Faggoting

Advanced

What is Faggoting?

The word "faggot", "fagot" or "fagott" is not overly popular in English but not without interest. A faggot, according to Webster's, could be:

1. A bundle of sticks; probably from the Italian "faggotto", diminutive of Vulgar Latin facus, from Latin fascis "bundle of wood" - and that we have met before.
2. A bundle or heap of iron or steel pieces to be worked into bars by hammering at welding temperature.
3. A person hired to take the place of another (for more or less fraudulent reasons).
4. A term of contempt for a dry shriveled old woman.
5. The punishment of burning at the stake.
6. A batch representing a fagot to be worn by those who recanted heresy to show that they only narrowly escaped punishment by fagot.
7. A gay person.
8. A bassoon or fagotto. In German a bassoon is always calles a "Fagott".
9. A discarded cigarette butt.

- As a verb, to faggot or faggoting means

  1. A special technique to join two pieces of fabric or lace, leaving a space in between the pieces to show more or less complicated stitches.
  2. A special knitting technique in which every stitch is a yarn over or a decrease, whatever that might mean.
  3. Forge welding a bundle of bars of iron and steel.

- In German, faggoting metals would be described as "**gerben**" or, in older versions "**gärben**", "**gärwen**". The respective word family has just as many meanings, including the tanning of leather, to mix doughy stuff (including food stuff and clay) by kneading and to weld raw steel / iron pieces to a solid mass.
  Related is the word "Garbe" = bundle of cereal plants after reaping or sheaf. You just as well could call it a fascicle / fagott.

I have no idea how smiths in what now is England called their "faggoting" around 500 AD or so, but the German ones most likely did call it "gärwen" or something similar.
Whatever. Fagoting (or gerben) in a general sense obviously just means the formation of one piece of iron / steel by hammer welding several pieces. You could talk about faggoting your bloom instead of compacting it, and so on. I won't. I will use the term "faggoting" exclusively for:

A rather interstting if ominous point aboht faggoting is:

Faggoting was a basic forging technology from rather early on - and it was almost completely ignored in all the literature about the history of iron and steel

- Weird - but there you are! My guess is that the people researching iron and steel history had no first hand experience of forging and just didn't know what a real smith was doing all day long. It's in some way similar to Engelhardt's complete ignorance of the pattern-welding that was going on all aorund him. There are none so blind as those who will not see.

In an old-fashioned bakery the kids on occasion were allowed to make their own cake from pieces of dough left over from making the serious stuff. Let's say there were pieces of white dough, light brown sweet chocolate dough, and dark brown bitter chocolate dough. You could of course just throw the lumps at random into a form, bake the mix, and get a patchy looking multicolored cake with varying flavors.
If you want a homogeneous cake with one color and one flavor throughout, you would do some "gerben" in the sense of kneading. Small kids would do that. The older ones were motivated to learn a few things on the side and made their dough in a way that resembles what smiths would do with pieces of different iron / steel:

- From pieces of about the same size by rolling with a rolling pin. Cut of edges etc. to make the pieces rectangular with the same size
- Put the sheets on top of each other, forming a block.
- Roll out the block to a longish sheet.
- Fold one half of the sheet back on top of the other half.
- Roll out to a longish sheet.
- Repeat several times

If you start with 7 layers - 2 dark brown, 2 light brown, 3 white - each about 2 mm thick, you have 14 layers after the first folding, 28 after the 2nd, 56 after the 3rd,..., 7 times 2 times 2 times 2 .... times 2 (multiply 2 by 2 as often as you fold).
Excuse me, I forgot this is an advanced module. So the number of layers N_F after F foldings is obviously $N_F = N_0 \cdot 2^F$ with N_0 = number of starting layers. Folding 7 layers 10 times, for example, gives $N_F = 7 \cdot 2^{10} = 7.168$ layers. To your eye the stack now looks rather homogenous.

An ancient smith didn't use a rolling pin but a hammer for the "stretching", and he did it at "welding temperature". Modern smiths in essence do use a kind of rolling pin that they call a roller. In contrast to dough the welding is not "automatic" but takes some consideration (I'll get to that). You loose some dough in the process whenever you cut of the edges after rolling to get a rectangular piece again; and you loose some iron every time you fold. No so much because you cut off the edges but because at the welding temperature you burn some of the iron, you form iron oxide or scale that you must remove.

