

Faceting Machine Alignment

By Don Rogers

What is a faceting machine?

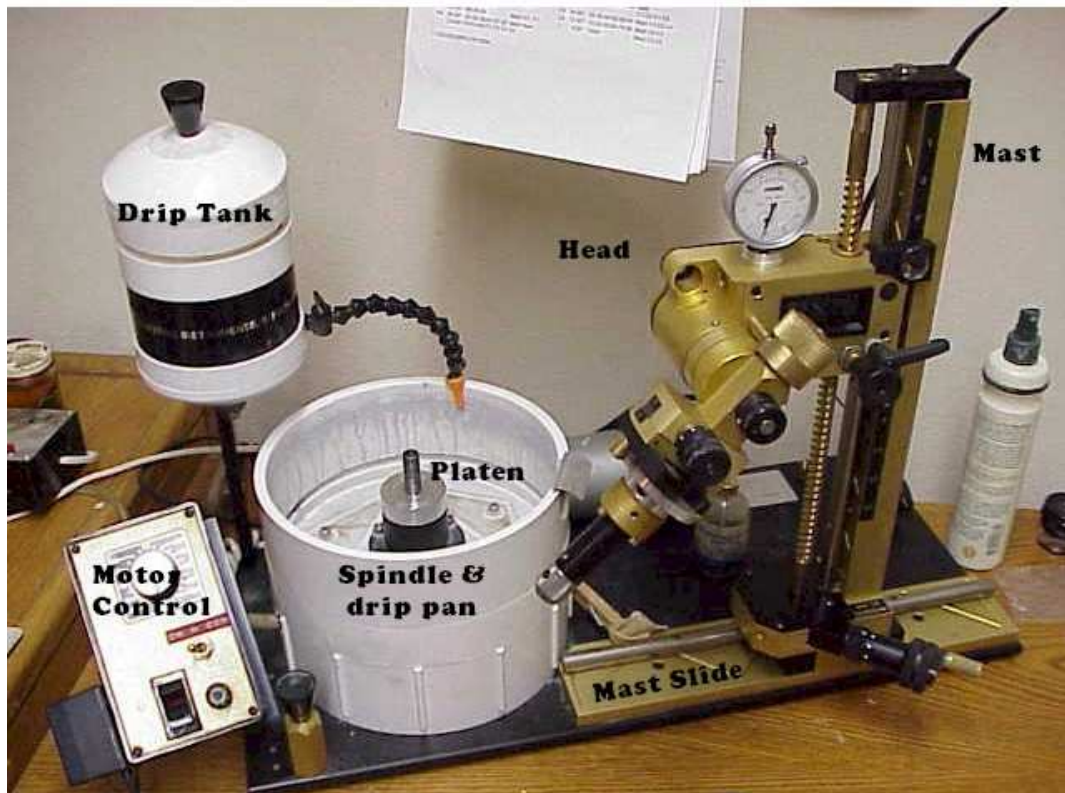
It is a tool that allows one to cut and polish flat spots on a stone. It is possible to facet a stone using nothing more than a flat rock that is harder than the stone to be cut, and your hand. Your hand and arm muscles introduce all motion. The precision of the cutting using this method is not very good. You have to guess at angles and it is difficult to make your hand move in only one plane. To overcome this lack of precision, several evolutions of tools and machines were developed which give the ability to accurately cut a flat spot on a stone at the angle and depth we want. Currently at the beginning of the 21st century, we have machines that can measure the angle we are cutting to 0.01 degrees. We can measure the depth of the cut to 0.0001 inches. Software that will calculate the exact angle and depth of cut is now available. What more could we want?

As a friend of mine would say, we measure with a micrometer, mark it with a piece of chalk, then cut it with a broad Ax. If the cutting is not as precise as the measurements, little is gained. In other words, precise measurements are only effective if you know where you are measuring from. This is the reason for writing this article.

There are any number of things that can cause problems with your cutting. Many of these problems are the result of your own eyes and hands and not the problems of the machines. However, if your machine is also introducing problems, it makes it more difficult to complete a faceted stone with the precision we want. If we know that the machine is accurate, then the focus can be on our techniques needed to resolve problems that arise in cutting. We can, if talented enough, overcome the problems of the machine. This is called work. Faceting should be fun, not work.

One more important point before we go on. The fact that a machine needs adjusting doesn't mean it is a defective machine. Wear, hard knocks, and other misfortunes will cause a machine to be out of alignment. The process of getting thrown on and off of trucks and airplanes getting from the manufacture to you can create the need to realign the faceting machine. If your machine has a lot of adjustment points, it is because the manufacturer understood that sooner or later adjustment would be needed and designed them into the machine.

Here are photos of two different types of faceting machines. The first is a mast type machine and the second is a platform type. Each type has its advantages and shortcomings.



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POLYMERIC SCINTILLATOR 88 DIGITAL



Raytech-Shaw

So, how do we know if our machine needs a little tuning? Well, can you cut long step cuts without having to cheat a little? Are your transfers always in perfect alignment? A saw tooth girdle never happens on your stones? Chances are that you have answered no to all of these questions or at least to

one of them. If so, you need to “true up” your machine. In order to assure accurate alignment, we need to measure it from known points of reference.

One important point should be made here. The sequence of the measurements and adjustments described in the rest of this article must be followed in the order given. If you have a problem and a quick check shows something is not aligned properly, **YOU MUST START FROM THE BEGINNING**, not skipping any steps. If a problem is with one of the later steps, you will have wasted little time in verifying that the problem was not a more basic problem which should have been detected sooner. This is a must!

The first check we need to make is on the laps. Are they truly spinning on a plane and not doing a random orbit?

It does little good to have a machine that measures to 0.01 degree accuracy when the lap is wobbling enough to introduce a full degree or more of problem. As the lap is the surface to which all measurements in faceting are referenced to, it is a good idea to have this as true as possible. To get the best measurement, you will need a Dial Indicator and some sort of Base for it. They can be obtained at discount tools stores for under \$40.00. This is less than the cost of a small piece of rough that you would screw up because your machine isn't cutting correctly.



