

ULTRA TEC VL CLASSIC FACETING MACHINE

USER MANUAL



*NOTE: Right Side Mount shown –
Left Side mount is mirror image*



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TEST REPORT

Each machine is tested prior to shipment. These are the test results for unit_____.

- **SPINDLE CONCENTRICITY** (.0005" in max – 12.5 µm)_____ By:
- **DOP-TO-SPINDLE OFFSET** (.001" in max - 25 µm) _____ By:
- **PLATEN VERTICAL RUNOUT** (.0003" in TIR – 7.5 µm)_____ By:
- **PLATEN PARALLELISM** (.0004"/inch - 10µm)_____ By:

WARRANTY

This warranty extends to the supplied machine only. ULTRA TEC is not responsible for any collateral losses in which the supplied equipment has been involved.

The ULTRA TEC Faceting Machine has a 15-year warranty, for the original purchaser, for defects in material and workmanship of all mechanical parts. Excepted are electronic and electrical components, which have a 2-year warranty, and exempted are parts which may require replacement because of wear, including springs, rubber drive components, and bearings. (If the unit is used under commercial factory conditions, the warranty periods are 2 years for mechanical components and 6 months for electronic and electrical components and exempted are parts which may require replacement because of wear). Excluded from the warranty are problems resulting from misuse, wear, modification, or accidental damage.

If the unit fails to function properly, consult your representative or call the factory to discuss the problem. If it is found necessary to return the unit, send it in its shipping container, prepaid, with a note that briefly describes the problem. If it is found necessary to return the unit the factory will provide by email a Return Material Authorization (RMA), a completed copy of which must be included in the return-material shipment.

ULTRA TEC will correct the problem by repair or replacement and return the unit to you. ULTRA TEC is not responsible or liable for unauthorized repairs, alterations, or any contingent damages.

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INTRODUCTION

ULTRA TEC Faceting Machines have been manufactured since 1965 and are recognized as the World's finest faceting equipment. The machines represent years of development and research and offer the user unrivaled precision and repeatability.

The ULTRA TEC approach is to provide designs which are direct, simple, and which do not compromise the gem-cutting task. ULTRA TEC equipment allows maximum accuracy, brilliance, and yield from the rough material.

Each ULTRA TEC Faceting Machine is manufactured in the USA by trained craftspeople who understand the equipment and the need for its precision machining and assembly. These people are proud of their efforts. The warranty page of this manual shows the test results signed by the person who performed the final calibration.

We welcome you to the family of ULTRA TEC Faceters. We believe you will become an enthusiastic Ultra Tec user. Word of mouth recommendation has been an important factor in our growth and we sincerely want you to join that growing group of satisfied ULTRA TEC owners.

ABOUT YOUR ULTRA TEC FACETING MACHINE

In using your ULTRA TEC, keep in mind that it is a precision device, capable of exceedingly fine angular and linear settings. It is, nonetheless, a rugged machine that will provide you with many years of use. Normal cleanliness with minimal care will give you many hundreds of faceted gems.

As with any electro-mechanical device, there can be occasional problems--and if you experience one, re-read the user manual for the function involved, to assure that you are performing the operation correctly. If you still experience a problem, communicate with your ULTRA TEC representative or with the factory.

LEARNING TO FACET

Having a teacher is good, but you can learn to facet without a teacher--many people have. These pages can help, and with one or another of the available instruction books you will find rather rapid success. If you can get some good advice, so much the better. As you proceed, tasks that seem difficult will become easy.

Remember that faceting is a "doing" process. A pound of thinking and pondering will not be as helpful as an ounce of trying. Working with the equipment -- getting a "feel" for it and for the gem material, will allow you to progress rapidly.

1.0 UNPACKAGING THE UNIT

The machine comes in protective packaging which you may want to save, along with its box, in the event that future shipment or storage is necessary. These are the included items:



The **Mast** is packaged in a separate box.



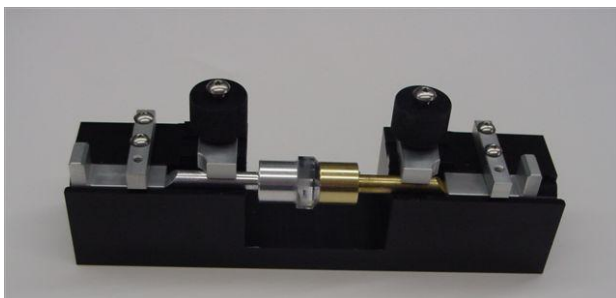
←-Tabling Adapter,
and Alignment Bar



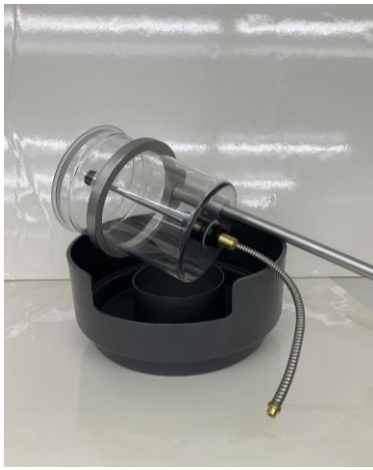
←AC Adapter, Calibration Block and wrenches (if you have purchased a digital Mast)



← set of **Dops**, wrenches, drain hose retention screws



← Transfer Fixture



← **Splashpan, Drip Tank**

The **Base**. To Remove the Base from the box, reach under the wood support base and lift.



← **Anti-Splash Sponge and Clip-installed on splashguard.**

2.0 SETTING UP

2.1 THE BASE

The ULTRA TEC Base can be placed on a tabletop, or it may be mounted permanently into a workbench. For permanent mounting, the cutout dimensions are 7 7/8" by 18 1/2". As a template for the cutout, use the Wood Base—the cutout corresponds to the inside dimensions—you can trace that with a pencil

2.1.1 ELECTRICAL HOOK-UP

Setting the base on a long side, you can see that the electrical power cord is coiled next to the motor, extending from the speed control. Pull out the cord – ready for plug-in to the AC source

The machine will operate from a power source that is 110VAC or 240VAC. The delivered power cord on the machine has a 3-prong Plug, typically used for 110-VAC input. A user with a 220VAC source needs an adapter that fits the 220-240 VAC input socket and adapts to the 3-prong Plug on the machine (often called a “Travel Adapter”).



← That AC Plug Adapter would look something like this. There are many varieties of 220 plug-ins – different from country to country, and rather than our “guess” at your requirement, is best for you to obtain the needed Adapter. The Adapters are inexpensive, and readily available, and we know that you will get the right one (without guessing).

For operation, it is only necessary to plug into the source (there is no setting switch) – the electronics of the Speed Control adjusts its operation automatically between 110 and 220 (as does the power cord for the digital angle display).

2.1.2 THE DRAIN HOSE



The Drain Hose slides through the aluminum bushing on the back of the wood base, and fits onto the bottom of the aluminum Drain Funnel underneath the base plate. Attach the Drain Hose—push on firmly.

Lead the Drain Hose through the bushing in the rear wall of the Wood Base (or, if you have mounted the Base into a desk top, you may want to direct the Drain Tube straight down), and then to a container--a gallon plastic container is good. Be sure the hose does not kink, and that there are no loops in the hose on its way to the container—these are things that would prevent proper draining).

2.1.3 SPLASHGUARD

The splashguard is molded plastic, resistant to normal lapidary fluids (as a faceting lubricant, we recommend water with a few drops of clear dish-washing detergent).

Examine the Splashguard before mounting it on the Base – look underneath. Notice that there is a Drain that will fit into the Drain Funnel in the Base. When you mount the Splashguard confirm that the Drain is aligned into the Funnel – peek underneath.



When setting the Splashguard into position on the Base, be sure that the drain molded onto the Splashguard is set into the Drain Funnel in the Baseplate.

To set the Splashguard in place, grip the sides of the Splashguard and push down until the Splashguard seats – to remove the Splashguard for cleaning, grip the sides and pull up.