In both cases the uniformity increases with the number of foldings. So folding a lot is good? Not really. There are several reasons why there is an optimum number of foldings:

1. You loose material every time you fold. Too many foldings and you have too little left.
2. Costs for what is left increases exponentially with the number of foldings. So don't fold more often than required.
3. Every folding introduces some dirt because the surfaces to be welded are never completely clean. This is akin to sprinkling a little bit of salt on the dough surface before folding in the example above. Your dough will get more uniform with every folding but also less "cakey".

The last point is particular weighty if your hammer welding technology is not nearly perfect. The welded area increases with the same exponential law as the number of layers and if you introduce defects like slag inclusion or unwelded patches every time you fold, your steel becomes worthless after too many foldings.
The long and short of all that is:

**Don't fold too often in faggoting!
There is an optimum number of foldings that depends on your skills and the quality of your starting materials.**

If you start from very inhomogeneous materials with respect to the carbon and possibly phosphorus concentration that is also full of slag particles, proper faggoting will make it far more homogeneous, with less total slag content (some is squeezed out while folding), and only small slag particles (because of all the banging and stretching). But no matter how good you are at faggoting, the final product will not be as good as one made from more homogeneous steel with fewer slag inclusions.
Quite elementary - and very important. Good blade smiths around 300 AD (give or take a few centuries) had already reached the zenith of their craft. You, the smith in modern times, and any smith since then, cannot do better in terms of smithing skills. You only can do better because the materials you work with became better.

We might guess that the improvements in smelting technology produced blooms good enough for making a sword from *one* piece of faggoted steel around 1000 AD (give or take a few centuries). I'll get to that. But before I do this I must ask the tough if onerous question:

Who used faggoting the first time, when and where?

The answer, you guessed it, is simple: who knows? I certainly don't and I don't think anybody else would know. There is a reason for this ignorance. It is difficult to impossible to determine if an old iron / steel artifact has been faggoted. There are several reasons for this deplorable state of affairs:

1. In order to determine if a large piece of iron /steel is uniform, you must investigate a large area, for example the whole blade of a sword. A cross-section through the blade simply can't give you this information. The owners of old artifacts never ever agree to this - well, *almost* never.
2. If a large piece of iron is found to be rather uniform, it does not necessarily mean that faggoting was involved. Maybe some bloom happened to be rather uniform just so.
3. Normal metallography - investigating a polished and defect-etched surface with a microscope - may or may not indicate that faggoting took place. Just ask yourself what you expect to see on the surface of a well faggoted pieces of steel and you see the problem.

However, those are general problems. In a specific cases, something can be done and has been done. I' will first introduce and discuss the rathe recent work of **Stefan Maeder**, who more or less introduced faggoting to the archaeological world that so far has igmpred it. Then I will give examples from finds I made or was allerted to.

Japanese Polishing and Faggoting

With experience, you can always assess the quality of an old forged blade by looking closely at the blade - provided that it has been properly "polished". Looking at a (more or less black) as-forged surface or on a roughly ground one only betrays big defects like major cracks or huge inclusions. A perfect polish, producing a mirror-like surface may also not show much structural detail. If, however, your polishing procedure polishes different materials differently, you may now see something. That will automatically happen if the particles in your polishing slurry are not as hard as the very hard (martensite) parts of your blade but harder than the bulk steel.

Time to read up what I have written long ago about polishing. Here it is. And time to realize that early mankind, out to make that perfectly polished blade, would more or less automatically run across polishing procedures that render visible some structural details of blade on a "macro level", i.e. you can see it with the "naked eye" or at most by looking through a simple magnifying glass.
That part of early mankind that got totally obsessed with blade polishing are the Japanese. Others might have done it too; we simply don't know. Since no or very few Western swords older than 800 years or so survived with their original polished surface, we simply do not know how well all those Celtic, Romans, Merovigian, Viking, and so on, swords were polished.