Dial indicator and base

Step 1, The Lap and spindle

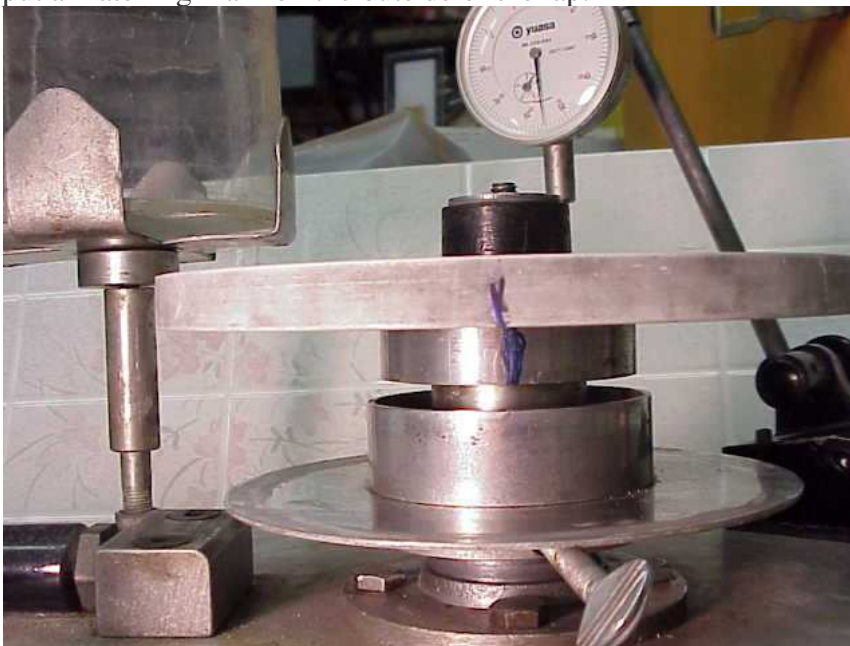
Ok now you have the correct tools to measure your laps, what to do?

First, clean the bottom of the lap and clean the platen that the lap sets on. A 0.01” thick piece of junk under the lap at one inch from the center will result in about 0.004” of wobble out at the edge. For example, take a 12” ruler and lay it flat on a table. Then place a pencil under the ruler at about the 3” point. Hold down the 0” end of the ruler and you will see that 12” end is off the table about four times the diameter of the pencil. Any bumps on the platen can be dressed off by “carefully” filing with a flat file. If the file slips off without catching on anything, there are not nicks, etc. that need addressing. Don't try to take a little extra metal off just in case, all you want to do is to knock down the burrs and high spots back to the original machine surface of the platen.

When you are satisfied that the platen is as true as you can get it for now, check



and clean of the bottom of a ceramic lap, or better yet, a master lap, and then mount it on the machine. Before mounting the lap though, put a mark on the platen with a #2 pencil or marking pen. It doesn't matter where, just as long as you can see it after the lap is on. Now once the lap is on and locked down, put a matching mark on the outside of the lap.



This will allow us to determine later, if the platen or the lap is causing any wobble.

Now set up your dial indicator and take a reading near the outer edge of the lap. Turn the lap by hand, using a light touch on the edge of the lap, and advance the lap about 10 deg at a time, fully releasing the lap each time. Move in the same rotation until you have gone completely around the lap. Take your readings while the lap is stationary. Be very careful not to spring the lap, as this will introduce an error reading that is false. Also, make sure the indicator base is not moving during the measurement. If you

get a wobble of less than 0.002", your lap platen is in good shape. Ideal would be less than 0.001". If the wobble is more, we now need to determine if it is a result of the lap or the spindle.

First, make another pencil mark on the lap at the high spot. Now use the marks that were put on the lap and the platen. Loosen the lap hold down and rotate the lap so the mark on the lap is 180 degrees away from the mark on the platen. Tighten everything back down and take a reading again. If you end up with the same amount of wobble and it is at the same high spot on the lap, you have a lap that is not true. Beg, borrow, or buy another lap to finish up the alignment.

If the wobble is not determined to be in the lap, but in the platen, you need to resolve it before proceeding. First check out the platen again for any high spots or dings that were not cleaned up earlier. If you can't find any problems, then you have one of two choices. First you can send the machine back to the manufacture to have the platen trued up. The other choice is to re-cut the platen surface with a platen-truing tool. This is actually a more desirable solution as the platen would be cut true to the bearings and mounting you now have, not to a lathe setup.

Step 2 The Platform or Mast.

Platform Machine adjustment.

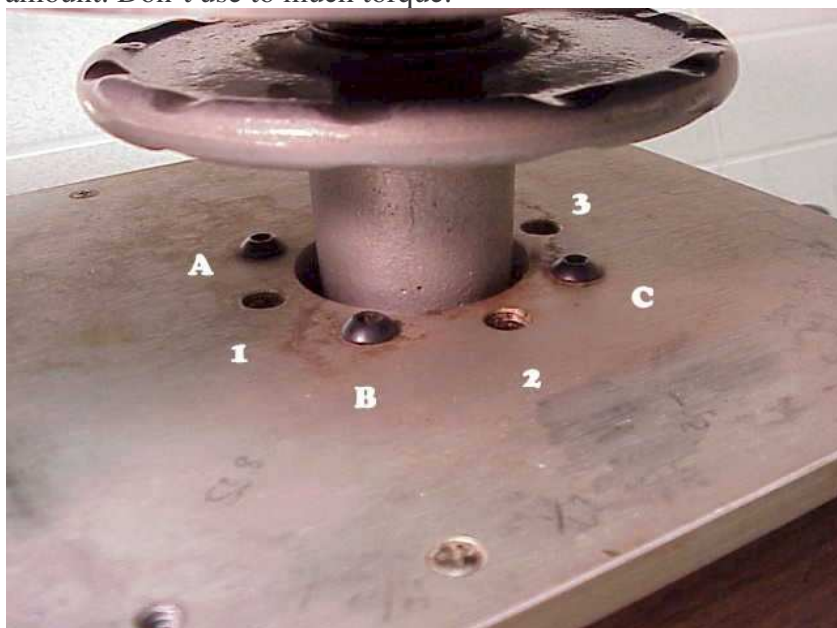
The platform machine introduces a second lap that must be true, the platform. We must first identify any wobble in the platform and compensate for it. Notice I didn't say correct it because to do so is a major machining process and as long as we know where the wobble is, we can work around it. Set up the dial indicator and measure the wobble or run out of the platform



Mark the high spot of the platform. Now looking down on the lap and platform put the high mark on the lap at 3:00 and the high mark on the platform at 9:00. With the lap and platform aligned in this manner, place the dial indicator base on the platform and set up the indicator to be touching the lap as close to the spindle as possible. Next, sweep the platform and indicator base to take a reading off the back of the lap and the front of the lap.