To prevent splashing of water from the, surface of the Lap – set the Lap onto the Platen and attach the retention Spring at the opening in the Splashguard (PIC). Then, wet the sponge (and give it a squeeze) and tuck the Sponge in-between the Lap and the inner Splashguard surface – the Sponge will set down against the shoulder in the Splashguard. Set as shown, the Sponge will prevent splashing as the Lap spins CW



2.1.4 THE DRIP TANK



The Drip Tank post slips into a fitting in the corner behind the Splashguard. Place the Drip Tank onto the post, position it, tighten the set screw, and it is ready. The flow rate is adjusted by turning the valve stem, and the water shuts off with an easy pressure. Avoid over tightening the valve. The tank fits snugly enough on the post so that it will not vibrate out of position, but loose enough for you to rotate it to the position you wish.

If you have purchased a FAUCET, rather than the Drip Tank, it fits into the same fitting in the Baseplate.

2.1.5 THE PLATEN

The Platen is permanently attached to the Spindle—a sub-assembly that rides in permanently lubricated ball bearings. When a lap is placed onto the Platen, take care that the undersurface of the lap is clean and is held down by the Safety Nut.

2.1.6 THE LAP HOLD-DOWN NUT (Safety Nut)



The Lap Hold-Down Nut is cinched down to hold the lap in place. It is machined of Delrin, which is soft enough to prevent damage to a gem which is accidentally bumped (the reason it is called a “Safety Nut”). It should be adjusted firmly to hold the Lap in place—the resilience of the Delrin Material will snug into firm position.

2.1.7 THE SPEED CONTROL



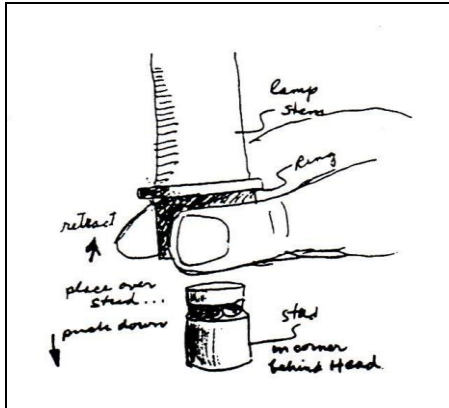
The variable electronic speed control converts AC current to DC, which the motor requires, and of course sets the speed.

The left-side Switch is a toggle for ON-OFF. The right-side switch is for selecting clockwise (CW) or counter-clockwise (CCW) lap rotation -- it has a central off position and two directional positions.

The central knob is a speed selector. The incremental positions of the speed selector are not exactly linear but may be considered as each increment providing an added 100 RPM up to number 7 (700 RPM at that point), and approximately 50 RPM per increment on the remainder of the dial. The top speed is approximately 1850 RPM. When using the directional switch, set the rotation so that the lap direction is not running into the gem.

When changing the lap direction, the motor should be off or running at a low speed. Repeated changing of direction at high speed tends to demagnetize the motor, which results in higher speeds, but lower torques. Don't worry about the occasional forgetting of this rule--just don't flick the switch back and forth for fun. The speed selector can be at any setting when turning the motor on or off.

2.1.8 THE LAMP



If you have purchased a lamp, it mounts onto the stud already assembled in the base, in the corner behind the head. The lamp mounting lock has a snap-on design. Pull back the nylon ring, place the lamp onto the stud, and push down the ring. You will feel the ring snap into the down position, where it holds the lamp securely.

2.2 THE FACETING MAST

2.2.1 MOUNTING THE MAST ONTO THE BASE.



Mount the Mast onto the Base. To mount the Mast, slip the nut into the keyhole, and slide the Mast forward into the slot. The Mast may be positioned in any convenient position along the slot. To lock the Mast into any particular position, turn the locking lever clockwise until you can feel it become snug. The nut (that fits below the Baseplate) can be adjusted so that the lever locks in a convenient position.

The *Collar-Locking Knob* (seen in the photo) holds in place the conical Collar (the Collar protects from residue the positioning components at the base of the Z-position Cylinder). Loosening the Locking Knob allows the Collar to rotate freely – there's no "right" rotational position for it (whatever position is convenient for you is OK).

Loosening the Locking Knob also allows the Z-position Cylinder to rotate freely (the condition you want as the faceting proceeds).

Still another function of the Locking Knob is that it binds together the several sub assemblies that make up the Mast, and when tightened – you can lift the Mast from the Baseplate (if you have reason to) - and the Mast remains in one piece.

After you have mounted the Mast onto the Baseplate -- your Mast has a Digital Angle Display (DAD). There is a power cord with an AC/DC plug-in Adapter. Connect the Adapter into a standard power source (110VAC-220VAC), and the Jack into the Angle Dial case on its lower right side (see the illustration in the section READING THE DIGITAL ANGLE Display). It has been calibrated at the factory. When you turn it on for the first time, the display will blink 99.99 (this happens at any time the power has been interrupted for any reason). As the 99.99 blinking continues, swing the Spindle (Quill) so that it points up (vertical), and then lower it down toward and past the 90-degree (horizontal) position. You will see on the display that the Angle Dial “finds itself”—it now reads the correct angle.

3.0 THE BASIC CONTROL FEATURES OF THE FACETING MAST

All faceting machines have three characteristics that the operator controls -- rotational angle, axial angle, height.

The precision and repeatability of the faceting machine in accomplishing these basic functions are what determine the brilliance and quality of the faceted gem.

Read the following sections and practice a few settings so that you become familiar with the controls.

3.1 CONTROL OF THE ROTATIONAL ANGLE—INDEXING



RAISING THE DETENT

Your Mast is supplied with an assembled 96 Index Gear and gear segment detent. The 96 Index Gear is the one most commonly used in gem design, but also prominent is the 64, and also used and available a 32, 72, 77, 80, and 120.

The index position is changed (in accordance with the gem diagram you are following, by raising the Detent (freeing the Index Gear to be rotated) – raising the Detent is done by squeezing down on the back of the Rocker. Then, rotating the Index Gear to the new desired position, and reset the detent.

3.1.1 FREE ROTATION OF THE INDEX GEAR (often called "FREE-WHEELING"--this is often used in forming a round girdle on a stone).



When the Detent is retracted it can be held in its raised position – allowing free rotation of the Index Gear- by engaging the Latch (near the back of the Rocker (as shown)).

3.1.2 CHANGING TO A NEW INDEX GEAR—ALIGNING TO THE KEY

'When you change the Index Gear it is necessary to re-align the keying—that is, to align the Index Gear 0 position at a 90° relationship to the Dop Alignment Pin (thus making the Pin parallel to the Lap surface). When doing this, also confirm that the Index Vernier is at a 0 position.

The tool for accomplishing the alignment is the Alignment Bar that is included with your machine.

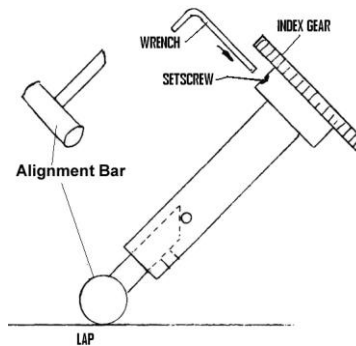


Faceting instructions call for use of specific Index Gears. Although transposing from one gear to another often can be done, it is easier to use the gear specified by the gem diagram.

1. To change an Index Gear, first, turn in the Retention Set screw so it does not protrude above Outside diameter surface of the Quill (it's OK – it will not fall into the inside diameter). Then, loosen the set screw in the hub of the mounted Index Gear and slide the Index Gear being removed forward and off the Quill. Also, remove the Detent (a gear segment)--it is held by a screw.

2. Now, install the new Detent and tighten the screw. Slide the new Index Gear onto the Quill and snug the set-screw slightly (so that the Index Gear can still rotate on the Quill). Back out (but do not remove) the Retention Set Screw (it will be used to retain the Alignment Bar in the next several steps).

Aligning the Index Gear to the Dop Alignment Pin.