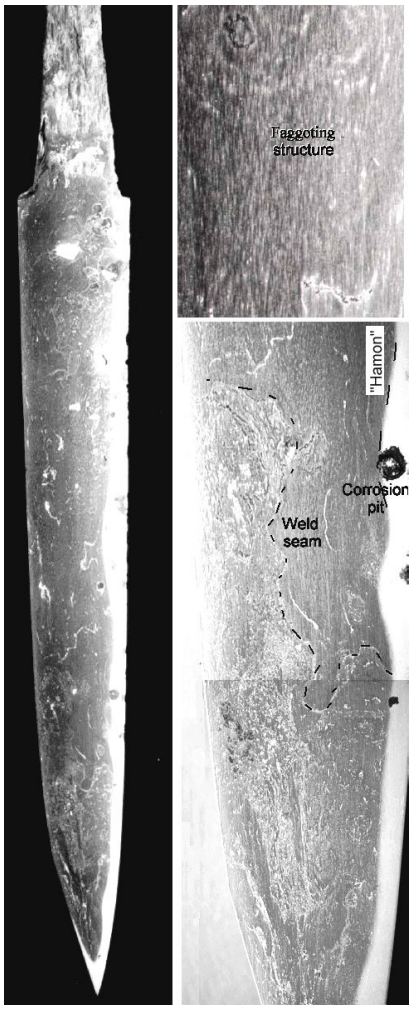
The Japanese do have well preserved old swords and, more important, their ancient art of polishing and evaluating polished sword blades survived until today.
Here is an example from a Japanes "tachi", forged around 1370:

Faggoted Japanese blade; front and back

Source: From teh (commecial) pages of the Japanese Sword Shop Aoi-Art

Japanese polishing makes the layered structure well visible. Of course, we can only see it because the welds are stucturally different from the rest.

That's why Stefan Maeder had three blades or parts of blades from South Germany evaluated by a Japanese polishing expert. Since all blades were heavily corroded, only parts remained after polishing down to the metal. What Maeder found out for his three specimen is rather interesting.
Here is one example:



South German sax from 600 AD - 750 AD after Japanese polishing

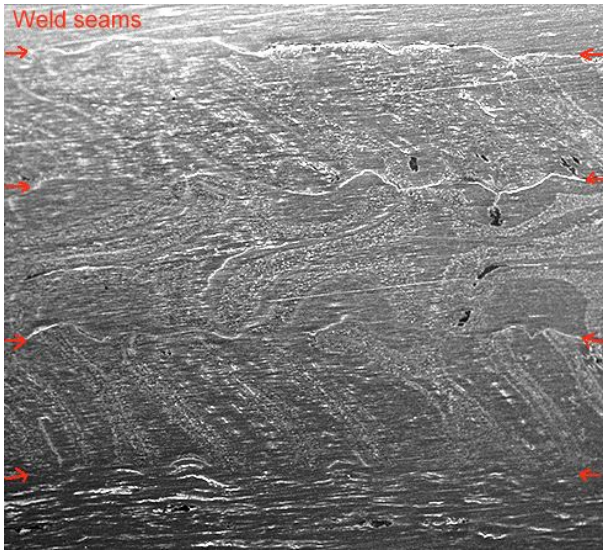
Source: Compiled from pictures in Stefan Maeder's thesis

What we see is:

- There is a lot to see. Even discounting black corrosion pits, the blade is not homogeneous.
- The front end is some steel different from most of the bulk; it has been welded on. The seam of this construction weld is clearly visible.
- The cutting edge is "white" and shows no structure. It is martensitic and must have been obtained by quenching. The well-defined "hamon" indicates "differential quenching".
- The fine structure of the steel, showing elongated fine lines, is typical for **pronounced faggoting** with about 10 foldings.

This interpretation is based on experience with Japanese blades that have a known history of their making.

Maeder thus proved his claim that the Japanese polishing method does allow to "see" certain structures of *Western* sword blades. He did not prove his other claim that modern metallographic methods cannot do the same because he did not make a comparison.
Here is another example of what you see after "Japanese polishing": a pattern welded blade with three twisted layers in the center. Once more there are distinctive signs of faggoting. The pronounced structure (white line) of some weld seams between the twisted rods might indicate not-so-good welding there or the use of brazing with a "speiss" flux.



