THE SCIENCE BEHIND BRUSHING

There are 3 basic principles to understanding what brushing does:

1. Brushing cleans/polishes/heats the ice.
2. Brushing reduces stone-ice friction which causes a stone to glide further.
3. Brushing pressure varies greatly through the length of each stroke which impacts the amount of curl.

The third principle is the critical concept to understanding how one can make a stone curl more or curl less. And for this I defer to Drs. Glenn Paulley and John Newhook and their work with instrumented brushes. These brushes have sensors in the brush head that provide information on brush head pressure and brush strokes per second. I have taken the liberty of using the following graph from their brushing study and converted the brush head forces from metric to imperial. I have also divided the brush stroke into 3 phases. This representation is referred to as **The Anatomy of a Brush Stroke**

THE ANATOMY OF A BRUSH STROKE

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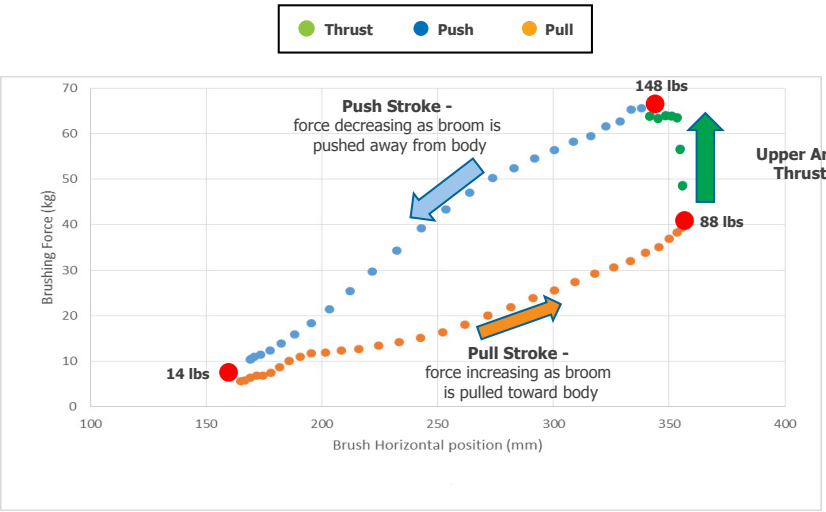


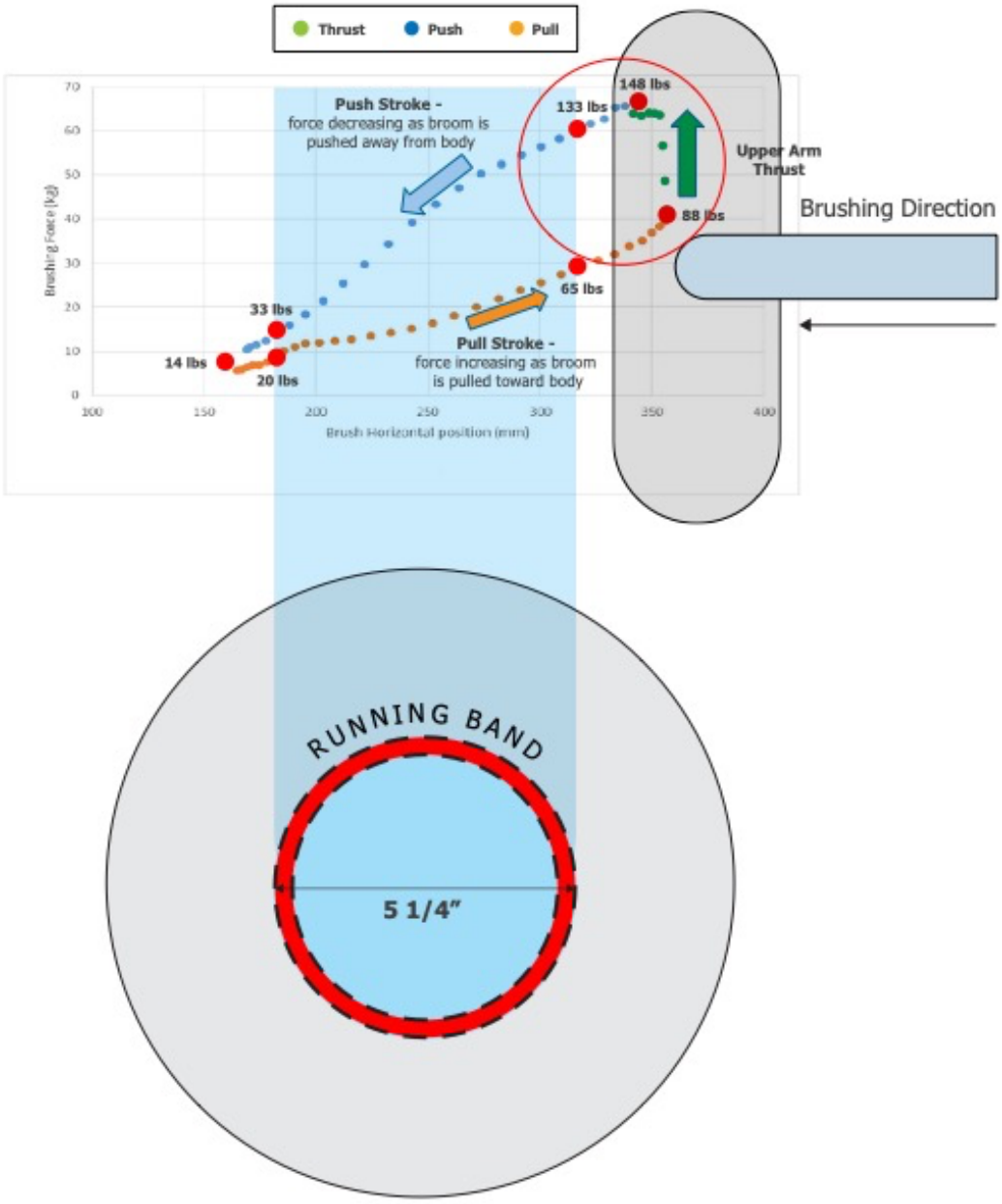
In the diagram, the brusher is positioned on the right-hand side and the brush stroke is going to the left. The dots represent pressure data collected at a rate of 300/sec.