1. Place your best flat lap onto the platen.
2. Set the Mast axial angle at about $40^\circ \pm 5^\circ$ (not at all critical). Engage the Detent with the zero position on the Index Gear (the Index Gear is still in an able-to-slip mode). Verify that the Index Vernier is set at a 0 position.
3. Insert the Alignment Bar into the Spindle, engaging the rear chamfer with the Alignment Pin, press it in firmly and lock it in by tightening the Retention Set Screw.
4. Onto the surface of the Lap, set a piece of paper—about 3 inches square (a piece cut from a shiny page in a magazine is good to use—it is very parallel). Set the paper onto the Lap—that is the “landing site” for the Alignment Bar, in the next step.
5. With the Angle Dial set at the approximate 40° , set the peripheral surface of the Alignment Bar onto the lap surface (that is, onto the paper)—press it down so that it is flush to the paper (the Angle Stop does not have to be engaged). As the pressure is applied to the Bar, the Quill will rotate within the Index Gear (remember, the Index Gear was set at 0 and still in an able-to-slip mode). Holding the Alignment Bar flush against the paper, tighten the setscrew on the hub of the Index Gear. Done.

If you are not replacing the Index Gear, but you do want to re-align the keying, set the Index Gear at 0, loosen the setscrew slightly that holds the Index Gear to the Quill (so that the Index Gear can rotate), and then follow steps 3-5, above.

3.1.3 THE INDEX VERNIER (Cheater)

The Index Vernier is for making rotational (indexing) adjustments. Each line is on the Dial is 0.1° .

The Index Vernier is used if there is a need to align crown facets to existing pavilion facets (after completing transfer of the stone), and, it is also used for slight adjustments when polishing (from which it gained the name of "Cheater" since it was making up for imperfections in alignment). The Index Vernier is also used in a few gem designs that ask for intermediate indexing positions.

If it is necessary to make a correction to the stone's rotational position, turn the Index Vernier Dial very gradually. Rotating the dial in a clockwise direction will rotate the stone (as viewed head-on) in a clockwise direction, and, of course, counterclockwise rotation of the Dial results in counterclockwise rotation of the stone. The "correct" starting position for the cheater is at 0—aligned to the 0 position of the Index Gear. See the section 3.1.3.2, below.

To assist in the rotational turning of the Index vernier, a small wrench has been provided



3.1.3.1 Index Vernier Tension.

The tension on the Index Vernier is set at the factory. If the tension should loosen, the index Vernier dial may "walk" from its set position as the result of repeated indexing. (Note: In normal operation, the Index Vernier Dial moves with the Rocker and so the Dial moves off position when the Detent is raised, and, when the Rocker is lowered, the Dial returns to its earlier position. If it does not return--that's "walking"). If walking happens, increase the tension on the Index Vernier by tightening the screws (front-facing - one on either side of the Detent). Those screws bear on the Index Vernier screw—if tightening, do so very gradually.



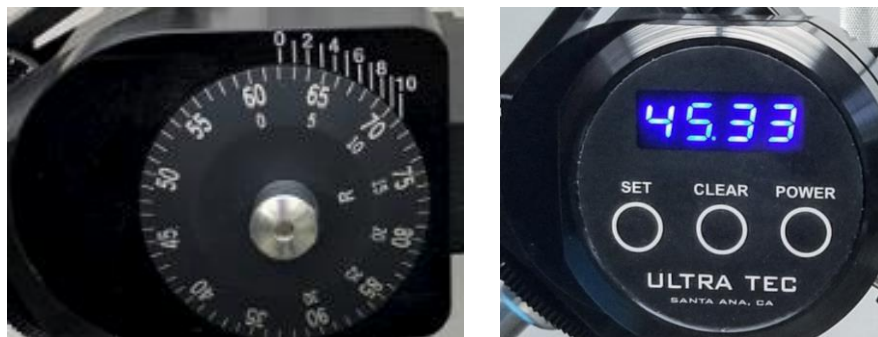
3.1.3.2 Verifying the 0 position of the Index Vernier

It is a good idea to verify that the Index Vernier is in its 0 position before starting to facet another stone. If you suspect that the Index Vernier has been moved more than a full rotation, go back and reset 0 on the Index gear and 0 on the index Vernier, using the Alignment Bar.

3.2 CONTROL OF THE AXIAL ANGLE – THE ANGLE DISPLAY

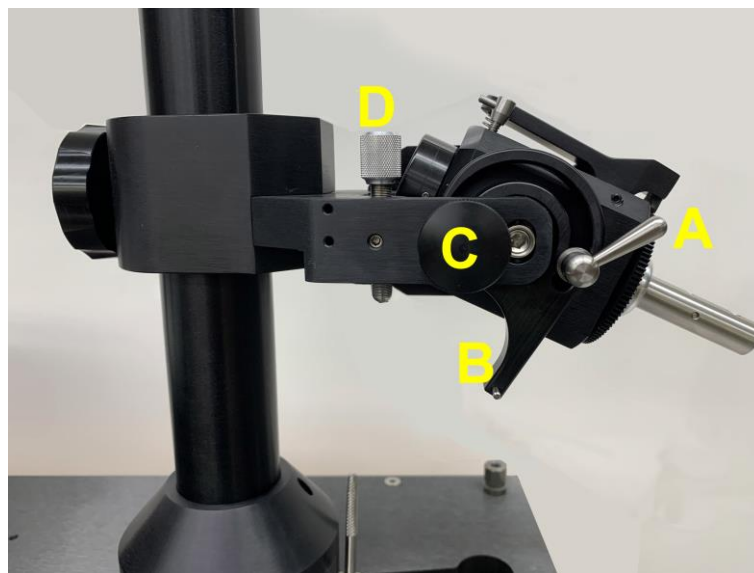
The Digital Angle Display provides excellent accuracy for the most important axial position – with readings in increments of 0.01 degrees (more recent gem diagrams do show settings of 0.01 accuracy).

In terms of the setting sequence, the Analog display is the same as the Digital display. The Analog readout is a vernier type with a readout of 0.1 degrees. On the Analog Mast the Dial Indicator is set to reflect the aimed-at angle – and responds to fine adjustments.



3.2.1 SETTING THE ANGLE--USING THE ANGLE STOP AND THE FINE ADJUSTMENT CONTROL

The Angle Stop is used to set the axial angle. It works in conjunction with the Fine Adjustment Knob. And is locked in position when the Angle Stop Locking Lever (A) is tightened (CW)



Here's a photo looking at the *back* of the Mast—at the angle-stop mechanism—so that you can see what's going on. You can see the Angle Stop Locking Lever, pointing down from the Angle Stop (B), and the Angle

Fine Adjustment Knob (D), pointing up from the upper Yoke surface. Tightening that Lever locks the angular setting of the quill.

The round central Tension Knob (C) functions as a brake - when the Knob is backed off (CCW), the quill swings down freely – as you turn the Knob in (CW) it starts to act as a brake, slowing the swing-down of the Quill, and, with the Knob fully tightened (CW) it acts as a full brake.

When you *use* these angle setting and adjusting features, you will not be looking at them (they are in the rear), rather, you will be feeling them as you look at the front of the Mast, as is shown in the photo and text below.

To set an angle:

- 1) Loosen the Collar-Locking Knob permitting you to swing the Carriage toward yourself – to a position that feels convenient, and with your stone off and away from the Lap.
- 2) Loosen the Carriage Knob and raise the Z-position (height) of the Carriage to the upper portion of the Positioning Cylinder – just where? Where it's convenient – a little bit of experience will teach you. Lock the Carriage Knob. Lock the Collar-Locking Knob.
- 3) Loosen the Angle Stop Locking Lever, releasing the Angle Stop from its locked condition, so that the angle can be changed. You may wish to put some degree of braking action onto the quill.
- 4) As you move to the next angle, hold the Quill with your left hand (making it a “handle”). Reach under the Angle Stop with your right fingers and push up and hold the Angle Stop –in contact with the Stop (the Stop itself is end of the fine-adjustment Screw – hold it there.



- 5) Tighten the Angle Stop Locking Lever (if you have put some braking pressure onto the Quill, release it – the Angle Stop Locking Lever will hold sufficiently.
- 6) Fine adjust the angle setting, as required.

