W.W. Greener and Laminated Steel

Greener 3 Iron "Silver Steel" courtesy of C.J. Opacak

William Greener first mentioned "**Silver Steel**" in **1835**, described production of a new steel in **1841** and **1849**, called it "Laminated steel" in **1858**, and was recognized as having invented "Laminated Steel" in **1886**. A percussion W. Greener 12b #19707 offered on the Julia auction site in 2007 was stamped "Inventor of Laminated Steel" on the top rib. Unfortunately, no close up of the barrels was provided, nor the date of manufacture. No British patent issued to W. Greener for Laminated Steel has been found however.
c. **1910** W.W. Greener confirmed his father's use of "best silver-steel Damascus" in the 9th edition of ***The Gun.***

William Greener, ***The Gun, or a Treatise on the Various Descriptions of Small Fire-Arms,* 1835**
http://books.google.com/books?id=oIEY4qL6_z0C&pg=PA1&source

Greener described 9 different gun barrels at that time, and in general was extremely critical of the quality of British gun barrels being produced:

1. Damascus Iron from only two sources: Mr Clive of Birmingham and

George Adams of Wednesbury

2. Wire-Twist Iron (Later known as Plain Twist)
3. Stub-Twist Iron and Stub Damascus

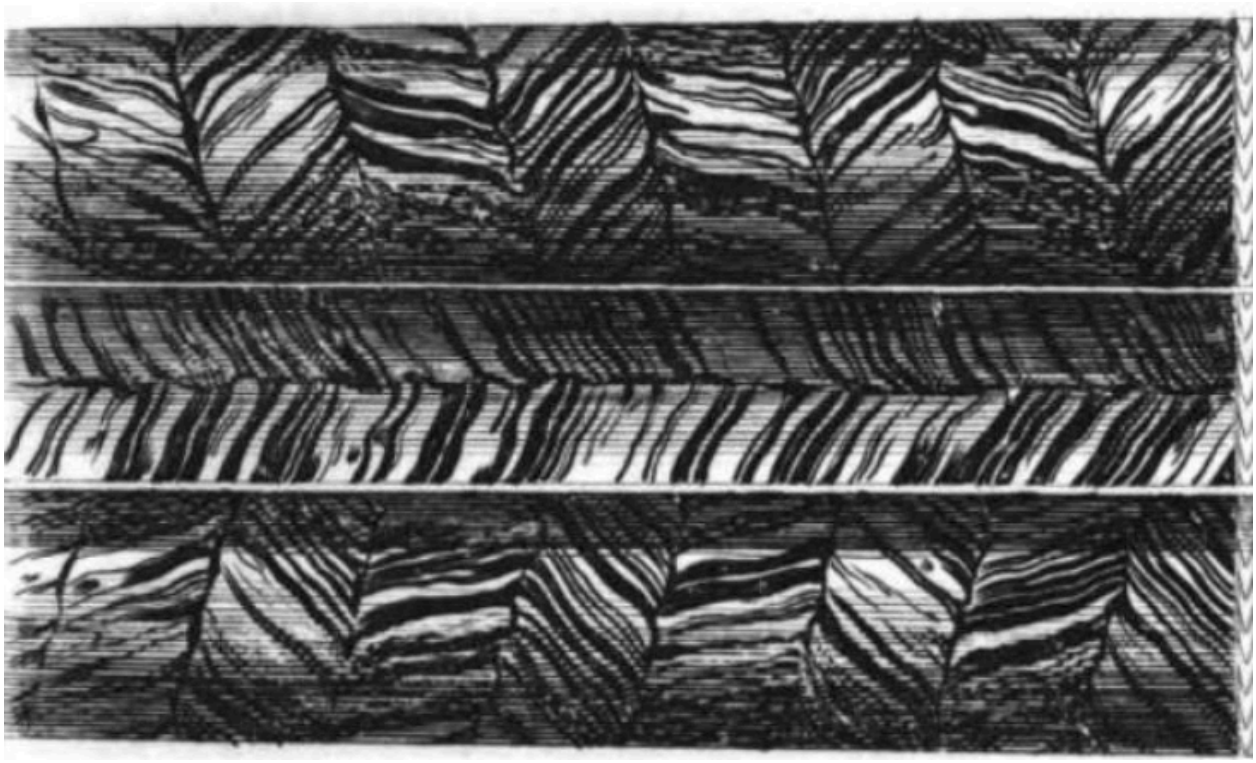
Made from horse-nail stubs (iron) mixed with coach spring steel, heated and fused into a "bloom of iron," then hammer forged or rolled into thin rods which were NOT twisted before being wrapped around a mandrel and hammer welded. Stub Damascus rods were twisted prior to wrapping around the mandrel.