When you start the brushing motion you first come down with your body weight over the brush head, which is represented by the 88lbs.

Then as you **Thrust** with your upper arm to start the push part of your stroke, the force increases to 148 lbs (green dots).

The stroke continues through the **Push Stroke** where the brush head pressure diminishes to 14lbs (blue dots). Then as you start your **Pull Stroke**, the pressure steadily increases back to where you started at 88 lbs (orange dots).

The subject athlete that was used in this study was an above average competitive brusher. I have collected data from competitive athletes that have much less force and others with more. But in all cases the pressure pattern would be the same, with pressure diminishing in a fairly straight line as you push, and increasing in pretty much a straight line as you pull the brush toward you. In this case there is 10X more pressure nearest your body at the start of the stroke (148lbs), than there is at the end of the stroke (14lbs). This uneven pressure causes a glide-grab effect across the running surface of the stone. The stone will always tend to go to where there is less brush head pressure as this creates more stone-ice friction or grab.



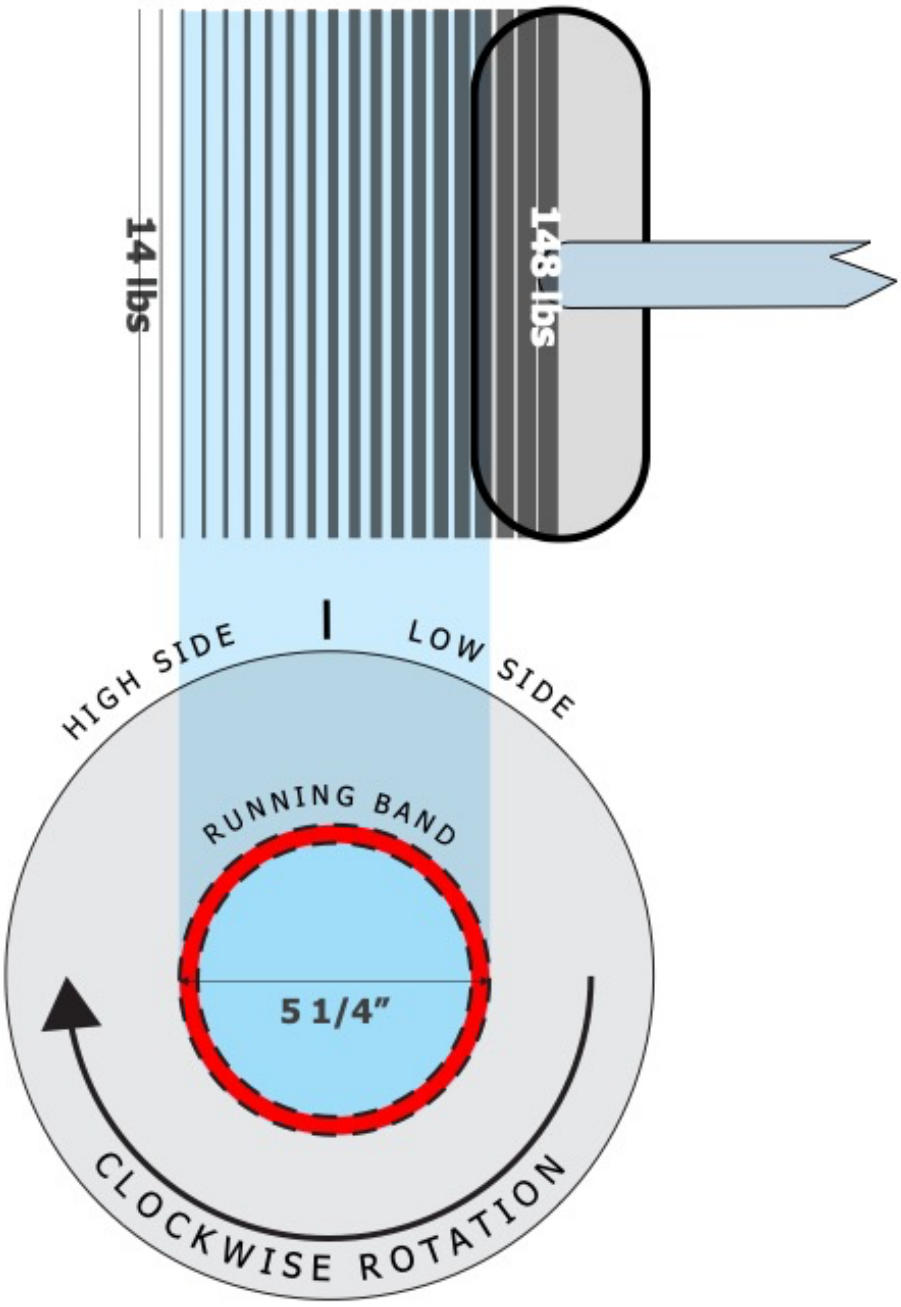
Adding a stone and a brush to the graph gives a better representation of what happens when you brush a stone. The most important thing to note is that the running surface of a stone is only 5 inches wide. Brushing beyond that has no impact on the stone.