The same sequence is used for a Digital readout or an Analog readout.

Making this angle setting will become “automatic” for you. Practice it (it’s complicated to write this description—but performing the task quickly becomes an easy natural thing to do).

7) Positioning the stone onto the Lap. Loosen the Collar-Locking Knob so that lateral swing is easy. Set the stone above the Lap, and, loosening the Carriage Knob, gradually lower the stone position, sliding down the Z-position Cylinder, toward the Lap surface – bring it close (perhaps about 2 mm away) – relock the Carriage Knob.

8) Using the Barrel (micrometer readout), continue lowering the stone until it contacts the Lap surface – and, a bit more (the amount of material you will remove – if you have the Dial Indicator you can see that amount).

You are ready to proceed with the faceting

3.2.2 READING THE DIGITAL ANGLE DISPLAY.



The Digital Angle Display reads the angle directly. It has been calibrated at the factory before shipment, and for your setup only requires being plugged in—the Power Cord, with its AC/DC Adapter has been supplied. If the readout “misbehaves” it may be that the source electrical input was interrupted – if that happens, there is a “reset” instruction (see the paragraph below - and a full recalibration is not necessary).

3.2.2.1 Digital Angle Dial Controls.

The “POWER” button is a push-on/push-off toggle switch – when turned ON the readout returns to its last setting.

It is possible, if source power has inadvertently been interrupted – the readout “misbehaves”. It is usually corrected by an easy “reset” procedure as follows: 1) Pull out the power input plug 2) swing the Quill so that it points up at the ceiling – all the way up. 3) reinsert the power plug – the readout should start to blink 99.99. As it continues to blink, gradually lower the Quill –as it approaches the 90 degree (horizontal) position it starts to read out properly – it “finds” itself—the calibration is maintained. Use it.

3.2.2.1.1 The Beeper. There is a “BEEPER” that signals reaching the STOP position. It is optionally ON. The SET button turns it ON. The “CLEAR” button turns it OFF.

3.3 CONTROL OF HEIGHT - VERTICAL POSITIONING



AFTER SETTING THE Axial Angle... usually, when a new angle has been set, the Traveling Block is relatively high on the Post. Loosening the Large Knob allows the Traveling Block to Slide down, carrying the gemstone toward, and finally in contact with the Lap – so that the work can be performed. Manually sliding can work – barely contacting the Lap surface. Then, an amount to remove can be set by adjusting the calibrated height setting at the top of the Post. Notice that the UP direction is marked – the up direction raising the gemstone from the Lap surface – most often the adjustment you will make is down – setting an amount to remove. Since this downward adjustment is used frequently, the start out vertical position will gradually drift down – it is a good idea, when starting to facet a stone to raise the calibrated height position to about half-way up the calibrated scale – to about 1.5 on the calibrated scale.

3.4 CONTROL OF FLATNESS

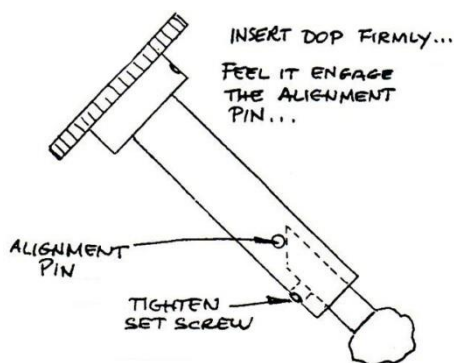
This control is built into your ULTRA TEC. The surface runout of the Platen is less than .0003 of an inch. (less than 8 microns).

Laps are manufactured to be suitably flat, but their accuracies vary, and all laps have some degree of error. The important lap is the one used prior to the polishing operation, usually a 600 or a 1200 lap. You will be able to detect *any* runout on a Lap, however small, but keep in mind that a highly detectable .002 inch runout over a 6 inch swing if the Quill, represents an angular error of only .02 degree. So, do not be overly concerned when the stone makes contact at one place on the lap, but not in another--the actual error may be very small, perhaps only a ten-thousandth of an inch—a few microns.

- A “TIP” -- Because no lap is “perfect” in its flatness, when faceting, on *any* lap, become accustomed to lifting the stone from the lap surface in about the same location—probably best toward the center. That will tend to minimize the out-of-parallel variation of the lap from place to place. It will become a good habit.

4.0 STANDARD TOOLS AND TECHNIQUES *Other than controls, there are these important "how-to's" in using the machine: Inserting and holding the Dop, using the Tabling Adapter, using the Transfer Fixture:*

4.1 DOP INSERTION and RETENTION



Dops are keyed so that they can be removed and reinserted – to the same depth and same rotary position. The back end of the Dop has a 45-degree angle chamfer (see note 1, below). The chamfer aligns with a transverse pin in the spindle--the Dop Alignment Pin.

The Dop Alignment Pin is at a right-angle to the Dop-retention Set Screw. When inserting the Dop, it is best positioned so that the chamfer on the Dop slips under the Alignment Pin on the side away from the Dop-retention Set Screw. Push in the dop firmly, and tighten the Dop-retention Set Screw

If you want to override the indexing mechanism--the effect of the Alignment Pin--pull the dop slightly forward, disengaging it from the Alignment Pin--the dop can then be freely rotated.

Note 1--The precision of the angle (nominally 45°) is not at all critical, and can be added manually, by eye, using a sander (it does have to be flat). Dops of 6.4mm and down can be done on the machine, using a sanding paper.

Note 2--V Dops and Emerald Dops, which are used for designs with long girdle facets, need not have a rear keying chamfer. The long girdle facet makes it easy and better to align off the stone itself--setting the facet against the lap and then locking the retention screw.

About the Retention Set Screws

You have been provided with two Retention Set Screws – one, set in the Quill (where it should remain) – the other is a “Spare” (save it someplace). An advantage of the headless retention Set Screw is that it does not have to be removed to mount the Tabling Adapter – or, when changing the Index Gear. When doing those things, turn the Set Screw inward so that there is no extension of it above the Quill’s outer surface. The Retention Set Screw never requires dis-assembly. It will not fall into the center hole in the Quill.



It also allows more clearance when working on the girdle of a small stone – clearing away the Knob.

*The headless retention screw is a material that that will not disrupt the surface of the Dop and has also been machined to optimize holding force - **do not use a steel set screw** - you have the spare one that you have put somewhere safe (and known)*

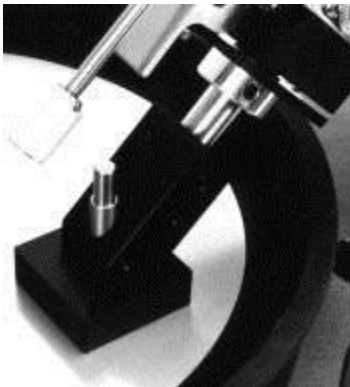
4.2 THE TABLING ADAPTER. Used to work on the table of the gem, it points the dopped gem straight down at the lap (it's often called a "45° Adapter", since, when it is used, the axial angle is set at 45°).

To assemble the Tabling Adapter to the Quill, turn in the Retention Set Screw so that there is no extension of it above the Quill's outer surface. Then slip the Tabling Adapter onto the Spindle, until it stops. Slightly snug the set screws which hold it to the Spindle.

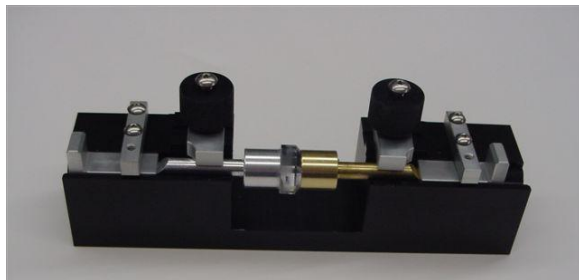
Alignment of the Tabling Adapter: Set the axial angle at 45°. Bring the bottom surface of the Tabling Adapter down onto the lap surface, and when it is flat from side to side, lock the set screws.



