumbler, and even climate and temperature can vary the results. It is best to follow some prescribed formula, and if it does not produce the desired results, alter the process until it does. It is surprising what a slight change in speed or slurry thickness can do.

Keeping a log of your findings is very important. Set up a chart to show the type of stones, abrasive used, speed, slurry consistency, how long it took for each step, and any other pertinent data you can think of. Whenever you tumble a new load, refer to your log. Soon you will have information which will enable you to turn out successive batches of well polished baroques.

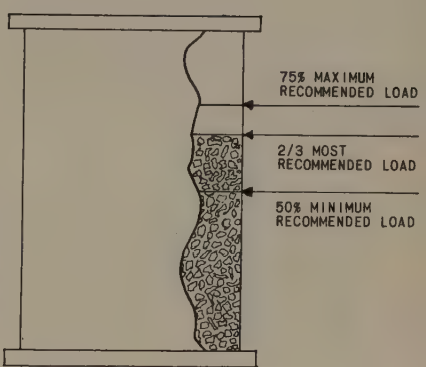
Abrasives

Silicon carbide abrasive grain is used almost exclusively for tumbling. In some instances, silica sand is used to tumble nodules and other stones to remove undesirable crusts. For shaping and smoothing baroques, however, silicon carbide should be used. Some tumblers use only graded grit, i.e. 80, 100, 220, 400, etc. Others use the cheaper ungraded grit, such as 30-60, 2F and 3F. The 30-60 grit contains grain sizes as coarse as 30 mesh and as fine as 60 mesh, and all sizes between. Grit designated 2F contains grains 280 and finer, and 3F is 320 and finer. *Note: as the number of a grit increases, the grain size becomes smaller.*

The grit is used to form the stones and smooth them for polishing. Like other types of gem cutting, a coarse abrasive is used first, then finer grit. There are several schools of thought on this subject. Three popular methods are: (1) Use two abrasives; coarse (about 80) and fine (400 or 600). (2) Use three grades of abrasive; coarse (about 80), intermediate (220) and fine (400 or 600). (3) Use one abrasive such as 30-60 exclusively. As the grit breaks down, it will become finer and automatically smooth after first having ground the stones. Every one of these methods has been used to produce good baroques.

Charging the Drum

Conventional Method



After the gem material has been broken to size, wash it thoroughly. Discard material that is hopelessly fractured. Unless you need filler, throw away material of poor color and quality. Remember that the finished baroques can be no better than the quality of the stone you start with. The bulk of the stones should be nearly the same size. Some experts advise adding some smaller stones because they carry grit to the depressions in the larger stones. Most instructions call for filling the drum a little more than half full of stones. Next put in a pound of coarse grit for each eight to ten pounds of stones. If the manufacturer supplied a grit kit with the tumbler use his recommended coarse grit. If not, try 80 grit. Add water to cover the stones. The tumbler will now be around ⅔ full. This is recommended because abrasion will reduce the stone size until the tumbler is about 2/5 full. It is desirable to keep the tumbler nearly half full. Do not fill it more than ¾ full. If you do not have enough stones you can add some Tumblex N, a product from Norton Company. This product is a natural stone of quartz hardness.

If you are using the open-end "cement mixer" style of tumbler, you are ready to start the motor. If you are using a tumbler with a closed drum, you may want to add one more ingredient to reduce gas.

Tumbler Gas

Tumbling in a closed drum usually releases gas. Many theories have been advanced that it is caused by the breakdown of the grit, breakdown of the stones, the interaction of chemicals from the grit or stone with the metal drum, etc. The pressure from the gas can rupture tin cans and even steel drums. There is no problem if you remember to open the drum every twenty-four hours to release the pressure. *Warning: the gas is believed to be acetylene; do not smoke when you open the drum and keep open flames away.*

Additives are sometimes used to reduce or eliminate gas. A tablespoon of baking soda for each eight to ten pounds of stone may be added. Some cutters add a tablespoon of lye instead of soda. Because lye is a water softener, it is thought to increase tumbling efficiency. *Caution: lye is caustic. Use it carefully and keep it away from children.*

Another suggested remedy is the use of rubber liners to avoid contact with metal drum sides. Some tumbling enthusiasts heat the water and the stones before putting them in the drum. When the mixture cools, it creates a partial vacuum which the gas can fill without building a high pressure. Finally experts advise keeping the tumbler in a cool place because heat seems to generate more gas. Some tumbling drums are equipped with relief valves. If your drum does not have a valve, remember to open it every twenty-four hours to release the gas.

The First Grind — Conventional Method

When the drum is properly charged you are ready to start grinding. If you have a closed drum, bolt or cap it securely to prevent leaks. Make sure that the drum is set on the machine so that it will rotate properly and start the motor.

Tumbling requires continuous action. Most tumblers only turn off the machines when they release gas pressure and check the stones. Motors will get warm, and should be watched for overheating. If a motor gets too hot to touch or starts to smoke, turn if off immediately and have it checked, repaired or replaced. It is advisable to attach the motor to an outlet with a safety fuse. If trouble develops when the tumbler is unattended, the fuse will stop the machine and eliminate fire hazard.

If you are unable to run the tumbler continuously, you will find that when it is idle for some time the load will form a compact semi-solid mass. This mass must be broken up before the tumbler is turned on again. This can be done with a putty knife or similar dull instrument. Another method is to turn the drum 90 degrees. Soon the mass will loosen and fall to the bottom wall of the tumbler, and the machine can be started once more.

You will soon learn to determine if the load is tumbling correctly. If it is not running fast enough, you will hear a distinct sliding noise. This can be corrected by speeding up the tumbler or perhaps by adding a little more water to thin the slurry. If it is running too fast, you can hear stones falling and striking the lower side of the drum. Either slow the drum or thicken the slurry. Sugar can be added to thicken the slurry. Add enough sugar to make a thick syrupy solution. Also, when you complete a tumbling run you can save the grit for use as a thickener

in future runs. The grit will be broken down and makes a good filler. Other fillers such as rice or walnut hulls, clean sawdust, bentonite, and clay flour are used with varying degrees of success.

When the stones are tumbling correctly you will hear them tumbling over each other, not sliding, not striking the drum wall. Some enthusiasts describe the sound as a "swish." Others liken it to the sound of pebbles being gently poured from one hand to the other.

The purpose of the first grind is to remove all the rough surfaces, crevices, blemishes, etc. When the grind is completed you should have rounded stones of about the desired size. Subsequent abrasive steps will remove very little material. A normal run in coarse grit requires about 100 hours or between 4 and 5 days. The time required varies with the hardness and toughness of the stones.

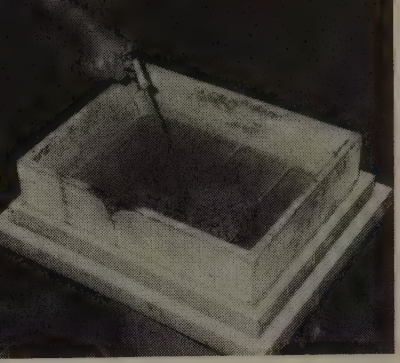
Daily Checks a Must

The stones should be checked at least every 24 hours. Turn off the tumbler and pick out a handful. Wash these stones thoroughly and dry them. Water on the stones hides blemishes. Inspect the stones thoroughly to see if the abrasive is rounding them. During the last days of the grind check to see if blemishes are being removed and the stones are forming pleasing shapes. You should also check the grit during the last few days. Wash the stones over a pan. A plastic colander or garbage tray works well for washing. Let the pan set until the grit settles to the bottom. Then pour off the water carefully and check the grit. It should be partially broken down, but not completely. If it is completely reduced to a fine flour, more grit must be added to the tumbler. Only add about ¼ as much grit as you started with. Sometimes you will find that the load has become a thick mass that is not tumbling properly. In this case, pour off some of the "goop" and add some clean water.

If your inspections indicate that the stones are not tumbling properly, you must either change the speed or the thickness of the slurry. Thicken the slurry to reduce speed if the stones are falling and fracturing. Thin the slurry or increase the speed slightly if the stones are not tumbling freely or if they are sliding.

You may find that in spite of all your efforts, flat spots are developing on the baroques. It is sometimes possible to remedy this by adding steel balls. The balls are heavier than the stones and will stay at the bottom of the load. They should cause the stones to tumble. This method should be tried as a last resort. Around 100 steel balls for a 12-inch drum should work. Increase or decrease the amount for other sizes of drums.

Silicon carbide grit will ruin bearings. During all your inspections, be especially careful that grit does not splatter on machinery and motors. If it does, wash it off immediately.