The most impactful part of the stroke is the first 2 ½ inches at the start (circled in red). Positioning of the brush during that part of the stroke relative to the running surface is critical. In the case of this diagram, the most effective brushing would be to start your THRUST part of the stroke closer to the edge of the path of the running surface.

BRUSHING SIGNATURES

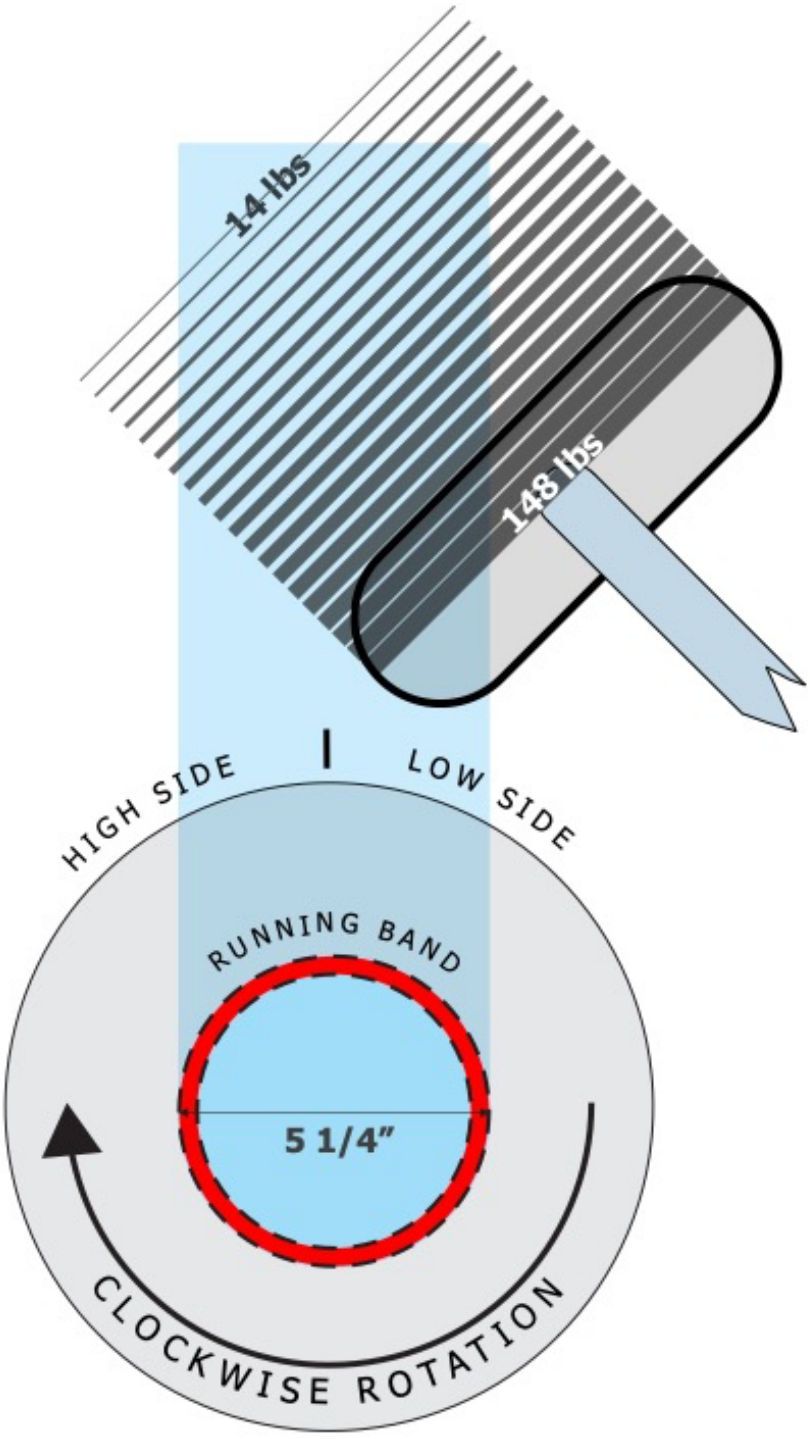
Let's look at how different types of strokes impact the curl of a stone. The different brushing patterns are referred to as "brushing signatures". They are numbered consecutively for reference purposes only