This measurement should be less than 0.001". This alignment being off causes you to cut deeper on one side of the stone than the other resulting in saw tooth steps and girdles. To adjust this out, you will need to adjust the platform mount. There are four cap screws and four set screws to set the alignment of the platform. Take some time to visualize how these interact. For example, if you want to tilt the platform, lowering the front, You would loosen screws B and C, as well as set screw 4. Only loosen these by about 1/16th of a turn. Now tighten set screw 2 and then tighten down screws B and C. You will need to tighten down set screws 1 and 3 also but only 1/2 as much as you tightened set screw 2. You will never completely loosen any screw. Also when A, B, C, and D are tight, none of the set screws should be loose. This is a delicate adjustment. Use care and always torque down the screws the same amount. Don't use too much torque.



Raytech Platform adjustment.

Mast Adjustment

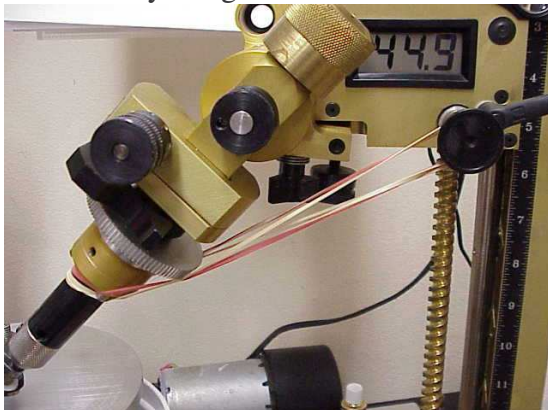
To make the measurements on a mast machine requires you to make another tool. You will need to make a dop that will hold a dial indicator. Keep it simple. Stuff from your junk screw drawer will most

likely fill the bill.



Set the angle around 45 deg. Set up the dial as shown in the second photo above.

Lock every thing down then use some rubber bands to hold the quill down on the hard stop



Now take your first reading from the edge of the lap and then the other edge



There should be less than 0.001 run out. Before attempting to make any other adjustments though, we need to get a right/left reading as well as the front/back ones just taken. Slide the mast left and right locking it down each time and check out the alignment again.



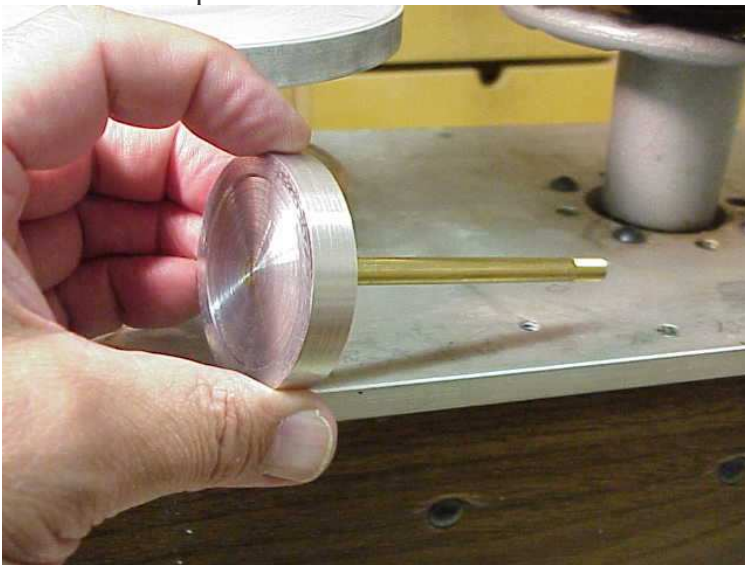
Now if an adjustment is made, you will need to go through the four readings each time.

On the Polymetric the adjustment will be made to the spindle. Most mast machines will adjust in this manner. The Polymetric uses a three point system rather than the four point of the Raytech. The same process applies though.



Step 3 The Head or Hand Piece.

OK, now we have a machine where the lap is spinning on a predictable path and it is flat and true. It is on the correct plane with respect to the platform or mast. Now take further measurements can be taken from the lap. From this point forward, most of the measurements will be made using a set of drafting triangles that you can buy at any stationary store for less than \$3.00. You will need two triangles, a 30,60, 90 and a 45,45,90. These usually come in a set with a protractor and a ruler. Get the small ones, you don't need large ones for these measurements. The second tool you will need is what I call a Monster Dop. This is a tool I make that is basically just a dop shaft that will fit your machine and a 2" diameter flat dop surface. All measurements will now be done from this surface compared to the lap.



The first measurement or check is done at zero degrees and zero cheat. We want to make sure that the Head and the lap are in the proper alignment. IE, we want to make sure that when the stone is swept across the lap while cutting and polishing it, it is not cutting at different angles on the start and finish of the sweeps. To check this out, use the monster dop and set up the head so the dop is setting flat on the lap. If the monster dop does not set flat on the lap, that means that the mast or platform is not an exactly 90 degree reference to the plane of the lap and an adjustment must be made to fix this problem. Follow the previous instructions for your type of machine. Your concern here is that the monster dop is flat to the lap. If the angle is reading 5 deg or -5 is not important just now. We will fix that next.