When the stones are thoroughly rounded and the blemishes are removed, you are ready to start the next abrasive step. Usually, about 75 per cent of the stones are ready. If you need them for bulk, keep the other 25 per cent in the load. Otherwise sort them out and hold them back for the next grinding load. Many people tumble two drum loads in the coarse grit so that they will have enough good stones for the next step. Everything must now be washed *thoroughly*. The stones can be washed in a plastic colander or a wooden frame with a bottom of strong screen. Don't use aluminum screen; it will leave marks on the stones. Hold the stones over a drum or a hole in the ground and wash them with water under strong pressure. *Warning: NEVER wash grit into your drainage system. It will soon clog the pipes.* It is best to drain the "goop" into a hole in the ground and cover it. Make sure the coarse grit is cleaned out of crevices in the stones. If necessary, use a brush to remove grit. Hose out the drum thoroughly.

After the stones are washed thoroughly, let them dry. Remove stones that are still rough or unfinished and keep them for another coarse grind. Unless you need them for bulk, discard badly fractured and unattractive stones. Then proceed to the next grind (to be covered in the next section).

A Professional Method

One professional tumbler uses only 30-60 grit for the entire abrasive process. His method is certainly not the *only* way, but it does turn out beautiful stones. For a load of stones of the hardness and toughness of agate he follows these steps:

1. Crush and select the stones as usual.
2. Charge the drum so that it is ⅔ full. The grit should total 10 per cent by weight and the stones 90 per cent. Add water so that it is a little below the level of the stones.
3. Tumble for 6 days. Inspect and release the gas daily. At the end of 6 days, drain the abrasive into a drum or other suitable container and keep it for using as filler. Recharge with new grit, 10 per cent by weight, and water.
4. Tumble for 6 more days and repeat step 3.
5. Tumble for 6 days. Then add some of the used grit you kept from steps 3 and 4. This will thicken the slurry for the smoothing operation. Tumble for 6 more days and your stones should be ready to polish.

The time required for the last smoothing will vary with different stones. Check them daily. When the stones have a *smooth* frosted surface, they should be ready. You can check to see if they will polish by touching them to a running buff with a little polishing compound on it. When they are ready, wash them thoroughly.

The next section will cover conventional smoothing methods, polishing, vibrating tumblers, and other pertinent subjects.

GEM CUTTER'S HANDBOOK

TUMBLING — PART 2

In the previous section two methods of grinding baroques were covered. If you have followed the conventional method, you are now ready for either an intermediate or a final grind. If you have followed the professional method successfully, you should now be ready to polish.

Again, it is suggested that you first follow the instructions received with your tumbler relative to what grits to use. If the instructions call for it, your next step will be:

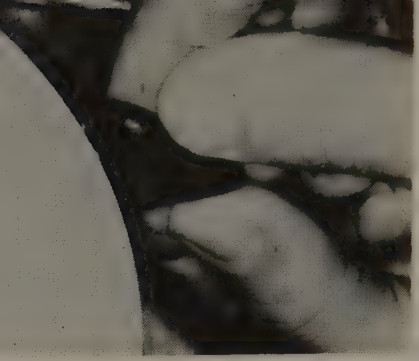
The Intermediate Grind

Before putting the stones back in the tumbler, be sure that the drum has been thoroughly cleaned and that all coarse grit has been removed. In your records, note information such as the weight of the stones after the first grind, when you put them in the tumbler, how full the drum was, and any other pertinent information about the appearance of the stones and tumbling conditions. Then add one pound of 220 or 2F grit for each eight to ten pounds of stones. Add enough water to cover the stones. Close the drum if you do not have an open-end tumbler, and start the motor. Check the stones and release gas pressure at least every 24 hours. The intermediate grind should take about 100 hours. Its purpose is to smooth, not remove material. The stones should have been shaped and the major amount of material removed during the coarse grind. Check during the intermediate grind to determine if the marks left by the coarse grit are being removed. When the coarse marks have been smoothed away you are ready for:

The Fine Grind

Many tumblers eliminate the intermediate grind and go directly to fine grit. Others believe it will take less time in the fine grind if an intermediate grit is used. Experimentation will determine which method is best for you.

Before the fine grind, the stones and tumbler should be thoroughly cleaned so that none of the previous grit remains. Place the stones gently in the drum so that they will not be fractured by striking each other or the tumbler walls. If you started with the tumbler ⅔ full, it should now be between 2/5 and ½ full. If it is not, more material should be added. Only material that has gone through the previous grits should be used as filler. As you progress in tumbling, you will accumulate extra material that can be used. Many enthusiasts tumble two drum loads in the coarse grit so that they will have enough stones for the fine grind. To the stones add one pound of 3F, 400, or 500 grit. Pour in water to cover, make the appropriate notes in your records and start the tumbler. Check the stones every 24 hours. The fine grind will take between 100 and 150 hours.



Checking Progress

If you have a buff for polishing cabochons, you can check to see if the baroques are ready to polish. After they have tumbled for about 72 hours in the fine grit, remove some from the drum and wash them thoroughly. Apply some polishing compound to the revolving buff and try to polish a baroque by hand. If it polishes immediately, the fine grind is completed. First make sure that the polish on the buffed stone is excellent and not just a shine which conceals pits and blemishes. Use this check every 24 hours until you are sure the stones are ready to polish. At this point the baroques should be absolutely smooth with a frosty appearance. Thoroughly inspect them to make sure they are *all* ready for polishing.

As with other grits, it may be necessary to add water if the slurry becomes too thick. *Do not add fresh grit* during the fine grind.

Slurry Thickness

It is often advisable to thicken the slurry in the fine grind. As mentioned in the previous section, you can save used grit for this purpose. Sugar and oatmeal are frequently used to make the slurry into a thick syrup. There are also commercial compounds available from rock hobby suppliers. Some of these additives are said to aid polishing as well as thicken the slurry. Instead of thickening the tumbling mixture, fillers, such as rice or walnut hulls, corn cob fragments, leather squares or sawdust are frequently added. The important thing is to keep the stones from chipping during this final grind. If they chip they must be run again in coarse grit.

The Superfine Finish

After the fine grind, a few tumblers run the baroques through an extra fine grit such as 600, 3F, 800 or 1200. Experts generally advise that this step is unnecessary. However, if you cannot get the desired results with the fine grit, it is worth a try. First, make sure your problems are not due to contamination from coarser grit.

Polishing The Baroques

When you have determined that the stones are absolutely ready for polishing, wash everything until it is super clean and absolutely free of grit. It may be necessary to scrub the stones individually with a brush. Sort out any rough or broken stones; they can scratch the others. Then charge the drum so that it is at least 2/5 full. Add either pure tin or cerium oxide in the ratio of ½ pound to every 10 pounds of stone. You can also use levigated alumina or one of the commercial tumbling polishes. Add water to cover and just a pinch of detergent soap to break surface tension. It is usually advisable to use one of the thickening additives (not used grit) or a filler to cushion the stones. If your tumbler

has variable speeds, set it on the slow speed. Start the tumbler and check the stones every twenty-four hours. To check, wash some stones, set them on an absorbent material under a good light, and watch them as they dry. When their appearance is the same, wet or dry, the baroques are polished. You can also check them by polishing on a dry buff (be careful of heat). If they polish immediately, the polishing operation is almost complete. Many stones require between 48 and 72 hours to polish. The time is much longer for others. Remember to record your results.

Burnishing

When you are satisfied with the polish on the baroques, remove them from the drum and again wash everything thoroughly to remove all polishing compound. Gently place the stones back in the drum and add water and detergent soap. Use enough detergent to make a thick slurry that will cushion the stones and reduce foaming. Tumble the stones in this mixture for about twelve hours. Then remove them and wash away the detergent.

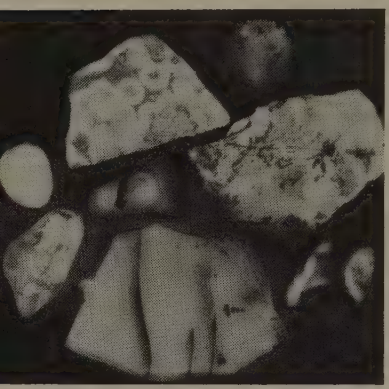
Spread the baroques on an absorbent cloth under a strong light and let them dry. Then sort them carefully and remove any undesirable stones. Baroques that are not well polished can be run again with another load. Stones with poor color and appearance can be saved to be used as filler.

A Professional Polishing Technique

The professional tumbler who uses 30-60 grit for all grinding operations (see previous section), also has a different method of polishing. On most stones he uses only detergent soap, no polishing compound. After the final grind he washes away all grit and then charges the drum with enough detergent soap and water to make a thick slurry. He tumbles this mixture for 2 or 3 days to prepolish the stones and wash away any grit and residue that may have gotten into inaccessable crevices in the stone. Then he empties the drum and washes the stones and drum. The thickness of the detergent slurry is varied for different stones. Delicate stones require a thicker slurry than tough stones. The chart below shows some of the mixtures used in mild weather and the time required for several different stones.