1.



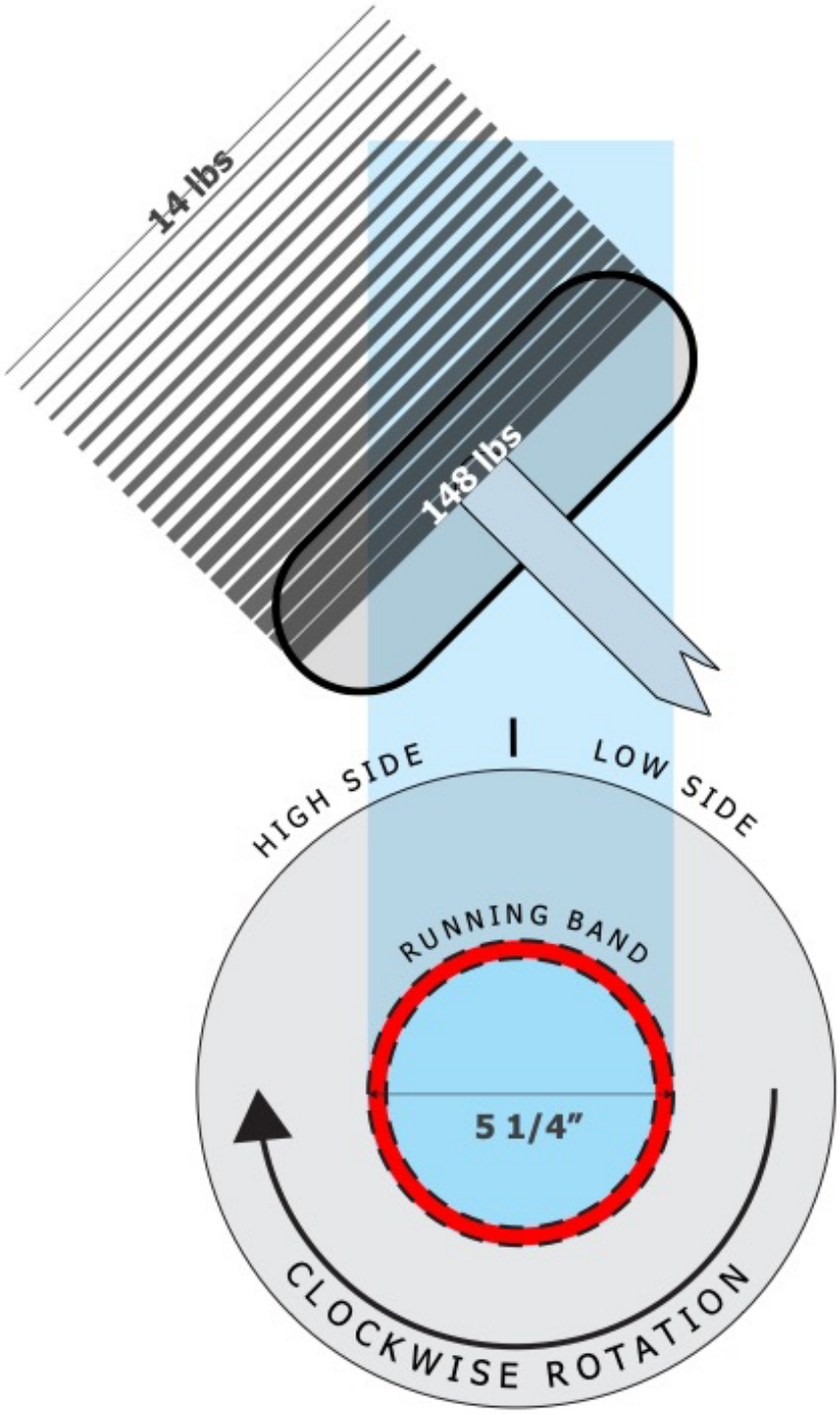
With 148lbs of pressure on the low side there is 10 times more cleaning/polishing/heating than at the end of the stroke. This will cause the low side to glide better and the high side to grab more. Thus this stone will curl less. **A curling stone will always deflect to the less brushed or unbrushed part of the stone.**

2.