4. Mr Wiswould's Iron Barrels and a similar product called **Silver Steel**. These are described as 3/4 steel and 1/2 iron which were also fused into a "bloom", welded under tilt hammers, then rolled into rods.

(This might represent early Two Rod Laminated Steel)

5. Charcoal Iron (without steel) – inferior to Stub-Twist
6. Threepenny Skelp Iron
7. Twopenny/Wednesbury Skelp
8. Sham Damn Skelp which apparently was stained to look like Wire-Twist
9. Swaff Iron Forging made up from small scrapes of lockplates and gunscrews.

Wiswould's Iron may represent the earliest attempt at what was later called Laminated Steel. Note the herring-bone or "angularly laminated" pattern.
http://books.google.com/books?id=oIEY4qL6_z0C&pg=PA18-IA1&dq



c. 1844-1869 W. Greener 7b Pigeon gun with Laminated Steel refinished by Paul Stevens

Barrel made of 3 tube segments, the thicker at the breech. Note weld line.

Transition to linear pattern (‘angularly laminated’)

Weld line and transition back to mosaic pattern

c. 1880s C.G. Bonehill with a similar pattern

W.W. Greener, ***The Gun and Its Development***, 8th edition, **1907**
http://books.google.com/books?id=3HMCAAAAYAAJ&pg=PA224&dq

In the foregoing descriptions of the methods of manufacturing twist barrels it is stated incidentally that some kinds are superior to others. The comparative strength of gun barrels and of the material employed in their manufacture, the merits and disadvantages of chosen varieties, will be found stated in detail later, but as the method of manufacture, as well as the material employed, affect the quality of the barrel, it is advisable to state here that, so far as known, the strongest forged or twist barrel is the **laminated steel now usually termed "stub-Damascus,"** made of three twisted rods to the riband.
The word laminated, as the designation of a gun barrel, arose from the fact that early in the last century thin strips, plates, or *lamina* of steel, piled alternately with iron strips or plates, formed the composite metal from which they were made. They differ from Damascus in so far as the **iron and steel are differently arranged in the pile**, so that instead of a decided curl in the figure there is only what may be termed "herring-bone" lines running spirally round the barrel from end to end.

The difference between Damascus and Laminated steel is:
1. Higher steel content
2. Better quality steel
3. Fewer twists
4. The steel and iron is mixed ("**puddled**") together and fused into a "**bloom**" which is then hammered or rolled into rods. The rods are then twisted, wrapped around a mandrel, and hammer welded.
"Laminated Damascus" starts with ***separate*** thin strips of iron and steel which are rolled into rods.
5. The rods may be subjected to additional rolling or hammering.

The usual Laminated pattern is, therefore, variegated or an irregular mosaic of iron (black) and steel (silver)

Greener Pinfire with rib stamped "Laminated Steel Indestructible By Gunpowder"

c. 1880 W.W. Greener "The Trap Gun" with (non-Silver) Laminated Steel courtesy of Leighton Stallones. Note transition to the mid-barrel tube segment.

Keith Kearcher refinished late 1880s Greener G60 is Greener's **Silver Steel**

Re-browned 3 Iron “Silver Steel” courtesy of Paul Stevens

The Science of Gunnery, as Applied to the Use and Construction of Fire-Arms, **1841**, may be W.W. Greener's description of his claim for inventing Laminated Steel

I have had as high as three-fourths of steel to one of iron, and where proper attention is paid to clipping of the steel to pieces, corresponding with the (horse-nail) stubs, and properly mixing the whole, welding (in an air furnace) and forging by the heavy hammer, reducing by a tilt ditto, and rolling down to the…rod, a most excellent, tenacious, and dense body of iron is obtained; while, by cutting into lengths of 6 inches, bundling a number together, and re-welding them into a bar, you gain an increased density and tenacity…rendering it…considerably more powerfully strong than any explosive fluid ever yet compounded could burst…