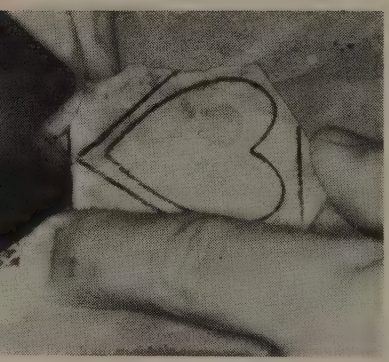
Stone	Detergent	Water	Approx. Time
Cryptocrystalline quartz (agate, jasper, silicified wood)	1 part	1½ parts	8 days
Crystalline quartz (amethyst, citrine, etc.)	1 part	1 part	12-15 days
Massive crystalline quartz (aventurine, etc.)	1 part	1 part	12-15 days
Common opal	1 part	1 part	7 days
Obsidian	1 part	1 part	7 days
Opalized wood	1 part	1 part	7 days
Rhodonite	1 part	1 part	14 days

Keep in mind that the results shown in the chart will vary with temperature and detergent used. The professional uses a detergent packaged by a local supermarket. At one time he used Tide, but when the formula of that detergent was changed, it no longer gave the desired polish. If you use detergent as a polish, you will have to experiment and keep a record to get the best results. The professional also believes there is some chemical action in a detergent polish. Once, when he let some agate set idle in detergent, the surface of the stones was etched. He advises that stones in detergent should be kept in motion at all times to avoid etching.



Tumbling Slabs

Small slabs cut from Mexican agate nodules, small thundereggs, and other material can be polished in a tumbler. The edges of the slabs should be rounded with a grinding wheel or coarse sander. The slabs should be mixed with round or baroque shaped stones about ¾-inch in diameter so that the baroques will be between 50 and 75 percent of the load. Charge the drum as you would with baroques and follow your regular tumbling routine. It may take longer to process the slabs than it does a load of baroques. Make sure that the slurry and drum speed are regulated correctly to avoid chipping the slabs.



Tumbling Preforms

Slabs can also be shaped into preforms and tumbled. Squares, triangles, hearts, crosses, and a multitude of other shapes can be produced. It is impossible to tumble them so that they will fit standard mountings, but they can be used with cement-on settings. They can also be drilled for jump rings or pegged bails.

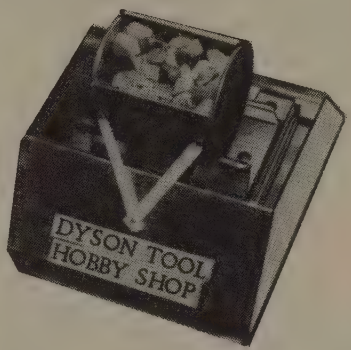
First mark the desired shape on a slab. Then saw out a blank just as you would for a cabochon. Then round the edges of the preform and grind away any projections left by sawing. Mix the preforms with baroque shaped stones as you would slabs and tumble them. Handle the preforms with care to avoid chipping or breaking. Like slabs they may require more time than baroques.

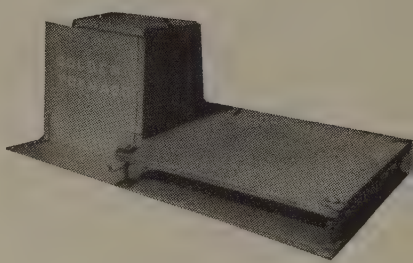
Faceted Baroques

Another type of preformed baroque can be made from pieces of transparent or translucent gem material. Stones with some color tint are most attractive. To make a faceted baroque, use a grinding wheel or a lap plate with 220 grit to grind a flat base on the selected stone. Then dop the stone on the base. Grind away all pits and blemishes and then grind random facets across the top of the stone. Use your ingenuity to make attractive patterns with the facets. Large facets can meet small facets. When you have accumulated a dozen or more faceted preforms, tumble them with stones of the same hardness. The preforms will not require as much grinding time and should be put in the tumbler after the rough edges have been ground off the other baroques. Inspect the preforms daily to determine when they should be removed from the drum.

Vibrating Tumblers and Tremblers

A different approach to tumbling is the machine that uses vibration instead of rotary action to tumble the baroques through the abrasive and polishing compounds. A variety of the vibrating tumblers and tremblers are available as finished machines or kits. According to some manufacturers these units reduce tumbling time 50 to 75 percent Basically a vibrating tumbler consists of a hopper or hoppers mounted on a platform. The motor vibrates the platform rapidly. Manufacturers' instructions vary, but charging the hopper is much the same as charging a rotating drum. The slurry must adhere to every stone. If the slurry is too thin, the grit will wash away; if it is too thick, the stones will not tumble satisfactorily. Some manufacturers supply an additive to make the slurry adhere. Instructions supplied with the tumbler should be followed.





Helpful Hints

Grit may be conserved to use as a thickening additive. It is not usually feasible to save grit to be used as a fine abrasive. Most reclaimed grit is broken down too much to be effective, but it may contain a few large grains that will scratch. The broken down grit used as a thickening additive should be derived from the same grain size as the new grit being used.

If you are tumbling some fairly large stones (1½-inch diameter or larger), remember to add some small stones to carry the grit into crevices. Thundereggs and geodes are sometimes tumbled in coarse grit to remove the outer coating.

Smooth stones such as beach pebbles will not require as much time for grinding as rough broken stones. Usually stones of varying hardness should not be mixed, but for the first grind it is sometimes possible to mix hard, smooth stones with rough, soft stones. Ideally, they will all be ready for the fine grind at the same time. Check them carefully every 24 hours.

Vary speed or slurry thickness for different gem materials. Stones that fracture easily should be run in thicker slurries. According to a professional tumbler, the slurry does not often need to be thickened for the first grind. He feels that if the stones strike against each other and the tumbler sides, they will break along cracks and fractures. He uses a thicker slurry for delicate stones such as obsidian. His experiments reveal that tough agates and jaspers will stand much rougher treatment. He seldom thickens slurries for these stones until the final grind.

Remember, always keep a log of your results. After you have tumbled several batches of stones, you will have a record that will help you reduce time and effort.

Tumbling can be used to orient some stones for cabochon cutting. It's the best way to find asterism in star garnets.

The grit and stone dust mixture from a tumbler is often difficult to remove from your hands. Sta-Lub, a product sold in auto supply houses, will remove it easily and protect your hands.

One hobbyist saves cerium oxide residue from tumbling. He strains it through cheesecloth or a nylon stocking and uses it to polish the chrome on his car.

When you are finished tumbling, be sure to clean your tumbler thoroughly and dry it. Put a little oil on oilite bearings. Do not allow oil to contact roller edges of drums.

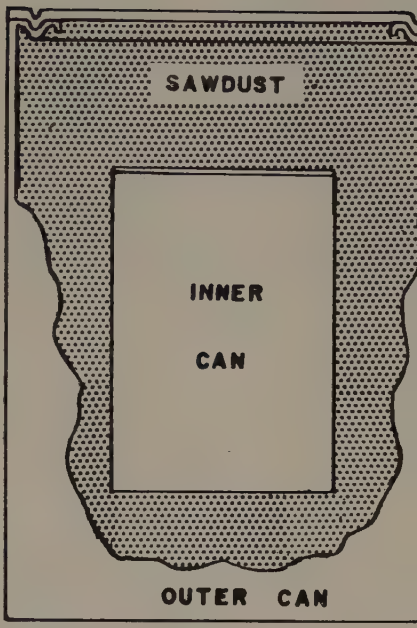
Avoid grit contamination. When you store grit, it is a good idea to keep coarse grit on a low shelf, fine grit on the shelf above, and polishing compound on the top shelf. Always keep grit containers tightly closed.

Egg cartons are handy for storing baroques. Stones of different color and size can be kept in the separate compartments.

One hobbyist eliminated the mess in his tumbler drum by tumbling stones in sections of inner tube. Two hose clamps are needed for each piece of inner tube. Clamp one end of the tube shut (see picture). Partially fill the tube with stones, grit, and water. Then clamp the open end tightly. The filled bag is then placed in the tumbler drum and rotated. Several bags can be tumbled in the same drum, and the drum does not need to be watertight. The tubing will expand, but gas pressure should be relieved daily. *Note*: it is a good idea to wrap the clamps with friction tape to prevent puncture.

More Hints

Tin can tumblers are noisy. You can reduce the noise by using two cans as shown in the drawing. The outer can has a one-gallon capacity and the inner can a one-quart capacity. Charge the quart can with a standard load of stones and abrasives. Pour about one inch of sawdust in the bottom of the large can and then put the quart can in the center of the larger one. Fill the balance of the large can with sawdust clear to the top, packing the sawdust firmly in place. Put on the cover, and place the can on the rollers of your tumbling machine. It will work on most machines designed for tin can drums. The larger can will change the speed of the tumbler, reducing it about one-third. If this is too slow, install a slightly larger pulley on the motor or a smaller one on the drive shaft.