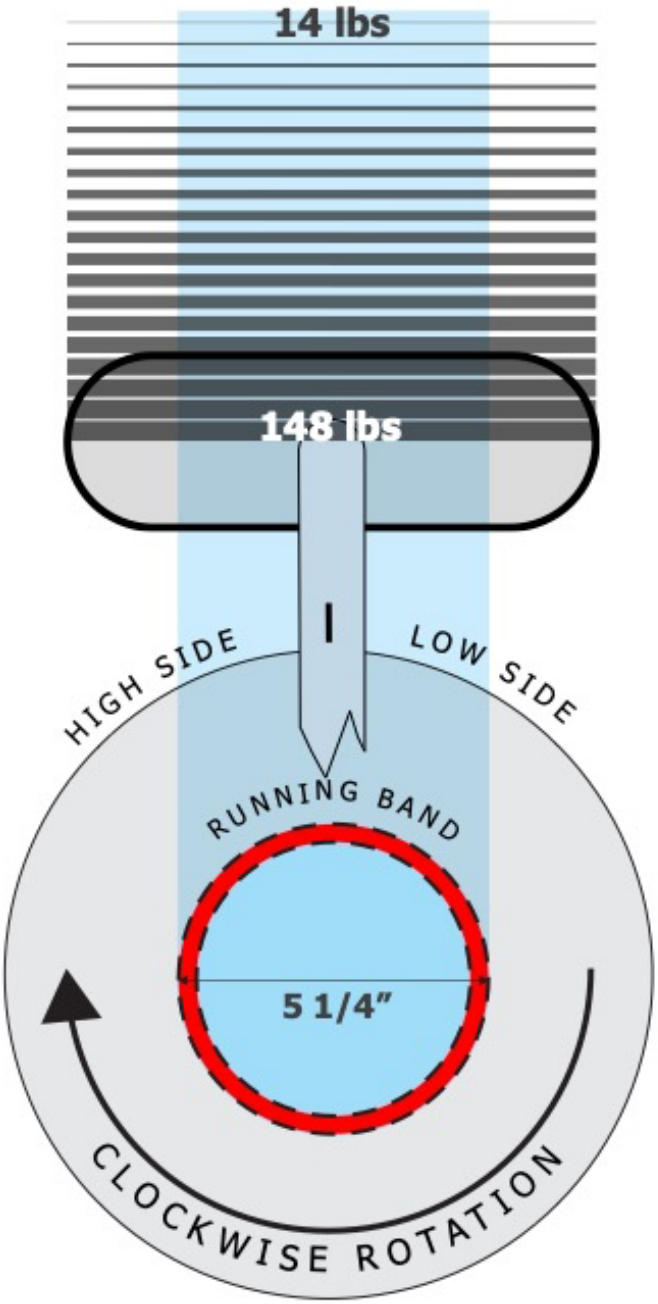
Brushing at an angle will have a similar effect on diminishing curl as perpendicular brushing does. But it will also add to the distance the stone travels as you will be overlapping strokes in the path of the running surface which will cause more cleaning/polishing/heating directly in the path of the running surface.

3.