The Mechanics Magazine, Museum, Register, Journal and Gazette
July, **1849** Ed. J.C. Robertson
"Paper read on the Manufacture of the Finer Irons and Steel, as Applied to Gun-Barrels…"
http://books.google.com/books?id=yRkFAAAAQAAJ&pg=PA298&lpg

W. Greener described a new technique for the production of gun barrel steel using scrap steel from old coach wheels.
Silver Steel?

Gunnery in 1858: Being a Treatise on Rifles, Cannon, and Sporting Arms, W.W. Greener
http://books.google.com/books?id=A4TPW796iD8C
I make my own laminated steel: the difference in silver steel and common twist steel merely consists in the variety of tortuous twisting the former undergoes, while the latter is tolled out into rods of 6-16ths broad, with the fibres running perfectly longitudinal. The method of making or welding the pieces into a **bloom**, is in the following way. Having collected sufficiency of mild steel scrapes, such as cuttings of saws, waste from steel pen making, old coach springs, and the immense variety of pieces arising from the various manufacture of tools, they are cut into pieces of equal dimensions, polished in a revolving drum by their friction of each other, until quite bright, and then placed for fusion on the bed of an air furnace. The parts first fused are gathered on the end of a similarly fabricated rod, in a welding state, and these gather together by their adhesion, the remainder as they become sufficiently heated, until the bloom is complete.
The steel is then removed from the furnace, and undergoes the effect of a three-ton forge hammer and tilt, until it forms a large square bar; it is then re-heated, and thence conveyed to the rolling mill, where eventually it is reduced to the size of the rod required. I generally have the metal required cut into short pieces of six inches long. A certain number are bundled together and welded, and then drawn down again in the rolling mill.
The barrels made of this metal, in general, beat all tried against them…The only difficulty is in the working; as the boring, filling, &c., are more difficult. The generality of barrel makers spoil this metal in an attempt to obtain figure; for all extreme twistings in the rod depreciate the metal, by separating the fibres…The extreme density of the metal renders the figure difficult to be shown distinctly, as acid acts upon it but slightly…
We have had as high as three-fourths of steel to one of iron. Where proper attention is paid to the clipping of the steel to pieces, corresponding with the stubs, and properly mixing the whole, welding and forging by the heavy hammer, reducing by tilt and rolling down to the smallest description of rod, a most excellent, tenacious, and dense body of iron is thus obtained; while, **by cutting into lengths of six inches, bundling a number together, and re-welding them into a bar,** an increased density and tenacity is gained…

Shooting, Baron Thomas de Grey Walsingham, Sir Ralph Payne-Gallwey, Lord Charles Lennox Kerr, Archibald John Stuart-Wortley, Gerald Lascelles, Simon Fraser Lovat **1886**
http://books.google.com/books?id=MT9NF4BnAFIC
A Short History of Gun-making
http://books.google.com/books?id=MT9NF4BnAFIC&pg=PA51
p. 73
Best Silver Steel Damascus barrels contain over 70% of the finest steel, and it is the systematic twisting and arrangement of the iron and steel bars, as they are welded together and beaten into a flat ribbon before being coiled into the form of a tube, that give the beautiful figure or pattern observed in a first-class twist barrel... Laminated steel barrels differ but slightly from those known as 'Damascus.' The former were ***first made by Mr. W. Greener*** (senior), of Birmingham, about 1850, and were composed of three parts steel and one part iron. At the present time the best English damascus, as well as laminated steel barrels, contain over 60% of the harder metal, and there is little perceptible difference between Damascus and a laminated Damascus barrel, as both are of very similar workmanship and materials.

In the 1910 9th edition of ***The Gun***, by W. W. Greener, on p. 231
In the best silver-steel Damascus, *used by the author*, the exact proportions of iron and steel used are such as have been found by experiment to give the greatest strength; the figure is fine and uniform.

And apparently by others; Westley Richards with 2 Iron "Silver Steel" courtesy of Mike Harrell

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