Sawing Baroques

Sometimes baroques can be sawed into attractive matching halves. The flat backs of these stones can be glued to cement-on pads on cuff links, button backs, etc. (Mounting baroques will be covered in the next section.) There are several ways to saw a tumbled stone. You can hold it by hand as shown in the picture. Note the position of the fingers; the stone must be gripped securely. Rest the baroque on the saw table and press it slowly into the revolving blade. Use plenty of coolant. If the stone starts to climb the blade, you are pressing too hard. Try this method on a reject stone first.

It is much safer to dop the baroque to a block of wood. Heat the stone as you would a cabochon. At the same time, melt some dopping wax and pour a glob on the end of a block. Set the stone in the wax. You can hold the block by hand or clamp it in a trim saw vise for sawing.

You can also make a sawing jig from a block of ¾-inch thick wood. Drill holes large enough for the baroques and saw slots into the holes. Insert the stones in the holes and pour melted paraffin over them. Then saw through the slots into the stones.

After you have sawed the baroques, round the sharp edges on a sander or rubber bonded abrasive wheel. The backs should be left rough for cementing. If they have wavy saw marks, these can be cut down on a coarse sander or grinding wheel.

Some Tumbling Formulas

In addition to the polishing methods shown in the professional's chart, here are some formulas used by other experts for some difficult-to-polish materials.

Apache Tears

1. For best results do not tumble these stones with other obsidian or other materials. 2. Coarse grind as usual. 3. Fine grind with 600 grit. Grind until the grit is broken down completely, and the stones have a fine semipolish. 4. Try polishing a tear on a buff with a polishing compound. If it does not polish readily, more fine grinding is needed. 5. Polish in a mixture of tin oxide and sugar. If the stones click against each other, reduce the drum speed. Add sugar until the slurry is a thick syrup. (Probably one of the thickening additives could be used instead of sugar.) Polish for 75 to 100 hours. Then wash and dry the stones. Finish by burnishing in a *very thick* mixture of water and detergent.

Crystalline Quartz

1. Allow enough time in grinding and use enough fine carrying material to carry grits to all surfaces. 2. Before polishing, run the quartz in detergent for 10 hours. 3. A satisfactory polishing compound is a mixture of three tablespoons of oxalic acid in a pound of aluminum oxide. Fill the drum ⅔ to ¾ full even if some filler such as corn cobs must be used. Tumble polish the baroques for at least 6 days. 4. After polishing, burnish in detergent for one day.

Abalone Shells

1. Tumble the shells in fine, clean, sharp, quartz sand and enough water to cover for 24 to 36 hours. 2. Wash thoroughly and dry. 3. Add tripoli in the ratio of 1 pound tripoli to every 50 pounds of shell. Tumble this mixture for 12 to 24 hours. 4. Thoroughly wash everything and dry the shells *completely*. 5. Charge the drum with the shells and enough hardwood sawdust to keep the shells from bumping. Add Stanoxite polishing compound (available from Gordon's, Box 4037M, Long Beach, California) in the ratio of one pound Stanoxite to every 50 pounds of shells. Run this mixture *dry* for 2 hours.

The next section will cover methods of mounting baroques into jewelry and other uses for tumbled gems.

GEM CUTTER'S HANDBOOK

TUMBLING

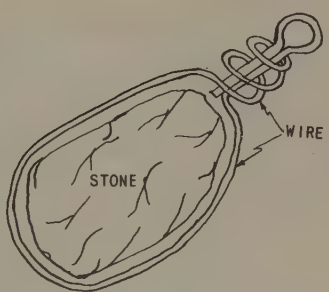
Part 3 — Mounting Baroques

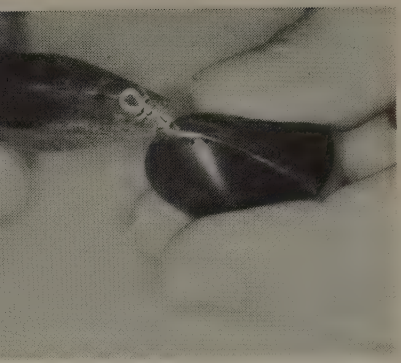
When you have successfuly polished some baroques, what will you do with them? They make attractive displays just as they are, but there are many better uses to which they can be put. Baroques are usually set in some sort of jewelry for which there is a wide variety of mountings. Tumbled stones can also be used to decorate utility items, make mosaics, and for other ornamental and artistic purposes.

There are several methods of attaching baroques to mountings and other objects. Epoxy cement is most often employed; it is easy to use and makes a good strong bond. Cementing methods and several other mounting techniques are reviewed in this section. In addition, there are instructions for making some jigs which will make the job easier.

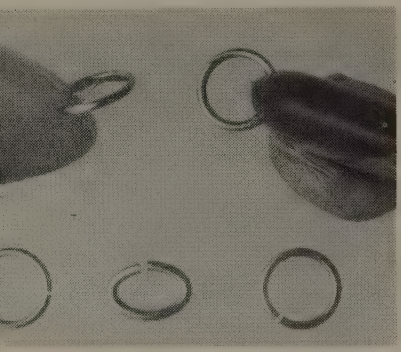
Twisted Wire Setting

A common method of mounting baroques is to attach loops to the stones and hang them from jewelry settings designed for that purpose. Wire can be used to form the loop. First a groove must be cut around the baroque. You can do this with a trim saw, the sharp edge of a grinding wheel, or the edge of an abrasive sharpening block. If you use a saw or grinding wheel, grip the baroque securely. Apply it to the blade or wheel lightly, and groove it around its entire circumference. You will need some smooth jawed pliers and jeweler's wire (available at rock hobby suppliers). Sterling silver or gold-filled wire of about 18 gauge is excellent. Cut off a piece of wire and fit the center into the groove at one end of the stone. Bend the wire around the baroque and into the groove. After making the wire as tight as possible, twist the ends one turn at the other end of the stone. Then bend one end of the wire down to form



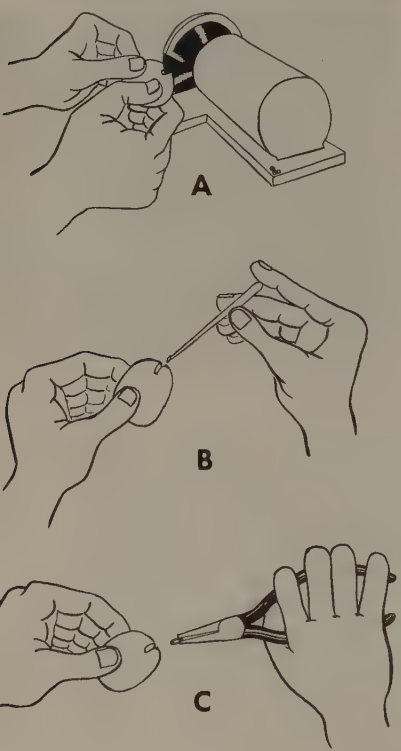


a loop, and if necessary cut off any excess so that the end will be against the stone. Wrap the remaining wire end around the bottom of the loop for a few turns and cut it off. File this end smooth with a fine toothed jeweler's file. Then grasp the loop and the twisted shank and twist it some more until the wire is tight around the stone. *Note: It is possible to have loops at each end of the stone if you twist one in the middle of the wire before forming it around the baroque.*



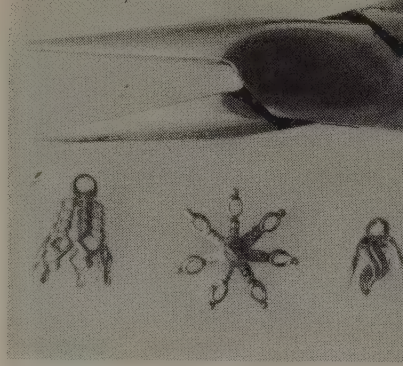
Nicking Baroques

There is a much easier way to attach a loop to a baroque. For this method you need a trim saw with a thin blade (a 4-inch x .020 blade is ideal), some jump rings and epoxy cement. Jump rings are small wire rings that can be purchased in a variety of sizes from rock hobby suppliers. They are available in gold or silver color and in round, oval, and triangular shapes. The first operation (A) is to nick the end of the stone with the saw. The depth of the nick should be about 1½ times the thickness of the jump ring. After nicking, wash the stone with detergent and dry it thoroughly. Next mix some epoxy cement. Use a flat toothpick to fill the nick with cement (B). Be sure the cement adheres to the sides and bottom of the nick. With some tweezers or long nose pliers set the ring into the slot (C). Put the joint in the jump ring at the bottom of the slot. Use the toothpick to lead the epoxy which squeezes out to the center so that the cement completely covers the lower part of the ring and fills the slot. Wipe off excess cement. Let the epoxy cure according to directions. The stone is then ready to attach to a mounting. See page 53. *Note: If the jump ring is too thick for the slot, you can enlarge the slot with a diamond abrasive nail file (available at cosmetic counters). Instead of epoxy, you may wish to use some of the new quick setting adhesives like Cemedine 3,000 (available at rock shops).*



Bell Caps

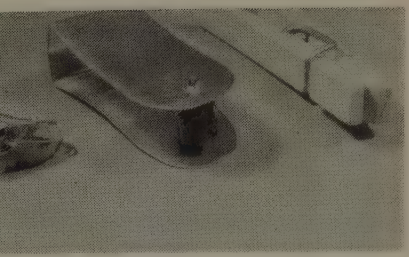
A bell cap is a jewelry finding consisting of prongs which fit over the tip of a baroque and a ring for attaching to a mounting. The prongs can be formed to fit the shape of the baroque. The cap is cemented to the stone, usually with epoxy. Gold and silver colored bell caps are available in a variety of sizes and styles. In addition to the caps and cement you should have a pair of jeweler's smooth jawed, chain nose pliers. The caps, cement, and pliers can be purchased at most rock shops.