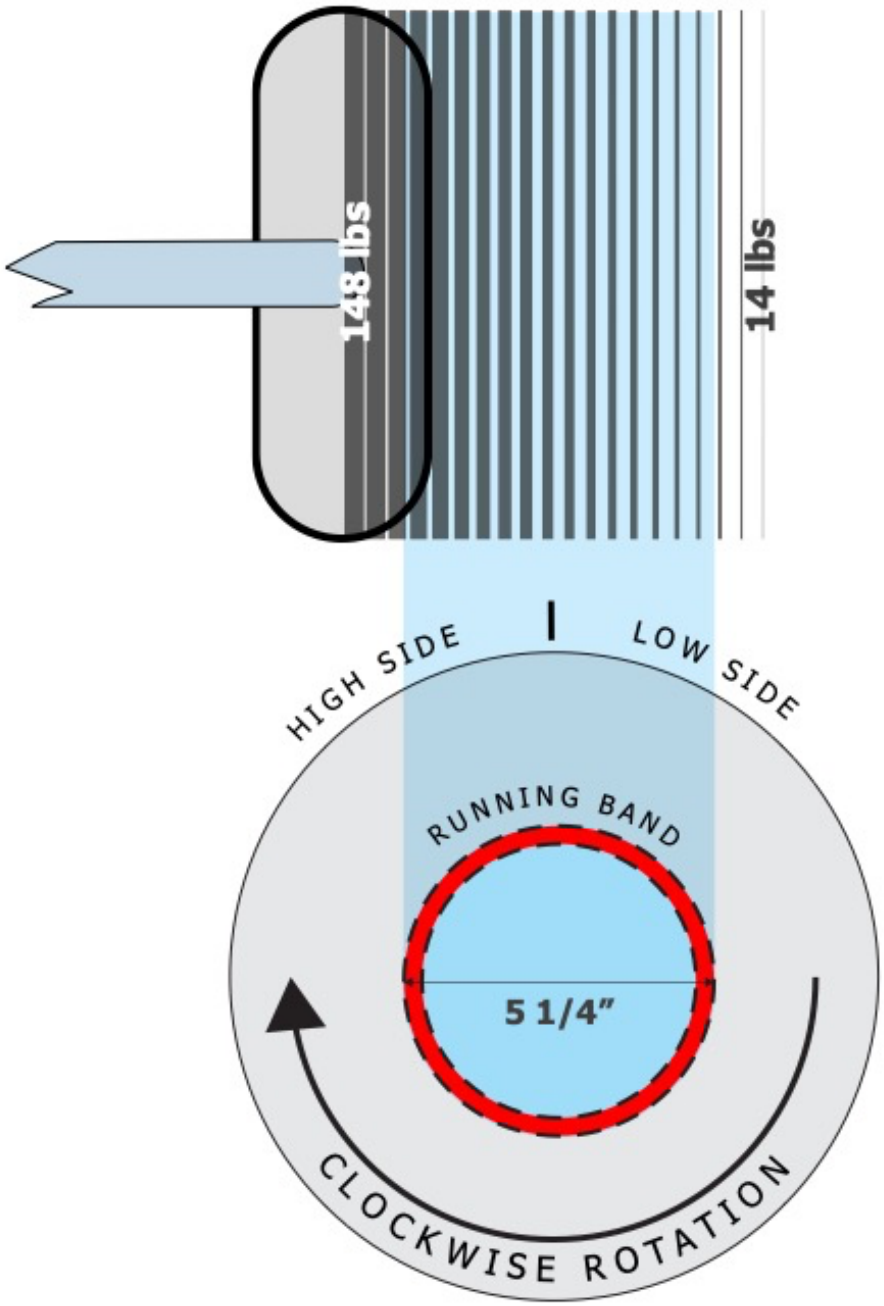
Brush head placement relative to the running surface is critical. All too often I see curlers reach over to the high side to try to keep the stone from curling as much. But in this case if you have more cleaning/polishing/heating on the high side, even though your body is brushing from the low side, you are causing the high side to glide more and the low side to grab more. This will have the opposite effect of what is intended, and the stone will curl more instead of staying straighter.

4.



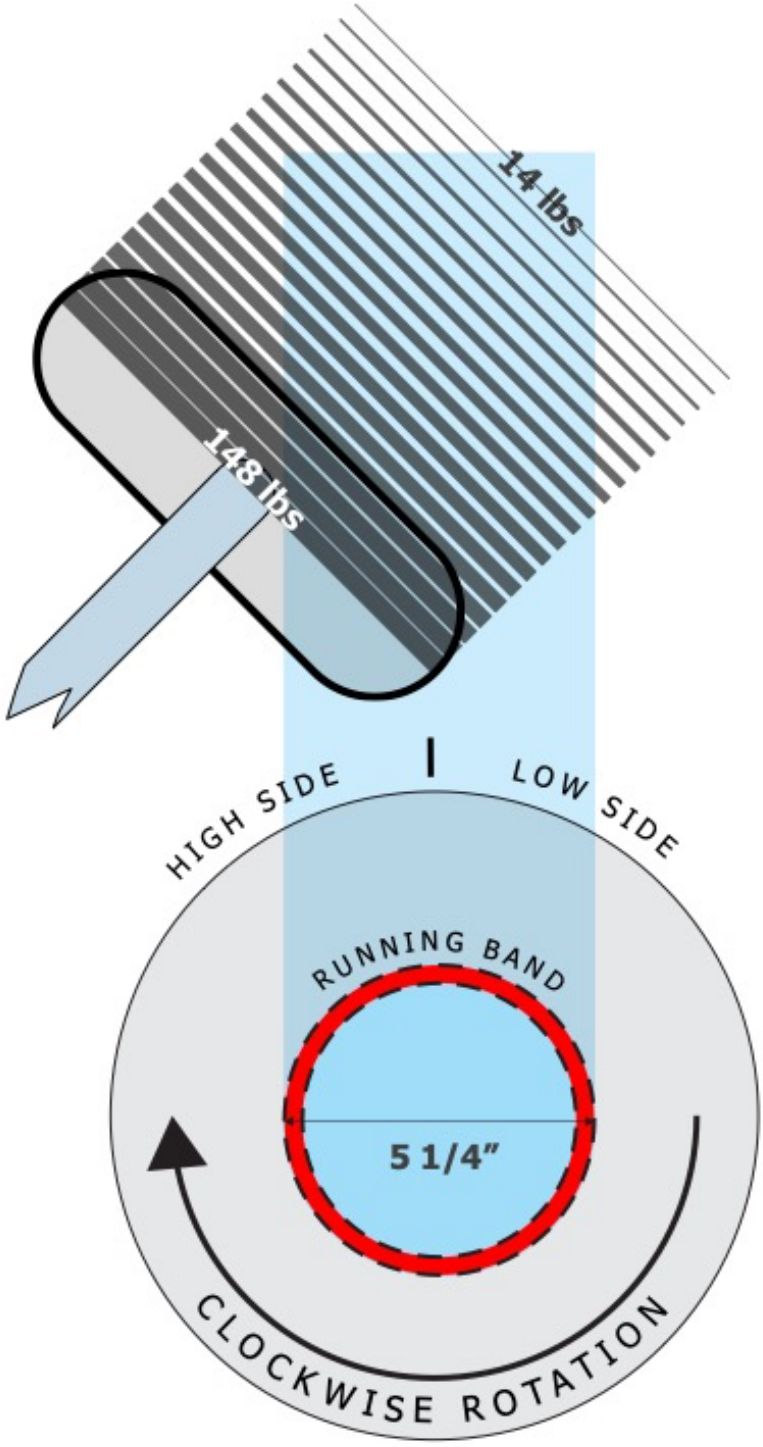
Brushing in what is often referred to as a “snowplowing” position will add the most carry to a stone without impacting the curl one way or the other because the brush head pressure is the same across the running surface with no resulting glide-grab effect across the running surface. The stone will still continue with its normal curl.

