Fluting of rifle barrels. (November, 2012)

In response to occasional requests for custom rifles (or new barrels) incorporating some form of fluting, this brief overview of the subject has been compiled for your information. While there are always people who are willing to promote anything that they can make some good $$ on, possibly one of the most unnecessary things you can do to an otherwise great match grade barrel, is to have flutes machined on it. While superficially there may seem to be some benefits (that are debateable at best) there are several negative implications with this process that are not widely known, or understood by shooters.

Variations in flute depth: the best barrels should ideally be perfectly straight in the bore with a smooth uniform finish, uniform or slightly increasing twist rate, and bore internal bore dimensions that are uniform from breech to muzzle (or even slightly tighter at the crown). The key word here is 'uniform'. Variations in flute depth along its length of even a few thousandths of an inch will mean that the barrel web / wall thickness will be thicker on one side of the barrel than the other. Not only will this affect the barrels harmonics, it will also mean that as the barrel heats up and grows in length, the warming barrel will bow in the direction of the thinnest web area. Obviously this will cause a point of impact (P.O.I.) shift as the barrel heats up. Basically, the flutes need to be machined to a uniform depth within 0.001" to ensure they will not adversely affect barrel movement under warming.

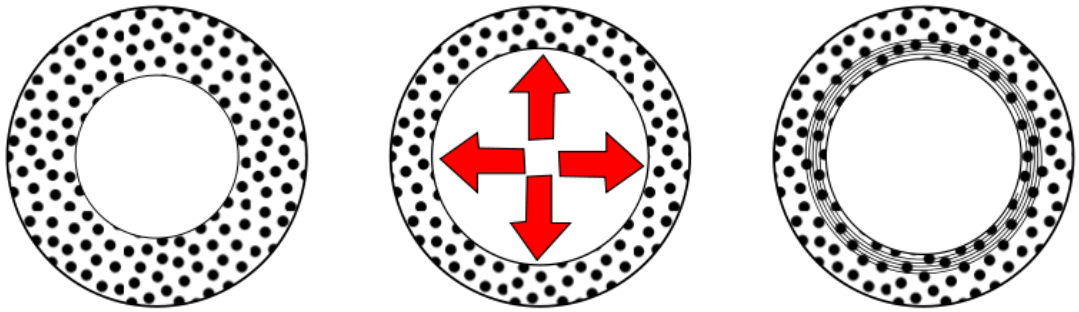
In the picture to the right, the spiral fluted barrel looks 'cool', but closer inspection reveals that the flute depth of cut on one flute line is deepest at about 0.051", while on the exact opposing side of the barrel the depth of cut is only 0.044" (measured in mid-section). What this means is that the barrel wall section is not symmetrical after machining cuts have been completed, and visual inspection of the bore shows it to be slightly bowed (and this barrel is from a barrel maker that has a good reputation for producing barrel blanks with usually very straight bores.) In my opinion, this bowing of the bore was created by the fluting process after it left the barrel maker.

Increased stress and creation of stress fracture path

Any machining on a barrel after rifling, initial contouring and stress relieving, will either add stress to the barrel, or in the case of button-rifled sporter barrels, fluting can actually relieve 'hoop stress', causing localised enlargement of the bore dimensions and this is usually detrimental to accuracy. In extreme pressure situations, autofrettage may occur causing localised work-hardening and/or distortion at the flute cut locations.

(See picture below.)
The tube (a) is subjected to internal pressure past its elastic limit (b), leaving an inner layer of stressed metal (c).

If the barrel (tube) wall has flutes machined in it, the stressed sections of the barrel wall come closer to the barrels outer surface, and as well as deforming slightly may be more prone to rupture if over-stressed.



a. b. c.

Most custom barrel makers will not flute any barrels under a #4 sporter contour, but even this may be a potentially risky modification to an otherwise good, safe, round-profiled barrel.

416 stainless also has the added problem of becoming brittle in a very cold environments. As a result stainless rifle barrels to be used in cold alpine climates should never be profiled too 'skinny', and should never be fluted. i.e. Krieger barrels take this issue seriously and will not profile their stainless 7mm and .30cal barrels below #5 contour. However they will profile chrome-moly (blued) barrels down to whatever contour you want (within reason).

Fluted barrels cannot usually be shortened or re-profiled. You can't cut and crown a barrel off in mid-flute section without it looking "unusual" and you often can't thread it for a suppressor or muzzlebrake. You also can't run a fluted barrel on a profiling lathe or steady rest again in a conventional manner.