Before starting to make the angle adjustments, let's talk about where precision is important and where it isn't. Most of your cutting is going to take place between 25 deg and 55 deg. The exception of course is the girdle that should be cut a 90 deg. What happens if the girdle is cut to 89.5 and not 90. Does it affect the stone. Nope, it just isn't 90. No harm done. So let's focus our attention on the area of the protractor where the measurements are most critical. IE 25 to 55 deg. We will make our measurements at 0, 30, 45, 60, and 90 degrees.

OK, you just set up the machine so the Monster dop was flat on the lap. Now with it in this position, we will make the first measurements.

Platform Machine only

On the platform machine, start by setting the protractor to exactly Zero. Now adjust the height of the platform and the three feet of the hand piece until the Monster dop sets flat on the lap and all three feet are touching the platform



Mark the position of the three screws on the hand piece. This will be the Zero setting. A note here, with the Raytech Facetfinder installed, it is necessary to make sure that you are resting on the front foot and not the facet finder when cutting 90 deg. If you need to correct this, just screw each of the three screws down one or two full turns to where the zero marks align again. Check the monster dop just to make sure. Now that the Zero degree is established, we will

walk through the other angles to document them.

First

All Machines

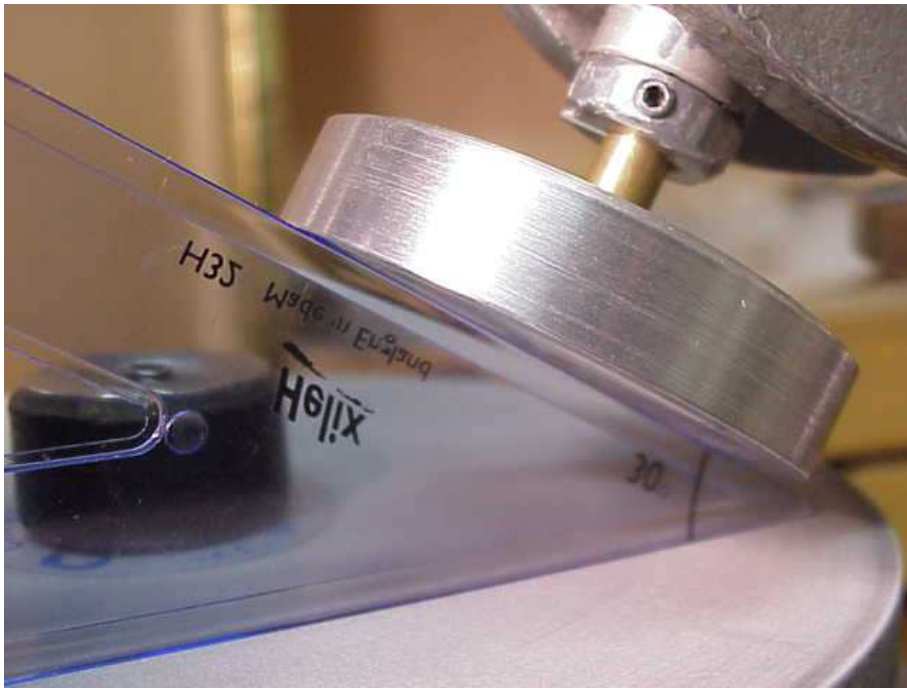
Now we are going to use the high priced angles that we got from the stationary store and check the settings at 30 deg, 45 deg, 60 deg, and 90 deg.

First raise the platform or head until the Monster Dop clears the lap by about 1/4" when the head is set to 30 Deg. Don't tighten down the lock screw on the angle though as you want to be able to move the head angle in the next steps.

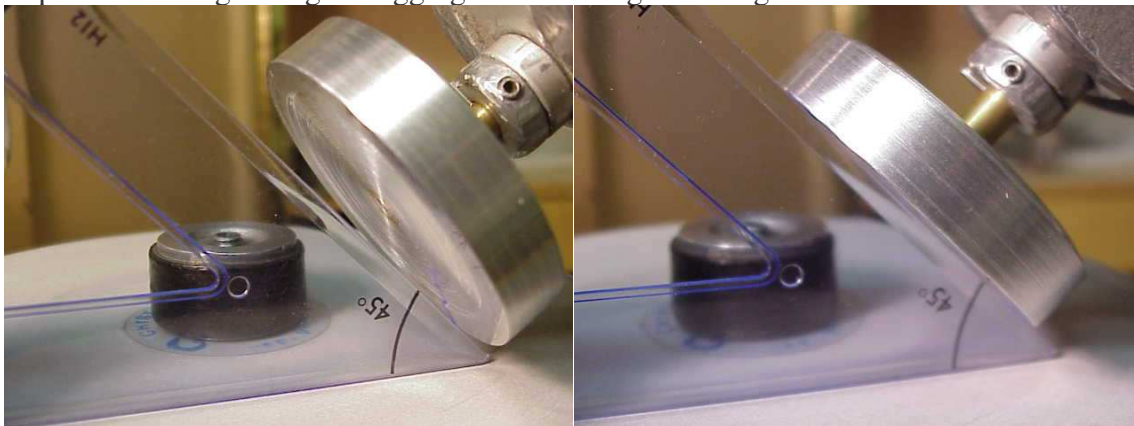
With the hand piece setting firmly on the platform, and the angle around 25 Deg, slide the angle under the Monster Dop as shown above. Make sure the the angle is at a 90 deg to the lap and hitting the Monster Dop at 12 and 6 o'clock