5.



Let's look at brushing from the high side. This will cause the high side to be cleaned/polished/heated and glide more than the low side. This will cause the stone to grab to the right and curl more.

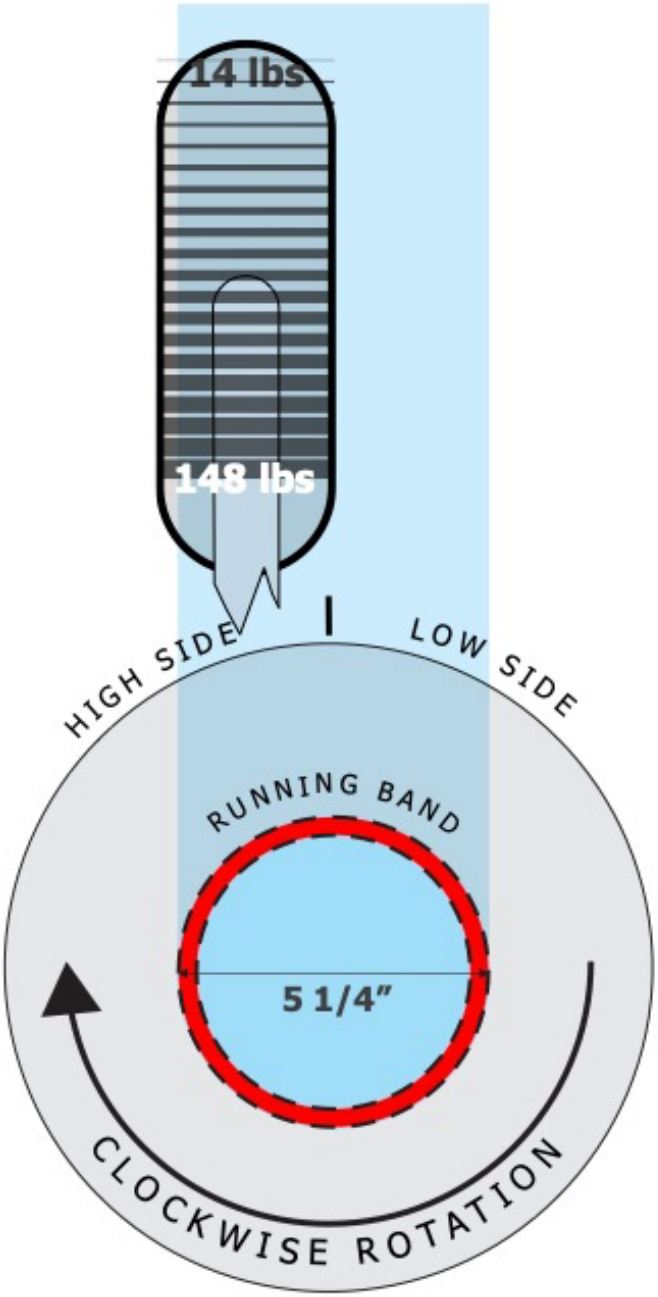
6.



This will cause the stone to curl more plus carry more than it normally would.