4.2.1 Tabling—some accessory choices.



You may wish to purchase a Tabling Aligner (shown on the left), an accessory for fast accurate alignment of the Tabling Adapter. The Tabling Aligner fits directly to the hole that holds the dop — eliminating several tolerance errors, and provides good “feel” of the flush setting onto the lap surface



4.3 THE TRANSFER FIXTURE. The Transfer Fixture (part of the Kit that comes with your machine) is machined from one piece, assuring its stability and accuracy. The ends of the Transfer Fixture are matched "V-Blocks", mirror images of each other--so there's no rule for which side to put the original dop or the new (receiving) dop. Use whatever feels comfortable. Also, the Transfer Fixture can be set on end, with the V's vertical--something you may find useful.

On each V-Block, there is a clamp for holding the dop in position in the V (or, with light tightening, allowing a dop to slide in the V), and a pusher that aligns the key at the end of the dop and pushes the dops together. Brackets that bridge over the pushers have nylon-tipped set screws that bring pressure on the pusher, keeping it in its track, as it slides.

When the clamps are loosened, they can be turned sideways, getting them out of the way for easy insertion or removal of dops. The chamfer of the keyed dop can face up or down in lining up against the pusher.

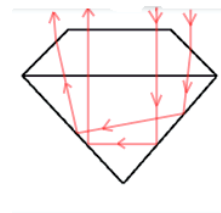
5.0 MAINTAINING AND ADJUSTING YOUR ULTRA TEC

- Your ULTRA TEC should be covered when not in use or stored in a clean place.
- All bearings are lubricated and sealed. It is not necessary to lubricate bearings.
- It is a good idea to lubricate the Dovetail occasionally. Use a tissue to clean the dovetail, and then apply a light film of grease.
- The drive mechanism does not normally require adjustment. The rubber shock mounts on the motor can be compressed, more-or-less, for any adjustment that may be necessary.
- To protect the accuracy of the Mast, keep the base clean and free of abrasive, especially around the sliding area. The smooth plate surface allows easy cleaning.
- The Index Vernier adjusting screw should be oiled once a year. If it feels too loose, it may be adjusted by tightening the set screw in the rear of the index latch rocker.
- The motor Speed Control is designed to operate our special motor. Do not alter or add to the circuit. If the motor has been disconnected from the control be sure the leads are reconnected before plugging in the power cord.
- Calibration of the Digital Angle Dial is permanent —see that instruction.
- Adjustments and calibrations are best performed at the factory. If this is not practical, communicate with us and we will assist you either verbally or with written procedure.

6.0 THE FACETING PROCESS

6.0 THE BASICS

The faceting process consists of taking a rough stone (it's called "rough") grinding a series of faces (or facets), and polishing those facets. The facets are positioned at very particular angles so that the light reflects from the pavilion and out through the crown. The proper angle, the one which assures reflection is different depending on the material being used--and that's the angle used for the "main" pavilion facets (friendly name: "the Mains").



The steps of faceting consist of a rough grind, a fine grind, and then a polish. The exact number of steps, and the sequence, can vary but it always ends with the polishing.

The discs that hold the grinding or polishing material are called Laps and most typically they have an eight inch diameter. Grinding laps have a diamond compound of some particular size (mesh) bonded to the surface of the lap. The higher the mesh number, the finer the particle size. For initial grinding – shaping of the stone – 260 mesh Laps are commonly used – although Ultra Tec recommends that 360 mesh be the coarsest Lap used – and then, only if the shaping cannot be done with a 600 mesh Lap. (Avoidance of coarse Laps is because they cause sub-surface damage in the stone that later show up as surface flaws, as pre-polishing and final polishing proceeds. Typical shaping Laps (minimizing sub-surface problems) are 600 mesh or 1200 mesh. Pre-polishing can be done with fine diamond compounds – like 3000 or 8000 mesh diamond compound, on a suitable pre-polish Lap (Ultra Tec recommends the high-tin-content BATT Lap). Final polish can be done with Cerium Oxide, or Aluminum Oxide, or a fine diamond mesh (14000 to 50000 mesh) on a suitable Polishing Lap depending on the gem material. Laps used for final polish include Tin, BATT, Phenolic, (and various others). Also, for polishing, there are "Ultra Laps"—mylar films to which the polishing media is adhered.

The rough stone is cemented to a metal dop, and the dop is inserted into the Spindle which positions the stone for grinding and polishing against the rotating lap. The pavilion side is done first, after which the stone is cemented to another dop ("transferring"), holding to the pavilion, to complete the crown. After the stone is complete it is removed from the dop, cleaned up--and there it is.

Now, if you are a "natural-born" faceter, you know enough to start. More than likely, you'll need some help, at least from the various books available. If you can obtain instruction from a teacher, that will give you a fast start (and we may be able to aim you at a teacher--call us). Most importantly, "have at it"--faceting, like 99% of everything else in the World is best learned by doing.

6.1.1 SELECTING ROUGH MATERIAL

Almost any inexpensive material can be used for the first stone. The goal of your first attempt at faceting should be to learn your machine's various functions and controls. Even though it is your first stone, it will be one of which you are proud. It will undoubtedly include some mistakes, however, and it is best to save valuable material for later on. As most beginner instructions do, we recommend quartz—nice pieces of citrine or smoky quartz are inexpensive and readily available. Now, a bit of caution, quartz—in some cases—may give you some difficulty in polishing (that difficulty usually goes away if you reverse the Lap direction of rotation). Starting out – could you use glass? Yes you can.

If you happen to have access to synthetic Spinel, that is a nice start-out material. It is an easy cutting and polishes very easily. An advantage of synthetic material is that you don't have to worry about inclusions, fractures, etc. The synthetic material will be "clean". Being a nice regular shape, it will also be easier to align on the dop, something which is more difficult with typically irregular natural material. Synthetic materials are formed in "boules", which are cylindrical--sort of carrot shaped. It is easy to get a slice about 1/2 inch in diameter and about equally deep, a good size for a first-time effort.

When you do use natural materials there are quite a few things to consider in making a purchase of rough. The most important factors are the shape of the rough--what size and type of gem will produce--and whether the rough stone is free of flaws (cracks, veils, inclusions, bubbles, etc.). The first time you purchase rough, ask someone to help you (including the man selling—he's not there to "trick" you—he wants you to come back again), and, observe others making a purchase. Don't feel intimidated by what seems to be a mysterious process. You will be surprised how quickly you develop skill in detecting flaws, particularly when you are about to exchange your own hard-earned cash for it.

6.2 LEARNING TO FACET

Faceting is a craft which offers many levels of accomplishment, and we have never met anyone who could not succeed at a personally satisfying level, (and often a profitable one as well). The rate at which people progress varies in relation to their aptitudes and learning experiences, but you will make progress and you will find even your beginning efforts will be gratifying. In the long run, some faceters attain Masters ranking by entering competitions; many more involve themselves in selling their gems to a market that is available for the unique custom cutting you will be able to perform; almost all follow the craft for personal relaxation and enjoyment. There are ample rewards for everyone.

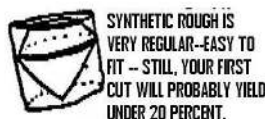
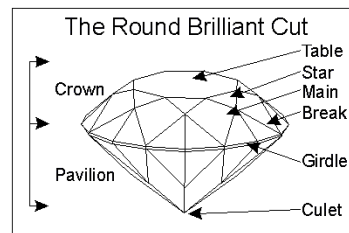
Many people are completely self-taught, including some very good faceters. Of course, it is good to have a teacher if possible, particularly in the very early stages--even a few hours of instruction will give you a running start. Almost as good would be a faceting friend whom you could call upon for advice or just to confirm that you are doing the process correctly. As you gain experience you will find that most advanced learning comes from talking to other faceters. If you are all on your own, however, don't fret about it--you can do it.

We recommend the book "**Amateur Gemstone Faceting**" by Tom Herbst (even if you mean to end up a "pro"). There are other how-to books—most of them good—and these days, the Web has much information—including designs. And of course, there is the basic start-out how-to information that is in this Owner's Manual. Also, keep your eye on the ULTRA TEC Website (www.ultratec-facet.com). And not least--think about joining one of the several Faceting Guilds—even if you cannot go to their meetings, their newsletters are valuable.