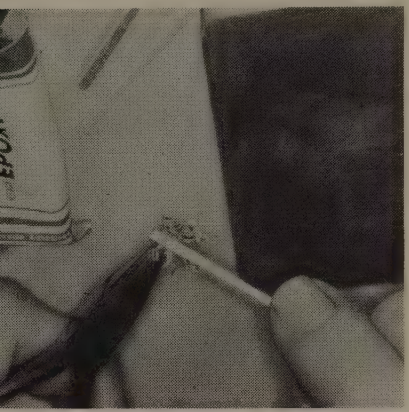
Before attaching the cap, the stone should first be prepared so that the cement will adhere. One way is to wash the baroque with alcohol and then with water to remove all oil and grease. A much better method is to rub the tip of the baroque with a piece of sanding cloth or broken grinding wheel. This produces a rough spot to which the cement can cling.

When the stone is prepared, push a bell cap onto the abraded tip. The prongs will be forced outward. With your fingers form the prongs to make a close fit around the baroque. You will probably have to use the pliers to bend some of the prongs. Often, just the tips of the prongs must be bent so that they will touch the stone.

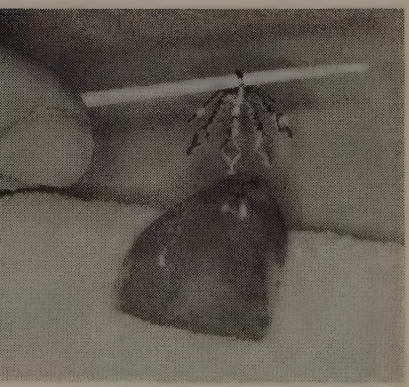
When the cap is properly formed, some arrangement must be made to hold the baroques for cementing. Some of the most common holders are a jar lid filled with sand or salt, modeling clay, styrofoam blocks, and pieces of soft foam plastic or rubber. The stones are pushed into the material so that they set upright. If you use foam plastic or rubber, cut slits in it to hold the baroques. Push the stones into the holding material and set the caps on them in proper position.



Clamps may also be used to hold baroques for cementing. Spring clothespins are commonly used. You can also make clamps from a piece of stiff wire. Form a small loop in one end of the wire for the cap and a larger loop in the other end for the bottom of the stone. Then bend the wire in the middle. Sheet metal clamps similar to the one pictured are available at many rock shops.



To cement the cap, mix epoxy according to the manufacturer's instructions. A piece of aluminum is a handy mixing plate. When you are finished cementing, wipe the block clean with a damp cloth before the epoxy hardens. Use a flat toothpick to apply epoxy to the inside of the cap and top of the stone. Use enough cement to fill the cap and coat the insides of the prongs. Then set the cap on the baroque, positioning it correctly. Some cement will squeeze out between the prongs. Most of it will shrink under the cap as it sets. If any cement runs down the stone, wipe it away with a clean cloth. Set the baroques aside until the epoxy hardens. This usually takes about 24 hours. Some epoxy can be hardened by heating in an oven which reduces the time to about 2 hours. Refer to the manufacturer's instructions. If you use this method, do not use a holding material which will melt.



Bails

Cement-on bails are also available for mounting baroques. Like bell caps, the bails are formed to fit the stone. If you sand the stone for cementing, only that part which will be under the bail should be abraded. Use the same cementing technique that you would for bell caps. With some bails, however, clamps cannot be used because they push the bails too far down on the stones.

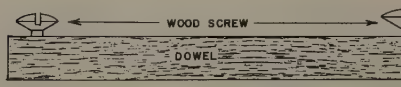
Up-Eyes

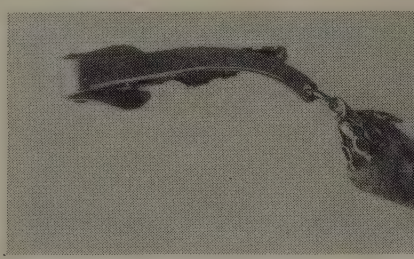
An up-eye is a prongless cap. These caps come in several sizes with a variety of flat and concave bases to fit different stone shapes. Some hobbyists use those with flat bases and grind a tiny flat spot on the tip of the baroque. Epoxy is used to attach the caps to the stones.

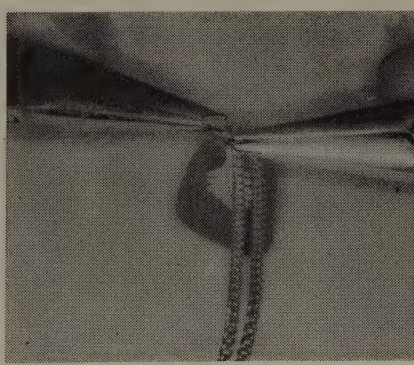
Attaching Baroques to Mountings

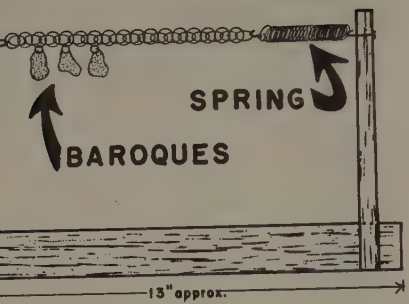
About the simplest jewelry finding in use is the earwire which has a split ring from which the loop on a baroque is hung. With a pair of smooth jawed pliers gently twist the split ring until it opens wide enough to accept the loop. Hang the stone on the ring and then twist the ring to close it.

Jump rings are required for most baroque mounting. These rings come in closed position, and must be opened for use. Twist a jump ring to open it; never spread it. You can use pliers for twisting or the tool shown in the drawing. The tool consists of a piece of ½-inch dowel with a large flat head, or oval head wood screw, near one end and medium size screw near the other. The screws are started into the drilled holes, then removed. Epoxy is spread on the threads and the screws replaced in the holes. The slots run perpendicular to the length of the dowel. To use the tool, one side of the jump ring is placed in the screw slot and the dowel used as a handle to twist the ring open. The procedure is reversed to close the ring. Some mountings, like the tie bar shown, have loops for jump rings. If you hang a baroque on a neckchain with a large ring, you will have an attractive pendant.

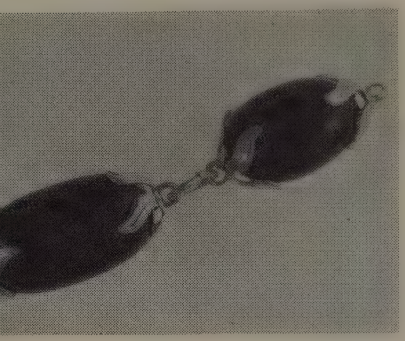




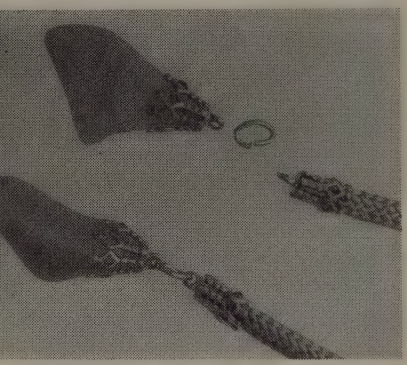




Several baroques can be hung from chains with medium to large links to make attractive bracelets and necklaces. It is difficult to hold the chain by hand and space the stones correctly. A jig, like the one shown in the drawing, simplifies the task. All you need is three pieces of wood, a piece of wire to make two hooks, and a spring. It is a good idea to make two jigs, one to accommodate bracelet length chains and one for necklace chains.



Instead of hanging baroques on a chain, you can actually use them as beads. Put a bell cap or up-eye on opposite ends of each baroque, then join the stones together with jump rings. To complete the string of "beads," attach a clasp and ring to the two ends. Sometimes, short lengths of chain are attached to the ends of the string and the clasp and ring attached to the chain. Clasps, rings and bulk chain are available at rock shops and from mail order suppliers.