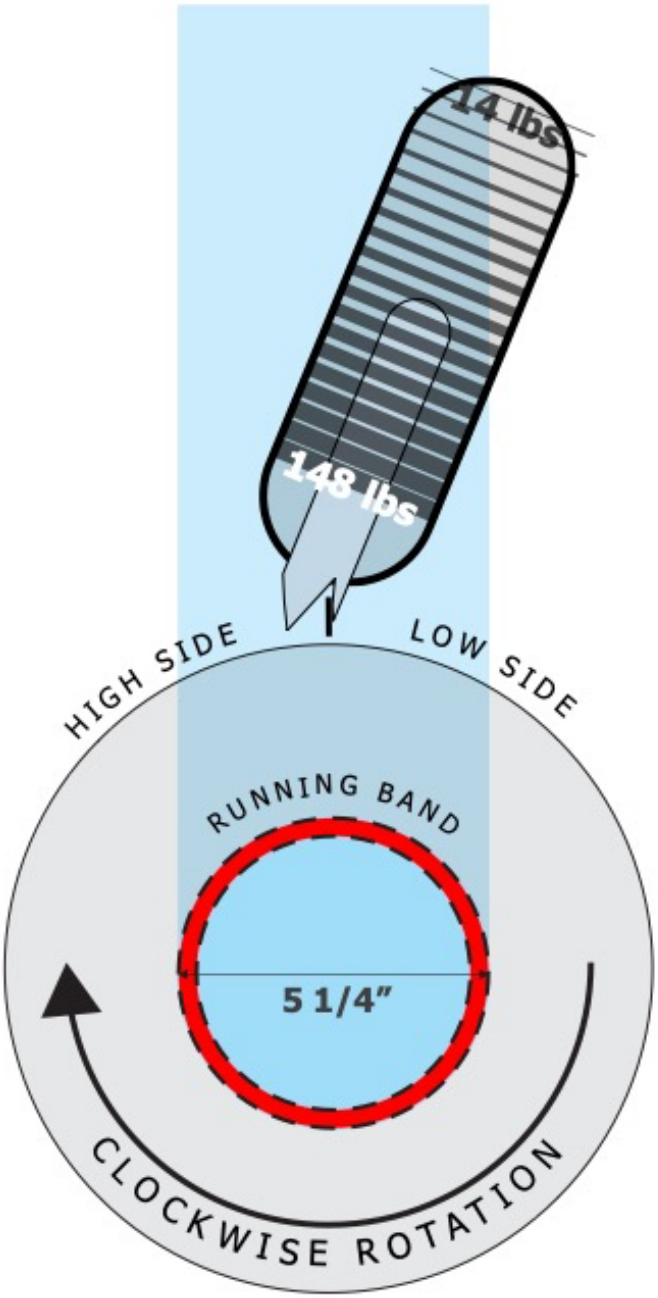
7.

“Knifing” is getting to be more common. This is very tricky as it requires precise brush head placement on only ½ of the running surface for optimum effect. Let’s have a look at a couple of these brushing signatures.



This would be most impactful on increasing the curl of a stone because you are cleaning/heating/polishing only 2 ½ inches or ½ of the running surface. This creates considerable glide on the high side and considerable grab on the low side as the ice is untouched there. The risk here is that the low side of the stone would be vulnerable to grabbing debris on the ice and may over curl. I think though with today’s playing conditions the risk is minimal and if maximum curl is required to execute the shot, it would be recommended.

8.



Occasionally I have noticed brushers get rather careless when they want the stone to curl and reach over too far with the brush. In reality, brushing in this manner would be creating more glide on the low side as most of the brush head pressure is on that side of the running surface, and the stone will grab more on the high side. This has the opposite effect of what is intended, and the stone will tend to curl less instead of curl more.

Here are some key takeaways for effective brushing:

- Every brush stroke has huge variation in pressure across the length of the stroke. The pressure is always greatest closest to your body.
- There is not one distinct pressure on the PUSH part of the stroke and another on the PULL part of the stroke. Although the PULL is somewhat weaker because the PUSH starts after the upper arm THRUST, they both change gradually on a straight line from one extreme to the other.
- The running surface of the stone is only the middle 5 inches of the stone, so brushing beyond that has no impact on the path of the stone.
- The brush is not a "rock magnet" such that if you brush on one side of the running surface, that the stone will tend to go to that side. IT WILL NOT!! The stone will always tend to go to the unbrushed side, or the less brushed side as that part will experience more stone-ice friction or grab.
- Increasing brush head pressure and number of strokes per second is more effective.
- Brushing technique, body mechanics, strength, body weight, conditioning, physiology, Ice temperature, air temperature, humidity, pebble density and size, pebble water temperature, and type of pebble water used, all impact brushing effectiveness

I have been asked several times for examples of good brushing. For women curlers I would say watch Kaitlyn Lawes as she is one of the best. And for men, Ben Hiebert never succumbed to the "scratching scam" and is someone you can observe for good brush head management.

For those who want to understand more of the science behind brushing you can reference Dr. Glenn Paulley or Dr. John Newhook, who in my mind, are the foremost scientists in the world on brushing. A good start would be to google "Glenn Paulley curling" or "John Newhook curling" and it will take you to a plethora of good information on brushing.