6.2.1 GETTING STARTED

Not everyone teaches faceting in exactly the same way. Listen to what others have to say (if you know he's an experienced faceter). On the other hand, there's nothing wrong with using this text now, as is, and saving other advice for later.

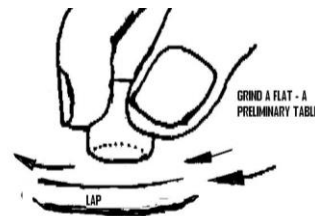
The cut that will be described here is a Standard Round Brilliant. It is the most common cut in the world. It is a good design for learning basic terminology and basic techniques. After you've done it, move on to other designs-- the merit of your faceting equipment is that it allows you to do things that native cutters with primitive equipment cannot do. You will find cutting custom stones is much more challenging and rewarding (including financially).



Now, back to the first-time stone. Having obtained a piece of material examine it to determine what would be the best orientation of the stone so as to maximize the yield. As you go on, there will be other considerations which affect the way you orient the stone for faceting, particularly color and cleavage characteristics But for your first stone, just consider the yield.

6.2.2 THE FIRST CUT – A PRELIMINARY TABLE

Having determined where the table should be, hold the stone in your fingers and using a 360 grit lap (or a 600 Lap if that's coarse enough to remove the material you want to remove), grind a "preliminary" table--you need a surface large enough for attaching the dop. This surface will provide you with a reliable reference surface for the cutting of the stone.

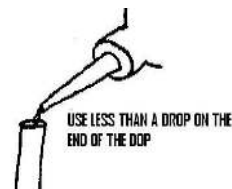


6.2.3 DOPPING THE STONE

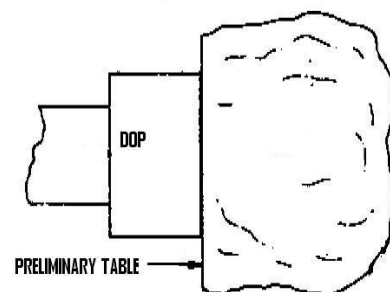
The stone is cemented to a dop--the process is called "dopping". Select a flat dop which ranges between 1/2 and 3/4 of the projected diameter of the stone. Clean both the stone and the end of the dop in denatured alcohol (obtainable at your hardware store). Wipe these items dry with a lint-free paper towel. Place just enough adhesive on the end of the dop to coat the surface (*see the note below). Bring the preliminary table in contact with the end of the dop. The adhesive we recommend



gives you about 30 seconds to position the stone--that is plenty of time and you will find you can position the dop by eye surprisingly well. In your first attempt you may use more adhesive than needed; you need less than a drop. Too much will cause the setting up process to take a longer--if you have applied too much, you can wick it off onto a bit of paper.

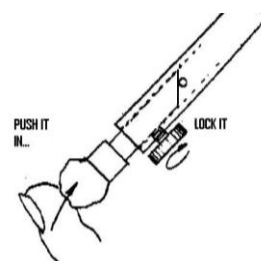


Hold the stone and dop together under finger pressure for approximately 30 seconds. Run a very light bead of adhesive around the stone and set it aside for at least five minutes to assure a good bond. Not very difficult. (Do be sure to observe the caution notes on the bottle--this type of adhesive bonds skin very effectively). After the waiting time, tug a bit on the stone to satisfy yourself it has adhered well.



We recommend is a "super glue", specifically Loctite 404, available from Industrial suppliers. It is expensive compared to others, but we found it more reliable, and still only a few pennies per dopping. If you don't have an Industrial supplier nearby, you can get Loctite 404 from us.

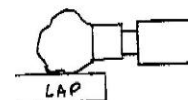
Insert the Dop into the Spindle, so that the chamfer on the dop engages the alignment pin in the Spindle--push it in snugly. Tighten the Dop-retention Set screw (it tightens with a normal CW action).



6.2.4 CUTTING THE GIRDLE

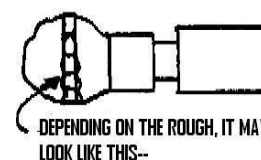
On this step, and the ones that follow, we refer to diamond plated laps as “coarse” (360 mesh) or “medium” (600-1200 mesh). Use the coarse lap where you are removing a considerable amount of material, and switch to the medium lap to finish shaping the stone. In general—on large stones there’s a lot of work to do with the coarse lap, and on small stones, hardly any (you will quickly learn which lap is appropriate). This instruction assumes the stone is about ½ inch (12-15 mm)

The first step will be to cut the girdle. Place a coarse lap onto the platen. To preform the girdle set the Angle Dial at 90.00 . Set the Index at 3 (the first setting of the Standard Brilliant Design). Start the lap turning at a speed setting about 6 or 7 (yes, you can slow it down if that speed makes you nervous—later on, you may be speeding it up). Set the Water Tank so that it is dripping at a rate of one or two drops per second, and clip down the edge of the Splashguard so it doesn't interfere with the stone's reaching the lap. Position the Head so there is no danger of the spindle hitting the lap.

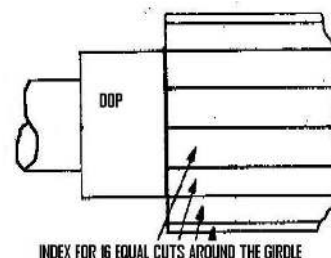


Girdle Facets – set Angle Dial at 90.00
96 Index at: 3, 9, 15, 21...etc...steps of 6...to 93

Using the vertical knob, lower the stone toward the lap until it makes initial contact. When you feel it, hear it, and see the Angle Dial readout go over the 90.00 setting, continue to lower the vertical setting a few divisions on the Vertical Knob, and grind a flat—the Angle Readout will read 90.00. As you do that you will be holding the handle, applying a relatively light and consistent downward pressure as you sweep the stone back and forth across the lap surface. You will see when the Angle Dial has returned to 90.00 (and, you will feel and hear when the cutting action stops).



OR, IF YOU STARTED WITH A PRETTY REGULAR SYNETIC SHAPE, LIKE THIS



Then index around the Index Gear, repeating the cut 16 times (on a 96 gear the stopping points are 3,9,15.....in steps of 6., to 93. You may have to lower the vertical position to get the girdle facets to join—to obtain nice even facets. As you work, you can see there is considerable material to remove, but as you reach the stop, come up against it lightly and consistently.

If you want a round girdle (it has gone a bit “out-of-style” these days), you would now place the machine into the “free wheeling” mode and round off the points. It is recommended that the series of flats always be placed on the stone before rounding. (watch the Angle Dial and be sure that the readout finally shows 90.00 all the way around, as you remove the high points).

6.2.5 SHAPING THE PAVILION – BREAK FACETS

Now, the pavilion can be formed – the Break Facets are done first.

You are still using the coarse lap, (switch to a medium lap as you approach the target angle—or, use a medium lap all the way—it's not so slow). Set a speed of 4 or 5 (later on, when you are more comfortable with your faceting, you will--probably--increase the speeds). The water drip, from the Water Tank, is at a rate of one or two drops per second.

Set the Index Gear at 3 (same settings as for the girdle). Set the Angle Dial at 45 degrees.

Set the stone down onto the lap, in the quadrant of the lap nearest to yourself, lower the vertical position a bit (so you get a reading higher than the 45.00), and slowly sweep the stone back and forth from the center to the edge of the lap and back, grinding a flat. Watch the Angle Dial go down—and finally reach the target of 45.00. You can repeat this—and as you get closer to where the facets will join at the tip (the “culet”), switch to the medium lap. You can observe where that depth of cut is getting closer by cutting several of these index positions (say, at 3 and the opposite index, 51)—repeatedly examining the stone as you adjust the depth of the cut

Then, with the medium lap, continue going down in vertical position—repeatedly examining the stone as you adjust the depth of the cut—the vertical setting—until the facets come to a tip at the bottom (or *almost*—it will be the Main facets that finally form the tip—the “culet”). That establishes the final depth for the Break facets.