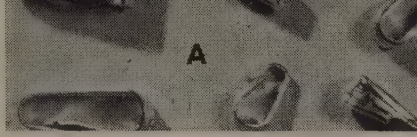
Baroques are sometimes used for bola tie tips. Four bell caps are used. Two caps are attached to the baroques. The other two are cemented to the tips of the bola cord. The stones are connected to the caps on the cord with jump rings. Instead of using caps on the ends of the cord, you can purchase bola tips with loops for jump rings.

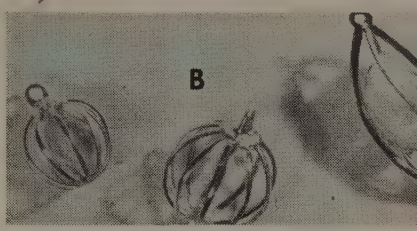
Flat Mountings For Baroques

Tie bars, cuff links, bola slides, earrings, bracelets, button backs, and a wide variety of other jewelry items are available with flat spaces on which baroques can be cemented. These mountings can be used for pebble shaped baroques, but work especially well for sawed baroques and those that are naturally flat. The backs of the stones should be abraded for cementing. Sawed baroques do not need this preparation; the cut surface is rough enough. Wash sawed stones with alcohol to remove saw coolant.

Other Findings and Mountings

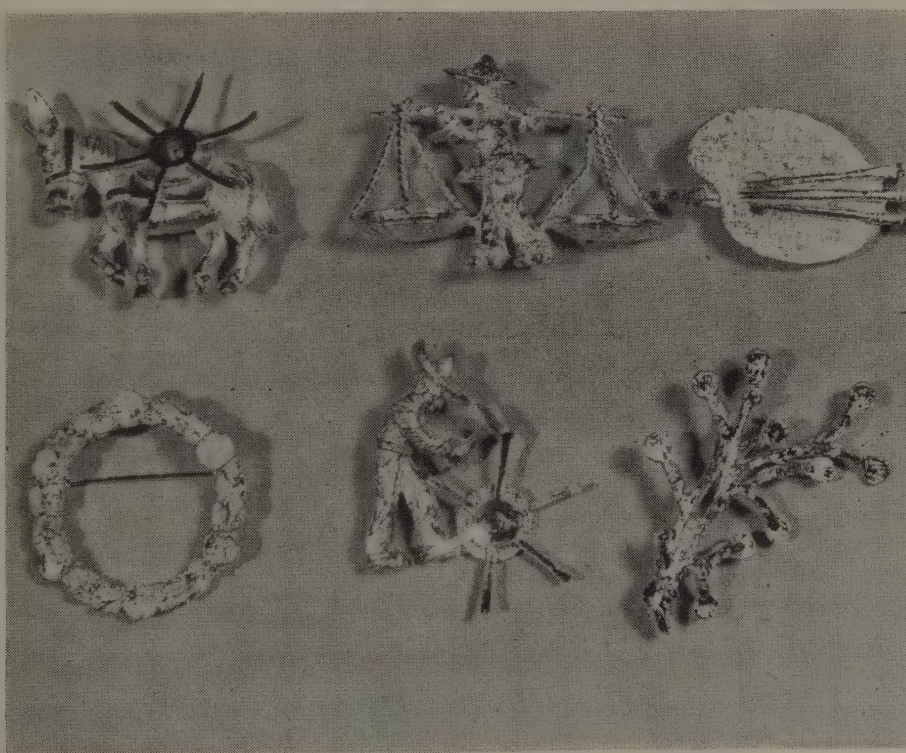
The findings shown in picture A are spring bails. These are used instead of jump rings when findings such as pendants are to be hung from chains. To use a spring bail, press in the top half and hang the finding on the bottom hook of the bail. Release the top half and the bail will close. The bail can be slipped over the end of a chain or opened up if the chain's end is too large.

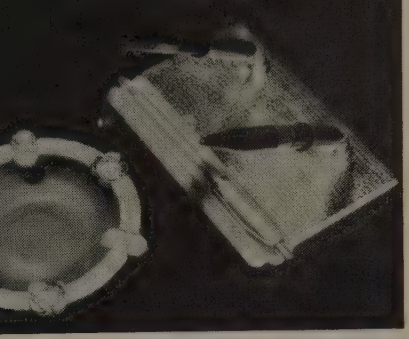




The findings in picture B are cages. Baroques can be placed in a cage by moving over one bar. After inserting several small baroques, move the bar back in place and hang the cage on a mounting.

Mounting styles are too numerous to list. Pictured below are a few novelty mountings which incorporate baroques into their design. Notice that some of the mountings have prongs which bend around the stones so that cementing is not required. (Courtesy of Crestmark Manufacturing Company.)

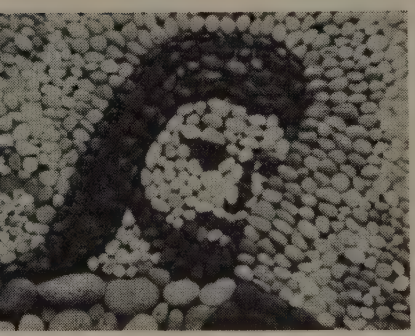




Using Baroques for Decoration

Baroques can be used to decorate items other than jewelry. They can be cemented to bookmarks, ashtrays, paperweights, pen bases, etc. Some utility items are made with settings for tumbled gems. If you cement baroques to other stone objects such as onyx pen bases, sand the back of the baroque and the spot on the other stone where the baroque will be placed.

Tumbled gems can be worked into artistic designs for plaques and other decorative items. On the plaque pictured, baroques were used for flower petals. Tiny tumbled gems are sometimes used to decorate greeting cards. Some hobbyists cement or push baroques into styrofoam Christmas decorations to make personalized tree ornaments.



If you are interested in a project with a challenge to it, an impressive mosaic can be made with baroques. Some enthusiasts tumble very small stones for this purpose. The stones are separated by color and size and stored in egg carton compartments or jars. White glue, like Elmer's Glue or Wilhold, is used as the adhesive. Anyone, who is not artistically gifted, can trace pictures or use a paint by number blank instead of drawing a picture.

Helpful Hints

The uses to which baroques can be put are limited only by your imagination. Tumbled gem jewelry is very popular, and most rock shops and mail order suppliers carry a wide variety of men's and women's jewelry mountings, key chains, etc.

Occasionally, a finding which has been cemented to a baroque is broken. To remove the finding you can dissolve the epoxy with a solvent such as Sherwin Williams "Wash-Away" paint thinner. Another method is to melt the epoxy by heating with a soldering iron.

If you have any baroques with small holes in them, try filling the holes with epoxy. The filling will not be noticeable on many stones.

GEM CUTTER'S HANDBOOK

CABOCHON CUTTING AND FLAT LAPPING WITH DIAMOND

Until just recently, the use of diamond abrasive in gem cutting was limited mostly to making saw blades, charging faceting laps and with various types of wheels or cups for cutting hard stones. A few cutters used diamond grinding wheels, but the general feeling was that these were too expensive for the average hobbyist. Now, some manufacturers have made available diamond tools that will grind, smooth, lap and polish stones with ease and efficiency. These new aids are a little more expensive than those made with silicon carbide as far as the initial investment is concerned, but in the long run they often prove more economical. Most of them are within the price range of the average hobbyist.

Diamond is the hardest substance known to man. On the Mohs scale it is rated at 10 which is only one point higher than corundum. However, a glance at the Knoop scale shows that it is really rated at 10,000 which is almost five times as hard as corundum (2100) and a little under four times as hard as boron carbide (2750). Because of its great hardness, diamond cuts rapidly and reduces the length of any lapidary work appreciably.

About Diamond and Heat

In advertising literature for diamond tools you will often find the statement that diamond cuts cooler than other abrasives. Yet in many gem cutting instructions, you are told that diamond abrasive must always be run wet because running it dry will generate heat that will ruin it. The reason for this seeming paradox is that diamond is an excellent heat conductor. It does keep the work cool because it conducts heat away from the stone being cut. If a coolant is used, the heat is transferred to it. However, if there is no coolant, the heat is conducted to the bond. A resin bond deteriorates from high heat and the diamond is released, ruining the tool. A metal bond retains the heat and, if high enough temperatures are generated, the diamond can carbonize.

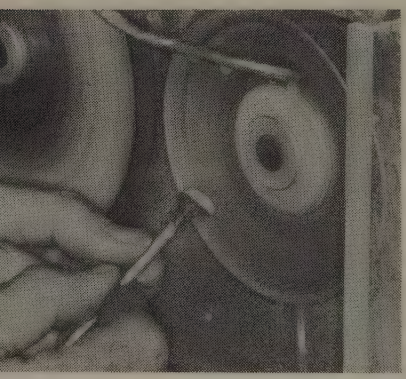
In most cases, a coolant must be used. There are some exceptions where diamond compound is used which are covered in the instructions that follow.