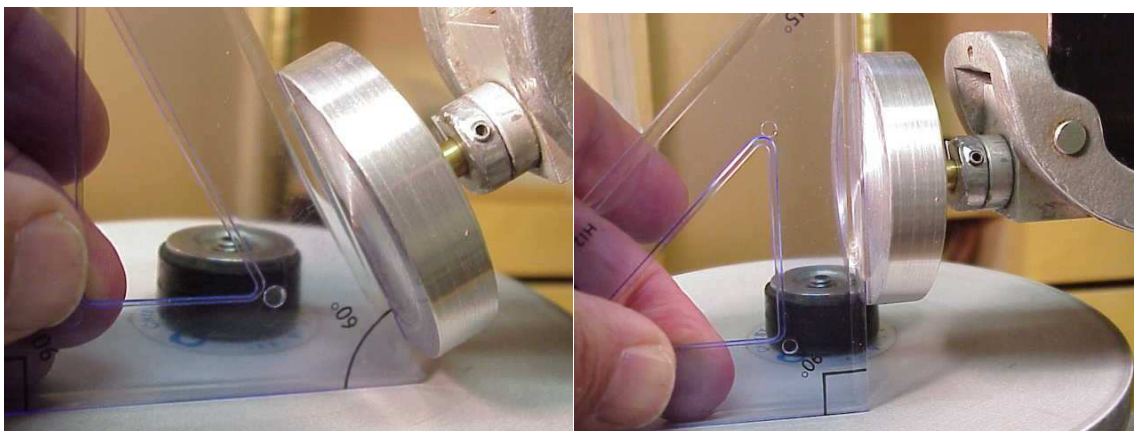
Now slide the angle under to the point that it contacts the Monster Dop at both 12 and 6 O'clock. Check the angle and note the exact angle reading. Log in this reading.



Repeat for 45 degrees again logging the exact angle reading.



and for 60 Degrees and 90 Degrees.



Hopefully, our chart of angles will show that we have 0.01 degree or less discrepancy for each of the five checks. If the readings are consistently off by the same amount, you can adjust the pot on your digital readout or on the Ultra Tech, you can adjust the protractor wheel. I do not know about what adjustments

are available on other machines.

Some may not be adjustable, i.e. the Raytech. There you will have to make yourself a cheat sheet to allow you to tweak the angles you are setting so they are correct

The Chart might look something like this.

TRUE	0	30	45	60	90
Read	0	30.05	45.25	60.1	89.94
Offset	0	0.05	0.25	0.1	-0.06

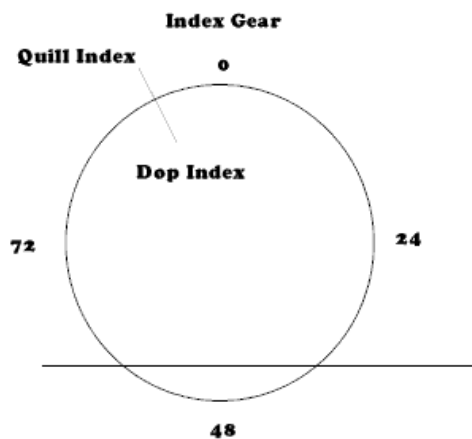
You would add the offset to the desired angle. You will need to interpolate the in-between angles. IE 15 degrees would be set on your machine at 15.02 or 15.03 Degrees.

Dop alignment and Transfer.

The most commonly accused for transfer problems, the transfer jig, is the least likely to actually be causing problems. The most likely culprit is your machine that we have just aligned. Now the machine is adjusted correctly so that the exact angle it is going to cut at any setting, and we know that it can be accurately cut anyplace on the lap without having to change the setup. What isn't known is the accuracy of the rotational position or Index.

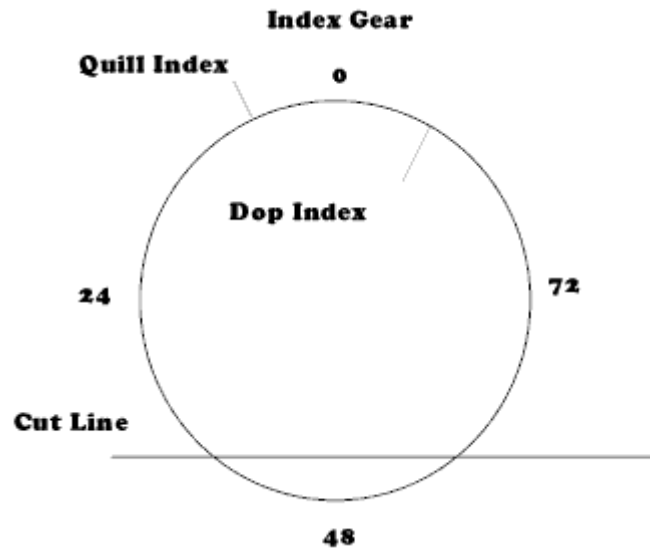
Now if your machine doesn't use indexed dops, like the older Ultra Tech, then you have completed the adjustments on your machine and only have to verify the accuracy of your transfer jig, which we will cover shortly.

If your machine does use indexed dops, then it is necessary to re-establish the actual zero index on the machine. Why is this a problem? If the dop index and zero tooth don't align exactly, when you transfer, the difference is magnified by two.

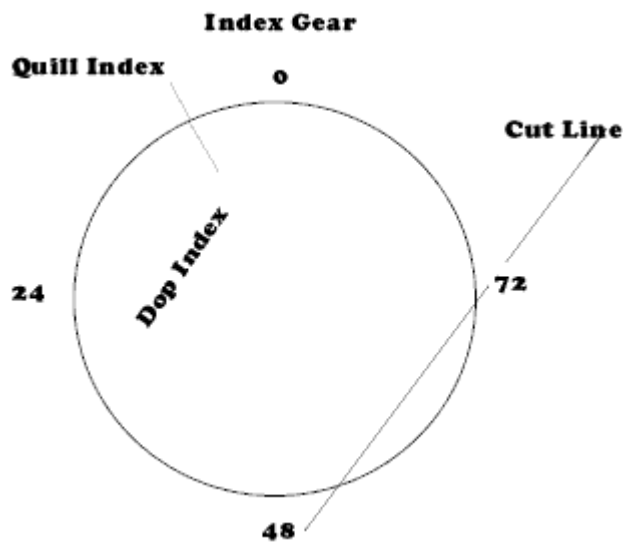


This is a representation of where the Quill index and the index gear are not in alignment. The dop index will always align with the quill index. That is what it was designed to do. The horizontal line indicates the cut line for index 0.

Now when transferring, the relationship of the stone to the quill changes. It is in fact flipped horizontally and what would have been index 24 is now 72.