With the first break facet in place at Index position 3 (and another position too, at 51), move to the next index position. Proceed to add the remaining break facets, in the sequence shown:

Pavilion Break Facets—set Angle Dial at 45°:
96 Index at: 3, 9, 15, 21...etc...steps of 6...to 93

Now, proceed to the:

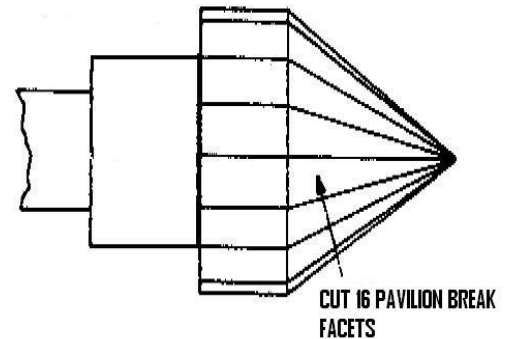
6.2.6 SHAPING THE PAVILION MAIN FACETS

In shaping the main facets (the “mains”) you will be removing very small amounts of material, Continue with the 600 (or 1200) mesh lap. Approach this *slowly and carefully* since the material will be removed very quickly. Inspect often. The main facet positions are:

Main Facets--Angle Dial setting at 42°:
96 Index at: 96 (0), 12, 24, 36, 48, 60, 72, 84

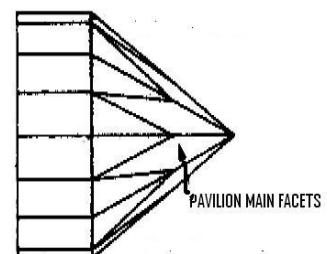
As you do this, inspect the stone and observe how the mains develop--after just barely grinding you can see the beginnings of the break facet. This observation helps you understand the faceting process, and after some experience you will know exactly where a new facet will appear.

The mains are cut until they meet the girdle, as shown in the sketch. Make note of the position of the vertical adjustment.



ADD MAIN FACETS--AND
POLISH IN REVERSE
ORDER

POLISH A SMALL
PORTION OF THE GIRDLE
AT 89.5 DEGREES



6.2.7 PRE-POLISH

The pre-polish lap is used (for example, a BATT Lap), with a 3000 diamond compound. You repeat the sequence of the prior steps. Examine the facet surfaces – it should be starting to look good..

Let's move directly to the final polish step.

6.2.8 POLISHING THE PAVILION

The technique of polishing that is recommended here is the use of Ultra Laps (these laps have the polishing medium deposited on a mylar film). This is one particular method—it is fast, allows the use of the abundant water for lubrication, and does not demand too much by way of developing skills (you will use many additional polishing methods as time goes by). Ultra Laps do cause a very slight rounding of the edge of the facet--but when (and if) you get to worrying about that, you will have become a good faceter and know a lot about various polishing methods.

In polishing this first stone, use an Aluminum Oxide Ultra Lap. Flood the surface of the polish lap with water and place the Ultra Lap onto it.. Then tighten the Safety Nut. Press out the air bubbles you see through the mylar--wet the surface of the Ultra Lap and push the bubble out with your fingers. The water on the surface of the supporting lap will be adequate to hold the mylar down while it is used for polishing--adhesive is not needed.

Set down the stone onto the Ultra Lap surface—you'll need to do a little raising of the vertical position to compensate for the Ultra Lap—resetting the target 40.00. Having done that—the facet on the lap—the angle setting at 40.00--back off the fine adjustment screw about a half turn. The 40.00 reading is maintained by the stone on the lap surface. Turn on the motor and set a slow speed--2 or 3 on the speed control dial. Polish in the same way you had been previously grinding, -- you can bear down to speed the polishing (you may see some fluctuation of the set 40.00—reading some lap error—that's OK)..

Lift the stone to inspect the surface-- you need to position the lap so the light glances off the surface and allows you to see the grinding scratches. You will see the polished surface as it gradually develops. Don't settle for less than an excellent polish—NO scratches. If the facet is being stubborn about polishing, you can try reversing the direction of the lap—that often helps.

Having completed the polishing on one facet, continue with the others, and having completed the main facets go on to the break facets. Note that you are polishing in reverse order to the grinding sequence.

As you use the Ultra Lap you will wear away the polishing medium, or it may seem to slice off in places. You can continue to use the Ultra lap as long as there is some area in which to polish--running the stone over a bare or bumpy spot does no damage. The individual Ultra lap should take you through at least several stones.

When you finish polishing the last break facet, you have finished the pavilion. Make a last inspection to satisfy yourself with the quality of the polish.

You are ready to Transfer the stone--cementing the pavilion onto a new dop, so that the Crown can be completed. Remove the dop/stone from the spindle.

6.2.9 TRANSFERRING



Read the section on the Transfer Fixture which explains how the dops are set into the fixture. In setting the dops into the fixture, see that the key (chamfer) on the dops are firm against the edge of the pushers", aligning the dops radially.

Set the new cavity dop into a V-block of the Transfer Fixture. Select a cavity dop which covers about 2/3 of the pavilion. Tighten the clamp on that dop. Into the opposing V-block, set the initial dop. Tighten the clamps so that it allows the initial dop to slide when pushed on by the "pusher".

Be sure the surface of the cavity dop is clean, and apply a drop of adhesive (or less than a drop--not too much) to the holding surface. Slide the initial dop--pushing it with the "pusher" to maintain its radial position--so that the pavilion is pressed firmly into the cavity dop, and lock the position by tightening the clamp on the initial dop, with the stone under some pressure into the cavity dop. With a toothpick (or whatever) put a small fillet of cement around the stone where it exits the cavity dop. Set the Transfer Fixture on end, the old dop side down--and wait. This is a good time to get a cup of coffee, or tea -- 10 minutes will probably be sufficient for the adhesive to set up, but longer is better.

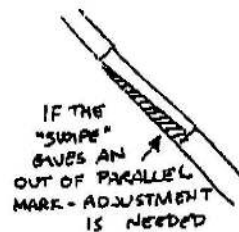
When you remove the stone, do it carefully--loosen the clamps and get them out of the way-- you now have cavity dop-stone-flat dop, and the original flat dop has to be removed. It's a complicated-sounding instruction, but it's easy: you need an alcohol lamp, a small damp cloth, and small pliers. Light the alcohol lamp. Hold the stone with the damp cloth (to keep the stone cool when heat is later applied), with the cavity dop resting in your palm (avoiding a stress between the stone and the cavity dop), and hold the old dop in the flame. As the dop warms, hold the stone firmly in your fingers (with the damp cloth), and use the pliers to apply a side pressure to the heated dop--and at some point the dop will separate from the stone--it sort of pops off. (In this process, don't make the mistake of removing the wrong dop(!)--a message from the Voice of Experience).

You are ready to facet the Crown. Insert the dopped stone into the Spindle and lock the position.

6.2.10 CONFIRMING ALIGNMENT WITH THE PAVILION FACETS

The Crown Facets are usually cut to align with the Pavilion facets--the keying arrangement will provide a reasonable alignment, but some adjustment may be needed. Use the Index Vernier.

To check the alignment, place a 1200 lap on the platen, set the index position of a facet, set the angle at about 85° and with the lap turning slowly, slide the stone across the lap. If the resulting mark is parallel to the edge of the girdle on the pavilion side, you have verified the alignment. If some amount of out-of-parallel is observed, make a correction by rotating the Index Vernier. Having completed the alignment, you are ready to proceed with faceting the crown.



6.2.11 FORMING THE CROWN – BREAK FACETS...

Proceed in a way similar to the faceting of the Pavilion, use the coarse lap only for removal of much material—finish setting the facet with the medium (graduated to a pre-polish) lap.

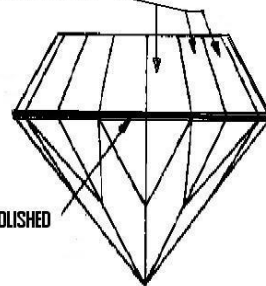
Proceed cautiously and inspect often.