Products Available

Diamond tools are available from several companies, but two manufacturers, Pacific Test Specialties and Minnesota Mining and Manufacturing (3M) are specializing in the field. The Crystalite line from Pacific Test includes flat and dish-shaped grinding wheels, special cloth discs (Crystalpads) for smoothing and polishing with diamond compound and the compound. From 3M Company there are strips, discs and endless belts with diamond in resin bond for cabochon smoothing. Also, 3M has resin bonded discs for flat lapping and metal bonded faceting laps that may be used for grinding.

Grinding

Flat and cup shaped wheels both come in coarse, medium, fine and extra fine. The flat wheels are excellent for profiling and the cup shaped wheels work well for doming cabochons (especially hard stones). A good combination is a coarse (100 or 180 grit) flat wheel and a fine or extra fine (600 or 1200) cup wheel. However, if you can afford only one, a medium (260) grit is best. Either the flat or cup shape can be used for all cabochon operations. These wheels can be mounted on any true arbor, including a faceting machine, that will run at the proper rpm. Shown here is the Diamond Demon, a machine produced by Terra Marine Products especially for diamond wheels.



Pacific Test Specialties recommends some type of water soluble coolant such as RocKut from Clark Sales or Covington Koolerant. The additives in these products act as wetting agents and retard rusting.

For the rough grind, assemble the wheel to the arbor, turn it on and adjust a drip flow which will be just enough to flush away any cutting debris (about 2 drops per second is sufficient). For an operating speed, try between 800 and 1600 rpm or between 2 and 7 on the speed control if you have a Diamond Demon. First, profile the stone to the template outline. You can use about any pressure you desire, but a light touch gives better cutting control. Like any grinding, you may hold the stone by hand or on a dop.

Unlike a faceting disc, it is not necessary to work across the entire face of the wheel. For rapid stock removal, you can use the outside, and for more control, you can cut closer to the center.

When you have cut close to the outline, dome the top. If you have a coarse or medium cup wheel, it will speed the job.

Finish grind on a fine or extra fine cup wheel, if available. Use about the same speed as for coarse grinding.

As you learn to cut with these wheels, experiment with running speed. Some experienced cutters report that they start at a lower speed with plenty of pressure and finish at high speed with very light pressure. At the end, they are touching only the tops of the diamond particles which produces a finer finish.

In using diamond, also bear in mind that the action is different than with other abrasives. Do not try to use the same techniques you would with silicon carbide. You are learning to use an entirely different tool. Experiment and get the most out of it.

During grinding and between grinding and smoothing, it is not necessary to wash the stone because there is no contamination. You may want to wash it off occasionally if any cutting debris accumulates so that you can check cutting progress.

If your machine has more than one arbor spindle, leave the fine grinding wheel on it when you start smoothing. If, during smoothing, you find an area that needs touching up on the grinding wheel, it can be done conveniently.

Smoothing

The diamond smoothing method developed by Pacific Test Specialties requires diamond compound, a metal sanding and polishing head with sponge rubber pad (A) and a special resin treated Crystalpad (B) available from the firm or its dealers.

The Crystalpad is attached to the sponge rubber pad with a good grade of feathering or Peel 'em Off type cement. Follow the instructions on the cement container.

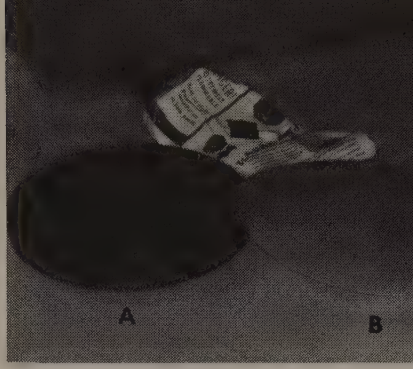
For smoothing, 600 grit compound is used, even if you have used an extra fine grinding wheel, because the pad, with its resilient backing, removes any flat spots left by the hard grinding wheel. If a finer grit were used on the cloth, it would take too long for this final shaping action.

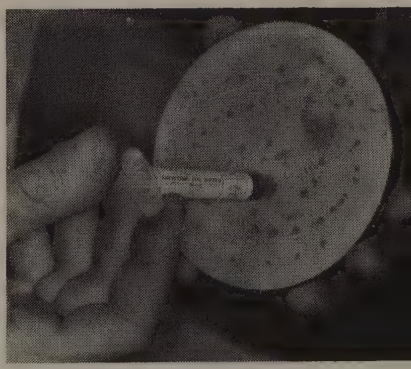
Diamond compound is available in syringes that make it easy to apply. Along the sides of the syringes are graduated marks that let you know how much you use. Apply the compound in tiny dots all over the Crystalpad, using about 2/10 gram.

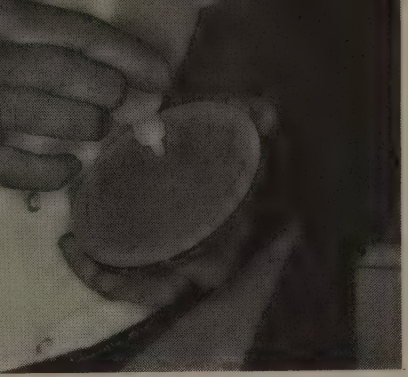
After the dots have been applied, spread them evenly across the pad with your fingertip.

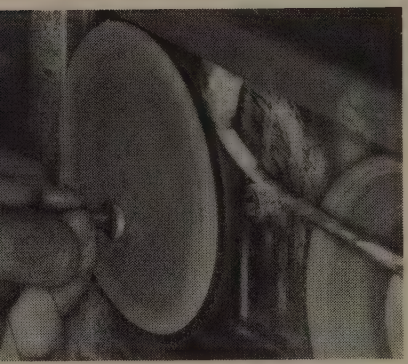
Note: loose diamond grit in oil or other carrier is not recommended by Pacific Test. It was found to be hard to apply and wasteful.

To finish spreading the diamond, add about 3 drops of diamond extender









fluid (available from suppliers of diamond compound). Again, spread it around with your finger.

The recommended speed is between 300 and 600 rpm or between 2 and 3 on the Diamond Demon control. Rotate the stone and check frequently. Do not wet the cloth, but keep a small jar of water handy in which to cool and clean the stone. Check frequently for overheating. You can also make the work cooler by adding an occasional drop of extender fluid to the Crystalpad or stone. Another way to keep it cool is to work the gem in the slower moving center of the disc.

When the stone has a semipolished appearance, smoothing is completed. Wash the gem, dop and your hands.

Note: Recharge the pad only when necessary. The diamond lasts a long time.

The other diamond smoothing method is to use abrasive cloth like Imperial Cabbing Products from 3M Company. Diamond grit is held to the cloth with a resin bond.

Imperial products are available in 6- and 8-inch discs, strips for regular drum sanders and endless belts for expanding drums. They are supplied in two grits, medium and extra fine.

If drum sanding is desired, the 3M Company recommends the expanding drum which it and other manufacturers supply. This type is advised because, unlike regular drum sanders, there is no bump where the cloth ends are pulled through a slot.

If a disc is used, 3M advises a 15 to 20 durometer neoprene sponge rubber pad which is what most lapidary equipment manufacturers supply with their sanding and polishing heads.

A 4-step sequence is prescribed for using Imperial products: 1. Grind the cabochon on an 80 or 100 grit wheel. 2. Finish shaping and smooth on medium grit diamond cloth. 3. Use the extra fine cloth to remove scratches left by the medium and prepolish. 4. Polish with your regular technique.

Recommended speeds are:

6-inch disc — up to 1200 rpm.

8-inch disc — up to 900 rpm. Experiment with disc speeds. Best results might come anywhere between 50 and the maximum.

8-inch drum with cabbing strips — up to 900 rpm.

6-inch drum with endless belt — up to 1,200 rpm. Most efficient between 800 and 1,000 rpm.

8-inch drum with endless belt — up to 1,000 rpm. Most efficient between 600 and 800 rpm.

Keep the diamond cloth lubricated with a steady spray of water. Sponges may be used, but a continual flow is much better. The water keeps the work cool and washes away cutting debris which, if it clogs the cloth cuts down on efficiency.

For best economy, use the entire surface of the cloth. For the finishing touches, if you are using a disc, you can use the slower moving center, but do not keep the stone in any one spot for long.