South German pattern welded sword; 6th century AD

Source: From a picture in Stefan Maeder's thesis

- It is thus possible to detect faggoting - up to a point. We just have almost no relevant data. There are, no doubt, some investigations into the matter that I'm not aware of, but all we can say from the examples above is that faggoting was known at least to some smiths around 600 AD. Most likely it was known much earlier but I have no proof of that right now (2015).
  Much later (Jan. 2018) I do have some hints that faggoting was known rather early by Celtish smiths. More to that lower down.
  - Faggoting requires extensive and conscientious fire welding. Just compacting your bloom also employs fire welding but not in a conscientious way. In fact, faggoting only makes sense if you do not produce too many new defects in the process. This brings us right back to fire welding as the most important technology in iron and steel working of blooms (as opposed to crucible steel).
- Stefan Maeder meanwhile was able to analyze another sword by " Japanese Polishing". It is a 300 BC Celtic Sword from La Tène. Here is the picture:

Structure of Celtic Sword revealed by Japanese Polishing

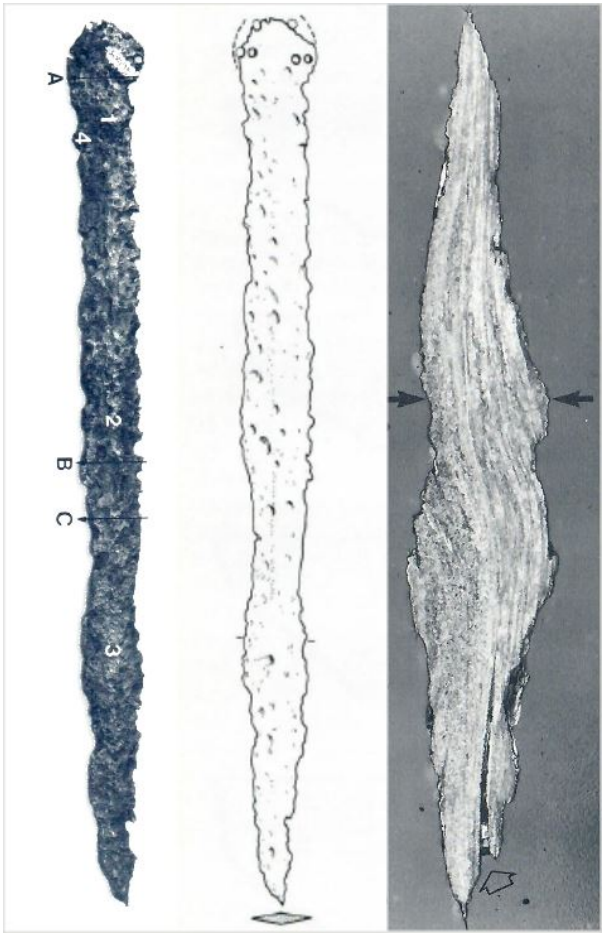
Source: From one of the many press releases (e.g. idw - Informationsdienst Wissenschaft).

- While a lot is said about the power of Japanese polishing for revealing structures, nothing is said about what, exactly, one sees. My guess is that we look at the result of faggoting a sandwich of two steels with just a few foldings.

The Sword from Singen

Singen am Hohentwiel is a town in the heart of Suebia and thus also old Celtic country. In 1950 a remarkable iron sword was found in one of many graves discovered there. The people in charge allowed it to be investigated by metallurgists. The results were published in a somewhat obscure "Festschrift" [1)] ; I give to you in full.

- I have already covered that sword here, so I will only make one statement here: What you see below It looks very much like faggoted steel. It that is true, at least one smith in Suebia (where else?) knew how to faggot iron and steel as early as about 750 BC!



The sword from Singen and an etched cross-section, showing faggoting for almost sure.

Source: Reference 1) below

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1) Wolfgang Kimmig": "EIN GRABFUND DER JÜNGEREN URNENFELDERZEIT MIT EISENSCHWERT VON SINGEN AM HOHENTWIEL"; p.37
and
P.O Boll. T.H. Erismann, W.J. Muister; Dübendorf: "Metallkundliche Unbtersuchungen einws frühen mitteleuropäischen Eisenschwerts",; . 45
both in:
Frühes Eisen in Europa. Festschrift Walter Ulrich Guyan zu seinem 70. Geburtstag (Deutsch) Hardcover – 1981 by Harold Haefner (Herausgeber)