(Note: the following rifle was fired with a slight dirt (or snow) obstruction at the muzzle – of which the owner was unaware. The bullet hit the obstruction, but instead of just blowing it out, the barrel pressure built up and failed initially at the flute section, causing the whole barrel to split up along the flute line towards the chamber. If the barrel had been un-fluted, the worst that would have (most likely) occurred would have been a slight bulge at the muzzle, which could have been shortened back an inch or two then re-crowned. This rifle needed a new barrel and a new stock. The manufacturer's agent refused any warranty in this case.)

Commonly Claimed Fluting 'Benefits'

Fluting reduces weight – yes, depending on flute depth cut, it may be okay if you have an existing heavy barrel (hammer forged or cut-rifled) and just want to lose some weight without reducing the length or profile. However if you are doing a new rifle build from scratch then you are better starting off with a round-profiled barrel of the exact weight that you want.

Fluting Increases Stiffness – this is misleading.

- A fluted barrel will have **less** rigidity than a non-fluted barrel of the same diameter/length/profile. (But it will weight a bit less).
- A fluted barrel will only be stiffer that a round profiled barrel of the same weight, if it is a larger diameter.
- A STIFF BARREL DOES NOT NECESSARILY MEAN IT WILL BE AN 'ACCURATE' BARREL. The importance of this point cannot be over-emphasised. I have seen sporter-weight barrels that will consistently out-shoot much heavier profiled target-weight barrels. The barrels bore and groove dimensions, uniformity of twist rate, uniformity of bore surface finish and size, stress relieving, and to a lesser degree 'straightness' will all have an influence on how well a barrel with potentially perform with regards to accuracy and consistency.

Fluting Increases cooling rate due to increased surface area – yes, but this is only marginally so. The rate of cooling increase due to the reduced wall thickness at the flutes and any benefits are debateable, and the other fact is that a heavier barrel will take longer to heat up anyway. A fluted barrel may cool a bit quicker, but (by that rationale) it will also heat up quicker as well. The increase in barrel temperature from rapid repeat firing (such as in a target shooting match situation) will always outstrip the ability of the barrel to air-cool regardless of whether any such longitudinal fluting is present to assist cooling or not.

Fluting Increases accuracy – usually never. In fact there are detrimental effects from fluting that can actually reduce or destroy accuracy in some barrels. On button-rifled barrels especially fluting can cause the bore to open-up or expand under the flute cut-out sections, and any variations in the depths of the various flutes, may cause the bore to alter its' straightness (or stress) profile, causing point of impact shifts as it heats up.

Circumstances where barrel fluting may be okay:

- You have a heavy contour factory / hammer forged barrel, and you want to reduce the weight slightly but don't want to reduce the diameter by conventional re-profiling.

- Any potential reduction in accuracy or performance is not a major concern.

- You just think that fluting looks cute and don't really care if it affects the accuracy much.

Recommendations if you are building or re-barrelling a new rifle:

- use a lighter (or standard) contour round-profiled barrel, instead of a heavier contour fluted barrel of the same effective weight. You will have a better chance of it shooting to your accuracy requirements.

- avoid adding fluting to your request list if possible, as so doing will only avoid the risk of playing russian roulette with the performance of your new match grade barrel blank. Once you have committed to fluting you can't undo it.

- fluted barrels cannot be shortened (into the flute section) or re-profiled at a later date if required (or if the barrel is to be re-worked and fitted to another rifle at a later date. i.e.: a barrel being taken off a heavy target or long range rifle, that has eroded the throat section but may be otherwise ok to be shortened and/or re-profiled and re-fitted up for a hunting rifle rig.)

Bolt fluting

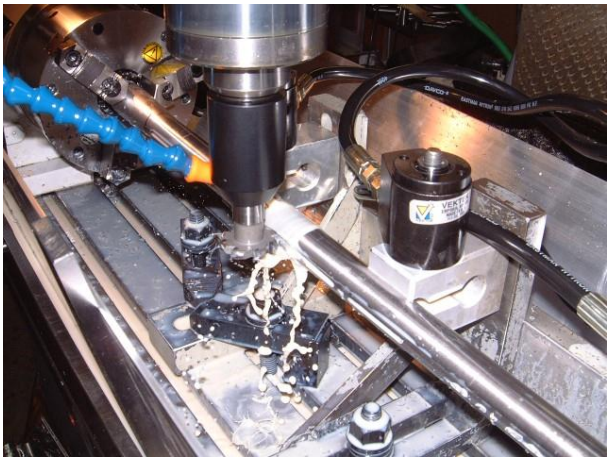
A lot of work to save 1-2 ounces. Can cause problems with scratched cases and some 'catching' or binding on cartridges with some magazine fed applications. Hardly worth doing unless you want 'pimp factor' over performance, or 'flash' over function.