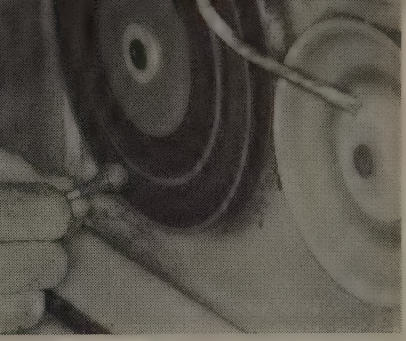
Apply light pressure until you learn how to use this type abrasive. Learn by watching the stone, observing amount of cutting debris and listening to the cutting action. Be sure that pressure is even. After some experience, you will know when to increase pressure. You will find that a light touch is all that's needed for small stones. Large stones, however, require a heavy touch. Otherwise, the diamond acts like a jeweled bearing instead of a cutting tool.

Turn the stone constantly, "peeling the apple." Never push a sharp edge into the cloth which could cause a ruinous rip. Some soft stones should be smoothed only on extra fine, but whenever possible, start on medium to prevent excess wear on the fine cloth.

The 3M Company recommends that diamond cloth be cleaned after use with water, detergent and a Scotch-Brite No. 74 scrubbing sponge.

Cutting Hard Stones

An efficient set-up for cutting star rubies and other hard stones is a coarse (180) or medium (260) diamond grinding wheel for rough shaping and an extra fine (1,200) cup shaped grinding wheel for finish grinding. The cup will make smoothing easier by removing many flat spots.

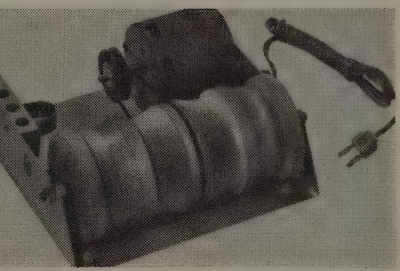


A grooved phenolic fiber lap charged with diamond compound is recommended by Pacific Test Specialties for smoothing. Laps with two grooves are available and some cutters put coarser grit in the outside groove and finer on the inside. The manufacturer cautions that you can contaminate the finer grit by accidentally touching it with your fingers or the stone after touching the coarse grit.

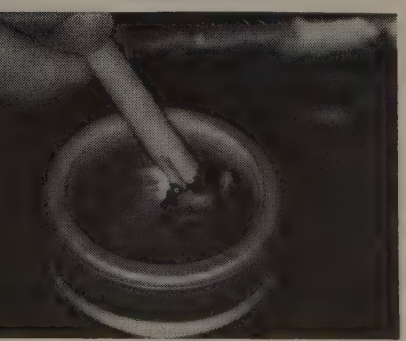
At least two grits of compound are required, 1,200 and 8,000. You will get a better polish if you use 600, 1,200, 3,000 and 8,000, and still better if you finish with 14,000. This sequence will both smooth and polish.

Charge the lap with tiny spots of diamond compound, using about 1/20 gram for a 6-inch lap. Spread the compound around the groove with your finger tip. Finish spreading it with a dopped stone. According to the manufacturer, the phenolic material is better because it does not as readily absorb the diamond as some other materials.

Run the lap slow, about 300-750 rpm, with coarse grit and up to 1750 rpm for fine. Rock the stone in the groove and check cutting action frequently. A newly charged lap releases compound which clings to the stone. Remove it with your fingertips and smear it back on the lap. As cutting action slows, add some diamond extender compound. Eventually, the lap must be recharged with compound.



Grooved maple wheels on machines from companies, such as Dorothy Blake Custom Jewelry and Lapidary Workshop Ltd., are also used for smoothing and polishing hard stones. Maple laps that can be grooved are available for use with vertical shaft (tub) machines. They are charged in about the same way as phenolic laps. To clean and cool the stone, a jar of water should be kept handy.



Other accessories for this type work include cups of copper or other material such as those from M.D.R. Manufacturing Company. These are designed for use on faceting units and other vertical shaft machines.

Other cutters have used hard leather impregnated with diamond. Accessories such as Rock's jade wheel work well for this type application. For a full description of this method and use of maple wheels and cups, refer to Part 3 of the sections on cutting cat's-eye and star stones.

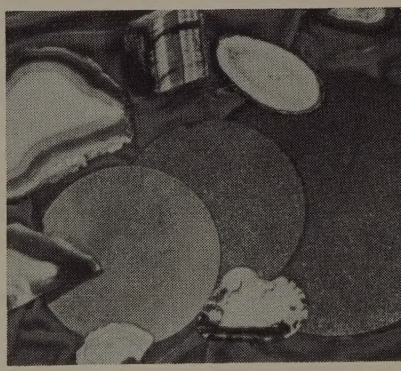
Polishing With Diamond

Except for hard stones such as corundum, you can use the standard polishing compounds after smoothing with diamond. However, you may prefer to polish with diamond also. You can use hard leather, or even maple impregnated with compound. The other method is to use Crystalpads from Pacific Test Specialties. Polishing grits recommended are 14,000 for agate, jade and stones of similar hardness, and 50,000 for opal and stones in that hardness range. As you progress more grits and cloths can be added to make you work easier and more efficient.

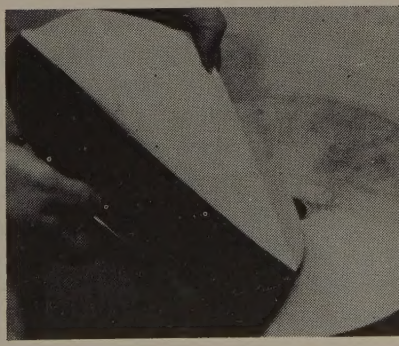
Follow the same technique as for smoothing. Charge the cloth with dots of compound, smear it with your fingertip and add extender fluid. Dip the stone in water frequently to cool and clean it. Keep the polishing disc away from grinding wheels and smoothing discs.

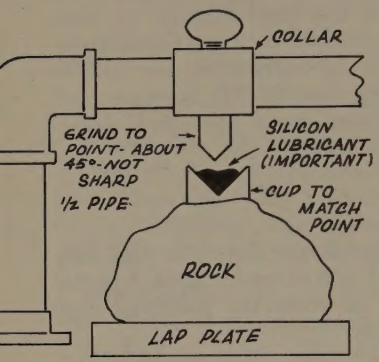
Lapping

Small flats may be lapped on the flat grinding wheels from Pacific Test. New metal bonded faceting discs from 3M Company in 100 and 220 grit may also be used for flat work as well as for grinding cabochons. Also included in the 3M line are resin bonded laps in grit sizes of 100, 220, 30 micron (about 400), 15 micron (about 1500), 9 micron (no equivalent in standard grit sizes) and 6 micron (no equivalent). The 6 micron will polish corundum. On softer stones it gives a good commercial polish or a good semipolish for competition.



The 3M laps are available with center holes for assembling to machines with spindles or with pressure-sensitive backings to attach to laps on which the center shaft does not project. A wide variety of diameters are available, but the most popular are 8-, 10- and 12-inch. According to the manufacturer, a stone up to 15 inches in diameter can be lapped on the 12-inch disc.





The most practical speed on 8- to 12-inch discs is between 25 and 100 rpm. At higher speeds a considerable amount of pressure is needed to break through the water barrier on the plate. Vary the speed according to the size of the stone being lapped, its hardness and the size of the lap. Each combination is different and you must experiment.

Use straight water for lubrication. The finer the grit, the less water required. On fine grit, there is little space between the lap surface and the tops of the diamonds. Too much water fills this space, making the work skim over the abrasive. However, do not cut the water so much that the lap runs dry.

The best sequence is to start with the coarsest grit compatible with the stone being cut and work through all the successive grits. If you cannot afford all these discs, choose a coarse, medium and fine.

As the size of the stone increases, so must the pressure. There is a point at which using a diamond lap is not feasible because you cannot exert enough pressure to make the diamond cut; at this point the diamond acts as a jeweled bearing, not a cutter. The average person can exert 30 pounds pressure for about 15 to 30 minutes. If this is exerted on a stone with a surface area of 50 square inches, you get less than 1 pound per square inch. This situation can be improved by making a pressure device similar to the drawing. It can be constructed of pipe, wood or many other materials. All that is required is a swinging lever that can be pushed down. Along the lever, position a collar. Make a quill of round tool steel which is pointed at a 45-degree angle on one end and threaded on the other end to screw into a threaded hole in the collar. Either fix the lever so that it can be raised and lowered or make the quill adjustable. Make a metal block with a 45-degree hole in it to receive the quill point. Dop the block to the stone and fill the hole with a silicone lubricant. In use, swing the lever to and fro and push down.

Helpful Hints

When you use diamond abrasive tools, you will find that their fast cutting action minimizes undercutting. They also deliver a consistent polish and there is no contamination.

They do not require a great deal of care. Just be sure the equipment on which they are run is true. Keep the diamond from loading with debris by frequent cleaning. Remember not to push sharp edges into resin bonded cloth. When lapping with resin bonded discs, grind away any nubbins left on the stone by sawing. Follow these instructions and you should have faster, more enjoyable cutting.

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