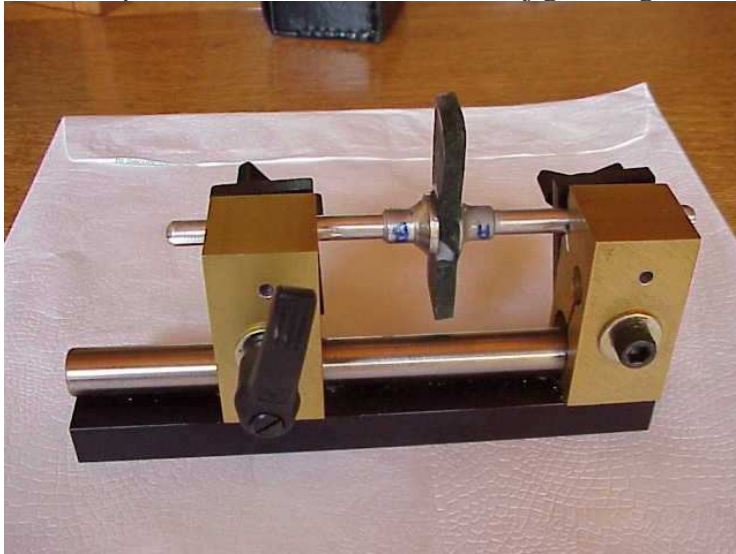
Note the problem here though. The dop index must align with the quill index so we have to rotate the dop until it does.



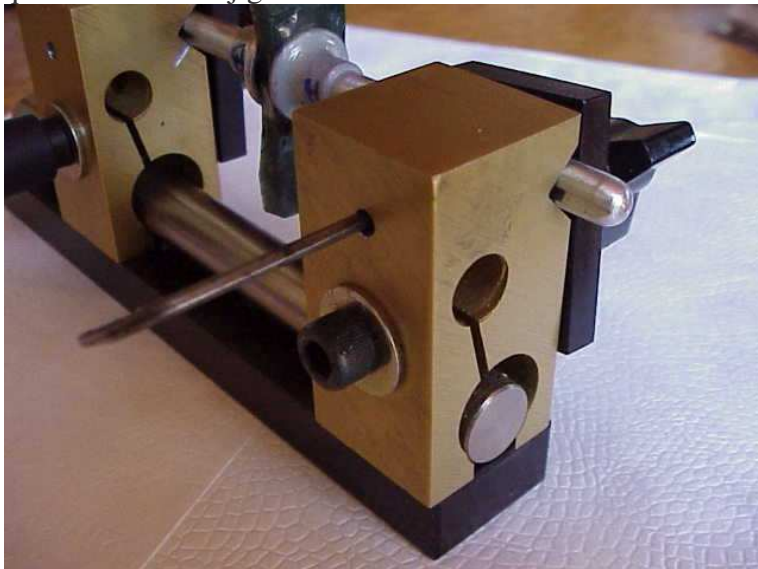
When rotating the dop to engage the quill index, the previous "0" index cut is no longer parallel to the lap, but is offset by twice the offset of the quill index to the index gear. This is where the cheater comes into play. Crank the cheater around until the old cut line is back to parallel to the lap. If you have a cut at "0", this isn't too bad as that is the way stones were aligned before the indexed dops. You are more likely to run into problems where the facet is not at "0" but rather, say, at "2". It is easy to set the index gear to "2" and realign the stone. If you do, you are in trouble because what you should have set the gear to "94" and then aligned to your old cut at "2". Remember the stone was flipped.

So, how do we overcome this problem. Well, first we must assure ourselves that the transfer Jig is not introducing an alignment error. This is very easy to check out. You will need two dops, with 3/8" or 1/2" tips and a rectangle piece of slab stock of any kind about 2" long by about 1" wide. Set a dop in each

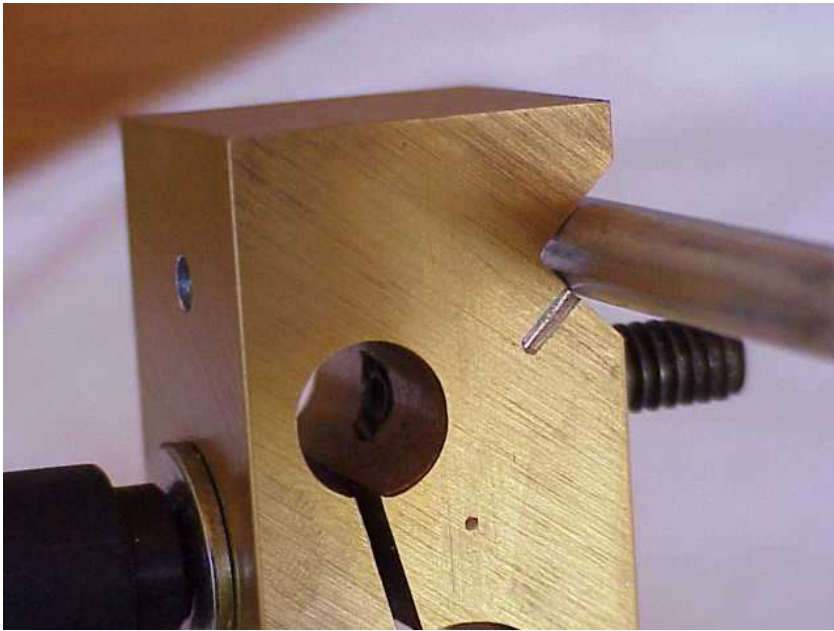
end of the transfer jig. Epoxy, using a slow setting epoxy or plastic steel, the piece of slab to both dops. Make sure that the long edge of the stone is bisected by the alignment scheme. When you install this dop in the machine, and set the index to "0", the long side should be parallel with the lap. Re-cut the long edge of this stone, leaving enough hanging over the dops so as not to cut into the dops. It is important that the dops are indexed into the transfer jig and tight during this step.