**Break Facets –set the Angle Dial at 52°
96 Index at: 3, 9, 15, 21...etc...steps of 6...to 93**

Cut the break Facets so that they meet at points along the leave a thin polished girdle of 2 or 3% (this is a guess--don't about it--your judgment in this will improve with time)-remember, it was polished previously.

CUT 16 CROWN BREAK FACETS

LEAVE A THIN POLISHED GIRDLE



girdle—
worry

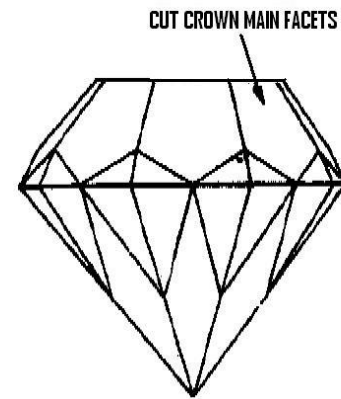
6.2.12 CROWN MAIN FACETS

Again, proceed cautiously and inspect often.

**Main facets – set Angle Dial at 40 degrees
96 Index at: 96 (0),12, 24, 36, 48, 60, 72, 84**

Cut the Main Facets so that they meet at points along the

girdle.

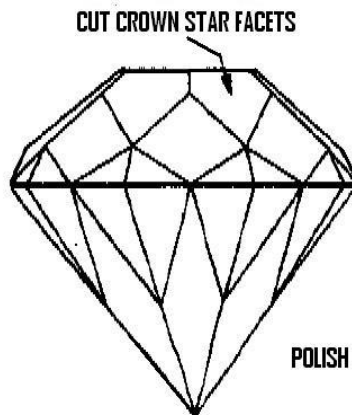


6.2.13 STAR FACETS.

Again, proceed cautiously and inspect often.

**Star Facets - set Angle Dial to 25 degrees
96 Index 6,18,30,42,54,66,78,90**

Cut the Star Facets to meet the points of the Break Facets.



POLISH IN REVERSE ORDER

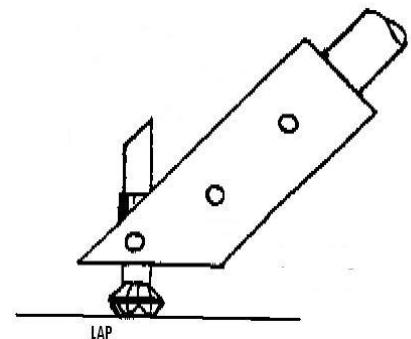
6.2.14 POLISHING OF THE CROWN FACETS

Polishing of the Crown Facets is done in the same way as the polishing of the Pavilion, and again, in reverse order. When you have finished polishing the Crown Facets, you are almost there-- the table is what remains.

6.2.15 THE TABLE.

Remove the dopped stone from the spindle. Place the Tabling Adapter onto the spindle (read the section about the Tabling Adapter).

Completing the Table. When you become more skilled you will find the rough table that was put on for the initial dopping is very close to the final table position. In this first attempt you will probably find there is still significant material to remove, and that you need to use the 600 lap (or the 1200 lap) to get to the final position of the Table Facet. Grind the stone to the final table position--and polish as with the facets. The table, compared to the other facets, is a very large facet and patience is needed in the polishing. Because of the relatively large surface areas, the polishing operation can be noisy--a squeaky noise (extra water with a few drops of detergent can be helpful). Steady firm pressure and slow lap speed will reward you with a well polished table--and a completed stone.



Remove the stone as you did after the first dopping--and you have it. Congratulations.

APPENDIX 1

TABLE OF FACET ANGLES

We thank Louis Roth for this table. Lou comments: *The cutting angles in this chart represent opinions, round-offs, and compromises, so please use it as a "handy guide" and not Gospel. If you see errors, or learn some later information, we'd appreciate your communicating with us.*

TABLE OF FACET ANGLES

SPECIES	SPECIFIC GRAVITY	HARDNESS	R.I.	*****CROWN*****				*PAVILION**	
				MAIN	STAR	GIRDLE		MAIN	GIRDLE
AMETHYST.....	2.66	7	1.54	43	27	46	49	43	45
ANDALUSITE.....	3.1	7 7.5	1.63	43	28	47	49	39	41
APATITE.....	3.15	5	1.64	43	28	47	49	39	41
AQUAMARINE.....	7.75	7.5 8	1.56	42	27	46	48	43	45
BENITOITE.....	3.6	6 6.5	1.75	37	22	41	43	42	44
BERYL.....	2.75	7.5 8	1.56	42	17	46	48	43	45
BERYLLIONITE.....	2.8	5.5 6	1.55	42	27	46	48	43	45
BRAZILIANITE.....	2.9	5.5	1.60	42	27	46	48	43	45
CASSITERITE.....	6.95	6 7	1.99	35	20	39	41	41	43
CHRYSOBERYL.....	3.6	8.5	1.74	37	22	41	43	42	44
CITRINE.....	2.66	7	1.54	42	27	46	49	43	45
CORUNDUM.....	4.0	9	1.76	37	22	41	43	42	44
CUBIC ZIRCONIUM.....	5.8	8.5	2.14	35	20	40		40	40.5
DIAMOND.....	3.52	10	2.41	35	20	39	41	41	43+
EMERALD.....	2.75	7.5 8	1.56	42	27	46	48	43	45
EPIDOTE.....	3.35	6 7	1.73	37	22	41	43	42	44
EUCLASE.....	3.0	7.5	1.65	43	28	47	49	39	41
FELDSPAR.....	2.6	6 6.5	1.53	42	27	46	48	43	45
FLUORITE.....	3.2	4	1.43	41	26	45	47	45	47
GARNET (ALMANDITE)...	4.1	7.5	1.83	37	22	41	43	42	44
GARNET (ANDRADITE)...	3.85	7.8	1.89	43	28	45	49	40	42
GARNET (GROSSULARITE)	3.62	7	1.73	37	22	41	43	42	44
GARNET (PYROPE).....	3.7	7	1.70	37	22	41	43	42	44
GARNET (RHODOLITE)...	3.85	7	1.70	37	22	41	43	42	44
GARNET (SPESARTITE)...	4.15	7.8	1.80	37	22	41	43	42	44
GARNET (UVAROVITE)...	3.75	7.5	1.87	37	22	42	43	42	44
GOSHENITE.....	2.75	7.5 8	1.56	42	27	46	48	43	45
HELIODOR.....	2.75	7.5 8	1.56	42	27	46	48	43	45
IOLITE.....	2.8	7 7.5	1.54	42	27	46	48	43	45
KORNERUPINE.....	3.3	6.5	1.67	43	28	47	49	39	41
KUNZITE.....	3.2	6 7	1.66	43	28	47	49	39	41
MORGANITE.....	2.75	7.5 8	1.56	42	27	46	48	43	45
OBSIDIAN.....	2.45	5.5	1.48	42	27	46	48	43	45
OPAL.....	2.1	5.5 6.5	1.65	41	26	45	47	45	47
PERIDOT.....	3.3	6.5 7	1.65	43	28	47	49	39	41
QUARTZ.....	2.66	7	1.54	42	27	46	49	43	45
RUBELLITE.....	3.15	7 7.5	1.64	43	28	47	49	39	41
RUBY.....	4.0	9	1.76	37	22	41	43	42	44
RUTILE.....	4.25	6 6.5	2.61	32	15	34	36	41	41.5
SAPPHIRE.....	4.0	9	1.76	37	22	41	43	42	44
SCAPOLITE.....	2.6	5 6	1.56	42	27	47	48	43	45
SPHALERITE.....	4.0	3.5	2.37	35	20	39	41	41	43
SPINEL.....	3.55	8	1.71	37	22	41	43	42	44
SPODUMENE.....	3.2	6 7	1.66	43	28	47	49	39	41
TITANIA.....	4.25	6.5	2.90	32	15	34	36	41	41.5
TOPAZ.....	3.5	8	1.61	43	28	47	49	39	41
TOURMALINE.....	3.15	7 7.5	1.64	43	28	47	49	39	41
ZIRCON.....	4.6	7.5	1.93	35	21	39	41	41	43