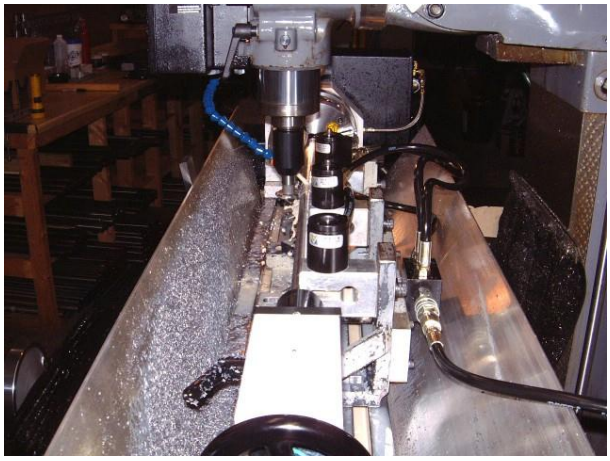
My position on fluting.

Since I was a gunsmithing student in Denver (1996/97) I have been aware that the machining steps for fluting can cause bowed barrels (or bowed bolt shafts). I occasionally get asked to quote on fitting fluted barrels for customers who are interested in re-barrelling or building a custom rifle. I advise them of the risks and will usually recommend that a non-fluted barrel is best, as well as being less expensive. If a customer insists upon a fluted barrel despite my advice then I will provide such a barrel (fluted by the barrel maker) and fit it for him, but it will be subject to a signed disclaimer of liability and that no accuracy or performance guarantee or warranty applies. If any issues with the fluted barrel arise then that will be a matter to be resolved between the rifle owner and the barrel maker.

Machining Complexities of fluting

The un-initiated will assume that fluting is a straightforward machining procedure – simply setup the heavy/breech end in an indexing head, and the muzzle placed on a rotating centre, and go to work machining the flutes to the required depth with a horizontal or vertical milling machine. Cutters often used are a convex milling cutter mounted on a arbor, or a ball-nosed endmill. Persons with limited machining experience will not realised that as the cutter makes its way to the midsection of the barrel the barrel will try to bow away from the cutter (or towards it) meaning that flute cut depth will be reduced unless the barrel is also supported in the midsection in at least 3 locations between the two ends / centres. One of the best set-ups I have seen in this regards is that of boutique US barrel maker/gunsmith Clay Spencer, who has even automated his system with a CNC controller to activate the barrel support clamps, rotary table and of course the spindle speed & feeds. However, many other set-ups I have seen in various machine shops are/were slightly 'agricultural' or basic in comparison.





Competition results: Where the BS stops!

Townsend Whelen once said, "only accurate rifles are interesting" and accuracy is usually the main reason for re-barrelling or building a custom target or varmint rifle. Benchrest rifles are the most accurate in the world, and the top benchrest shooters spend thousands of dollars on the best barrels, stocks, scopes and actions available in the world. Add to this hand-swaged custom bullets, special select powder and loading gear, wind reading gear and high-dollar shooting rests. The top shooters spare no expense – any little thing that can give them an advantage will be seized upon.

I recently raised the question of fluting with regards to accuracy on a couple of international shooting forums recently, to gauge the current trends and opinions on the subject:

Question: – At the last 5 benchrest supershoots (or IBS nationals), how many of the top 20 shooters shot fluted barrels?

Answer: – None. (Because there is simply no valid accuracy advantage with fluting.)

(Some Benchrest Central forum respondents claimed that there may have been only a handful of fluted barrels present out of a few hundred shooters. But none of them finished in the top of the results lists.)

Conclusion:

In order to justify the extra machine work and expense required in fluting a barrel, one has to objectively view the pro's and con's of the process. Various shooters, gunsmiths, or self-styled 'experts' will have an opinion on fluting, and this may be influenced by their own experiences – or how much money they are making out of it. For sure, some gunsmiths and barrel makers have made a lot of money out of promoting barrel-fluting over the years, but some barrel makers only do it reluctantly simply to satisfy a customer demand. If market demand once meant that they would lose significant amount of barrel sales if they refused to offer fluting (to those customers who insisted upon it), then they had to adapt or suffer the consequences.
However, with the hysteria over, we can objectively view the suggested benefits of fluting, and we can see that there is little if anything there to boast about at all, rather than adding $250-$300 to the cost of a barrel, as well as making it more challenging for the gunsmith to fit correctly. It also limits your options down the track if you decided to shorten or re-profile the barrel, or (in some cases) to fit a silencer to it.

As someone who tries to provide good honest advice to his customers, along with education, quality workmanship and value for money, my recommendation is against barrel fluting.