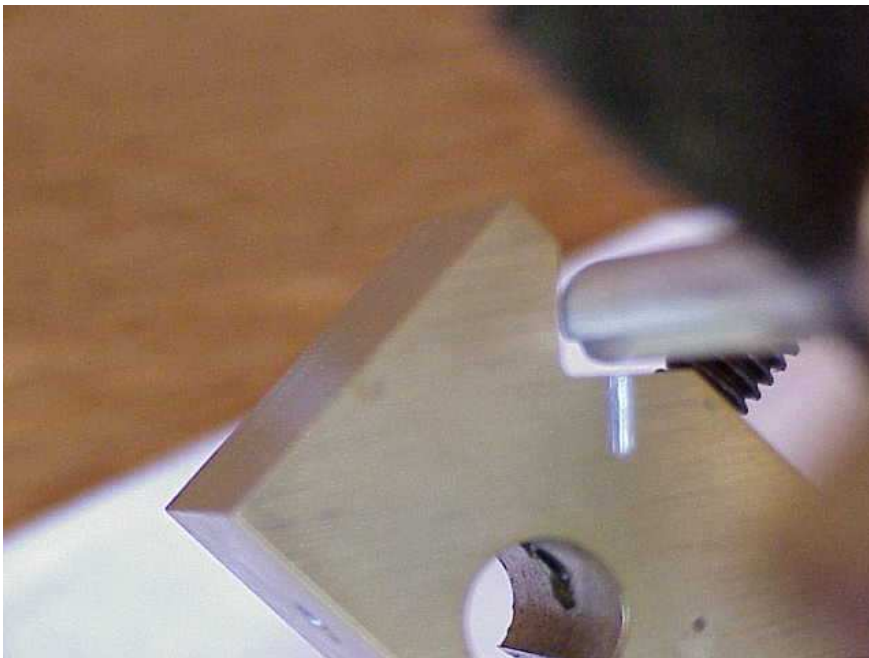
A note here is in order. This applies to machines that use a pointed set screw to align the dops in the quill and transfer jig.



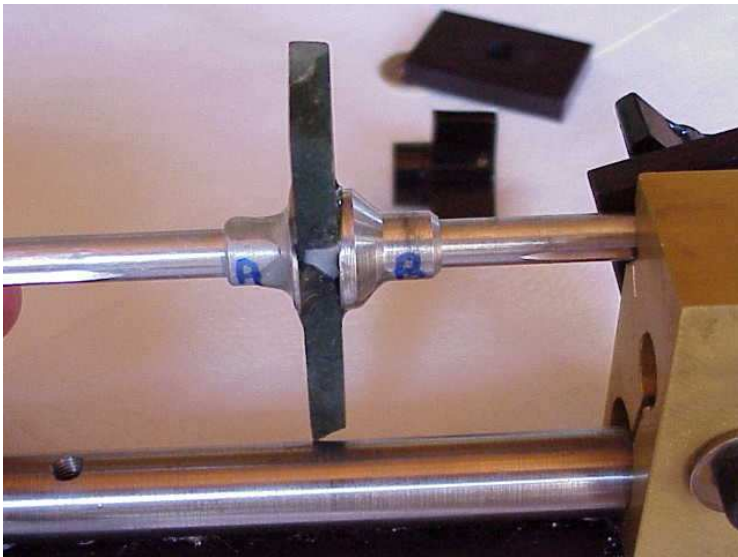
You need to make sure the set screw isn't setting too deep, preventing the dop from fully setting. Back off the set screw and then snug down the clamp. Then tighten the set screw until you feel first contact with the dop. Loosen the clamp and reposition the dop. You need to feel your way in. It takes a lot less time to do than to explain. Bottom line is that you want the dop fully seated in the block and the set screw as far into the dop as possible without lifting the dop off the V groove.



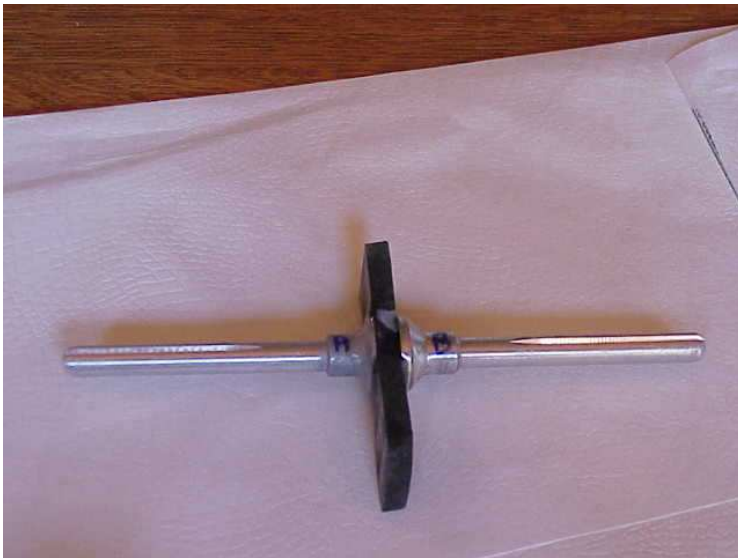
When the epoxy is fully set, you should then be able to reverse the Double dop and it should lay in the V groove as shown above. This indicates that your transfer Jig is in alignment.



If you get a miss alignment as shown above, you need to resolve the alignment problem in your transfer jig. To fix the alignment in the transfer jig, you will usually need to re-machine the Jig



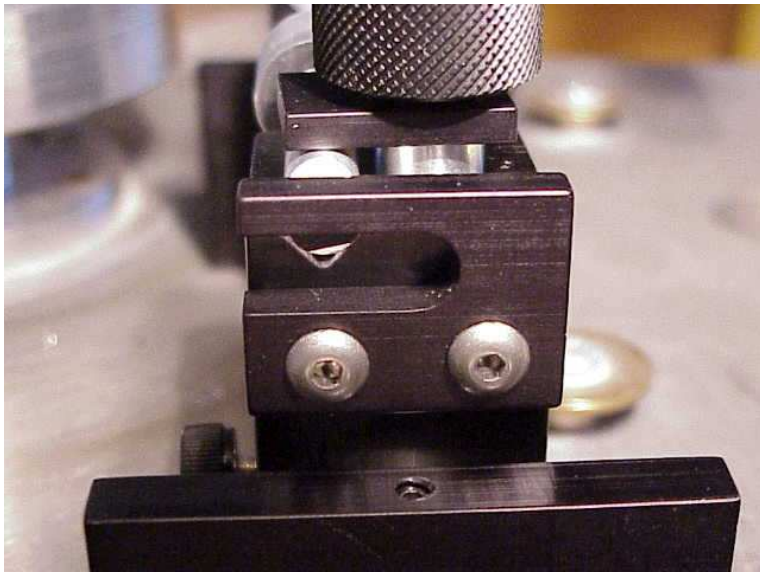
One thing to watch is that your stone doesn't interfere with transfer jig as the one in the picture above is doing.



The semi finished Double dop.

A note on your transfer jig. If you have transfer jig like the Ultra Tech keyed dop jig, it is possible to be in good linear alignment but be off in radial adjustment. In other words, the dops will lay in the groove correctly but the index will not align when the dop is flipped end for end.

On the Ultra Tech transfer jig, this can be adjusted out.



An end view of the Ultra Tech transfer jig

Index Alignment.

Now, the real reason you made this new tool. We are going to align the Quill index to the Gear index. Or at least identify where the real “0” is on the quill/gear combination. But to do this, first finish cutting the stone in the double dop. Set up the machine at 90 deg and “0” index with the cheater set to “0” cheat. Mount up a 100 grit or at least the coarsest lap you have and cut the stone so you have a smooth surface the length of the stone. If you do like I did on my Polymetric double dop, start with a bow tie shaped stone and then you will have a lot less stone to grind off to get an end for end bearing. Now that we have a bearing surface about 2” long, it's time to swap ends on the double dop. Do not change the cheater yet. What you will usually see is that the stone doesn't lay flat on the lap now as shown below.



Now adjust out $\frac{1}{2}$ of the angle to the lap and re-cut the stone for a new bearing surface. Once the stone is re-cut, flip it end for end again and check the alignment to the lap. Unless you are very good at guessing angles, you will have to repeat this series until you reach the point that when you swap the dop

end for end, you have full contact with the lap, Step 123, 123, 123 etc

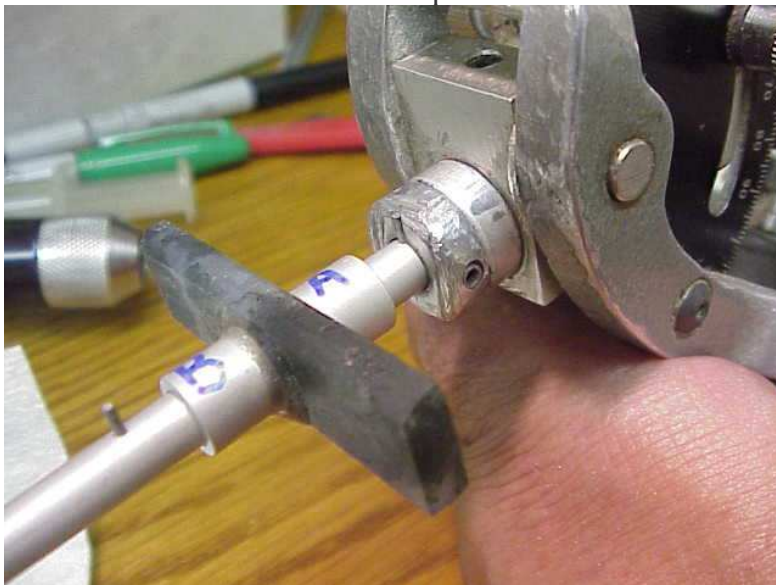
1. Cut a full flat
2. Reverse ends and note the miss alignment
3. Cheat out $\frac{1}{2}$ of the miss alignment



At this point, you have a double dop that you can use to set up “0” index on your machine.

We can either adjust out the offset in the quill to gear indexes or relocate the “0” cheat reference. The adjustment is the best course of action because it is something you can do each time the index gear is changed. It is not possible on some machines though.

On the Raytech, there is an option called an “Adjustable Collar” that is the beat up piece of aluminum that the dop pin is setting in and it also has a set screw at the 3:00 position. The collar is just to the right of the “A” mark on the double dop.



This process for machines that are adjustable will be the same. First set up at 90 degrees as if you were cutting a girdle.

1. Set the cheater to “0” cheat or the home position
2. Set the index gear at “0”
3. Loosen the adjustment lock, in the case of the Raytech loosen the set screw on the adjustable collar
4. Gently rotate the dop until it the stone has full contact with the lap.
5. Lock down the adjustment.

You now have a machine that is in alignment. If you change index gears, you will need to repeat these last five steps for the new gear, otherwise, you should not need to. You will be amazed at how nice it is to not have to find the alignment of the stone after transfer. Now you can have fun.

On the machines where an adjustment is not possible, you will need to remark the home or zero cheat. On the Polymetric, this is easy, just put a piece of tape over the old alignment line and mark on a new one when you have cheated so the stone sets flat onto the lap. Replace the “0” mark on the “X” side of the cheater scale.



The other machines are going to be a little more difficult but not impossible. At worst, document where the cheater is when the double dop is flat on the lap and return to that spot before starting a stone and at transfer.

In summary, below is the sequence of checks and adjustments. Please remember that if you are having troubles with your machine, and you need to go back through the adjustments, this sequence must be followed in the order given above. There is a two step quick check out that you can do if you think there are problems. If step 1 of the quick check is OK, then begin your re adjustments starting with step 4 of the adjustment sequence.

Adjustment Sequence List

1. Lap Wobble
2. Mast or Platform to Lap Alignment
3. Head or Hand Piece Angle Checks and Adjustment

4. Transfer Jig Alignment
5. Dop to Quill index Check and Adjustment
6. Trouble Free Cutting (at least as far as machine alignment goes)

Quick Check Out

1. Monster Dop at "0" Degrees
2. Double Dop at "0" index