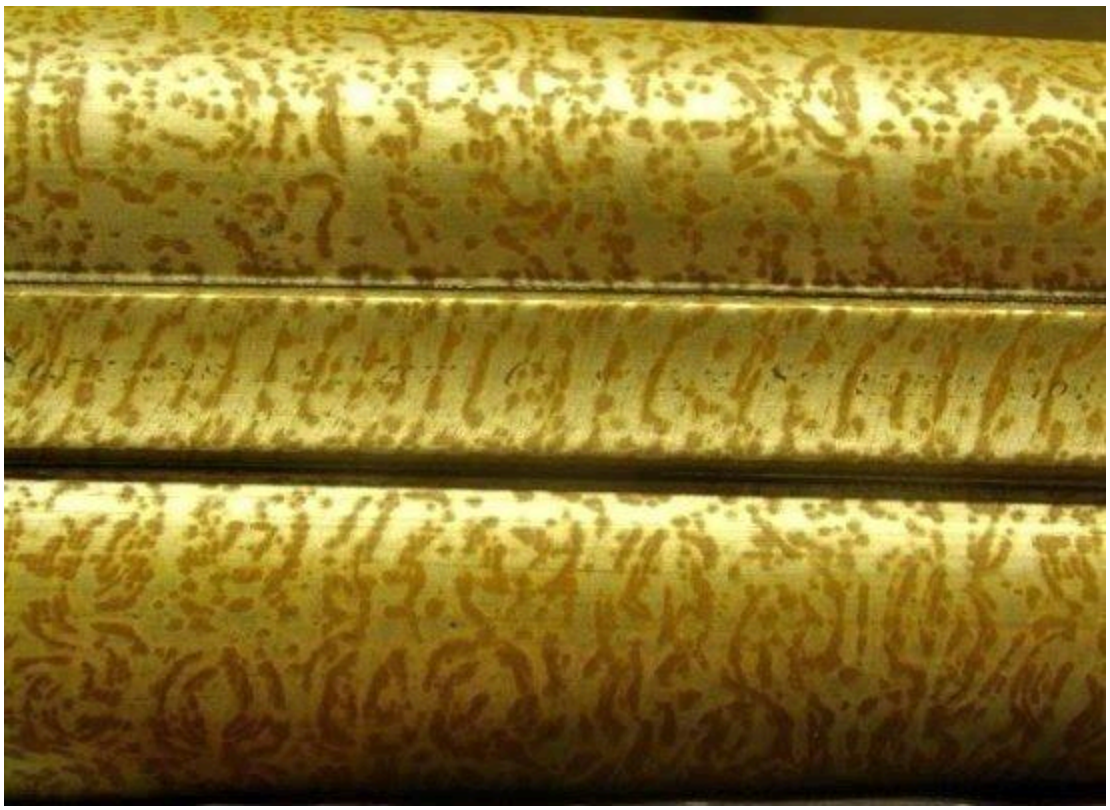
DAMASCUS RESTORATION
& Vintage Colouring Techniques

The pattern ('browning' or 'black & white') seen in damascus barrels is related to the different rate of oxidation of the low carbon steel (rapidly rusting and black) vs. the corrosion resistant wrought iron (white) when exposed to a mild acidic solution. The bores of damascus barrels remain 'silver' as they are not exposed to the acid.

As with blueing, the depth of the oxidation of the barrel surface is quite thin; less than .0001".



Sources of Confusion

W.W. Greener *Modern Shot Guns*, 1885
https://books.google.com/books?id=FW8CAAAAYAAJ&pg=PA33
The barrel, when finished and browned, shows the grain of the metal of which it is composed. **The darker parts are of iron, the lighter of steel.**

Practical Hints on Shooting: Being a Treatise on the Shot Gun and Its Management; Game, Wildfowl, and Trap Shooting; Together with Notes on Sporting Dogs and Ferrets, and Other Useful Information Relative to Shooting, K. Paul Trench, 1887, "Barrels"
https://books.google.com/books?id=xrwUAAAAYAAJ&pg=PA20&lpg
Pour a drop of nitric acid of 1.2 specific gravity on the barrel, and allow it to remain there for a few seconds; then wipe it off with a piece of chamois-leather. On **iron this leaves a light-grey spot, but on steel a much darker one—almost black.**

Journal of The Federation of Insurance Institutes of Great Britain and Ireland, 1904, "Gun and Small-Arms Factories" by A.E. Patrick, p. 149-175
http://books.google.com/books?id=-QUtAAAAMAAJ&pg=PA159&lpg
The **steel** being hard, resists the acids employed in the browning process and retains a **white** or light brown hue, whilst the **iron**, or softer metal, is so acted upon by the acid as to be changed into a **dark brown or black** colour.

Modern Gunsmithing by Clyde Baker, 1933, Chapter 7, "A Few Shop Kinks"
To distinguish between iron and steel, file the surface bright and apply a drop of pure nitric acid. After a minute or two, wash off with water. **On wrought iron, the spot will be a pale ash gray; on steel a brownish black**, and **on cast iron a deep black.**

Helpful discussions on DoubleGunShop courtesy of Ken Marburger
http://www.doublegunshop.com/forums/ubbthreads.php?ubb=showflat&Number=400876#Post400876

http://www.doublegunshop.com/forums/ubbthreads.php?ubb=showflat&Number=410844#Post410844

Comments by Steve Culver
In my experience with etching knife blade steels, low carbon steels come out light in color and high carbon steels are dark. Another experience that I have with etching, is on an original Belgian made barrel tube that I bought from Peter Dyson. This tube I obtained in its "as forged" condition; it never having been finished out. I did a light etch on this tube, using ferric chloride. **The iron etched white, the steel black**. I am confident that the iron in the damascus pattern is white because the chemise is still in this tube. It is my opinion that the chemise and the iron in the damascus are both of wrought iron. The chemise in this tube also etched white. Color variations between elements in damascus are caused by their different alloying content…they react differently to etchant and coloring chemicals. Given the various alloys that could be included in the metals, plus the numerous chemicals that can be used for etching, as well as coloring (browning/blacking/bluing); what the colors will be in the end product, I cannot state with confidence.
The process and chemicals used by a barrel finisher are what determine the final color. I think it possible that the iron could be the lighter element after an etching process and the darker element after a coloring process (browning/blacking).

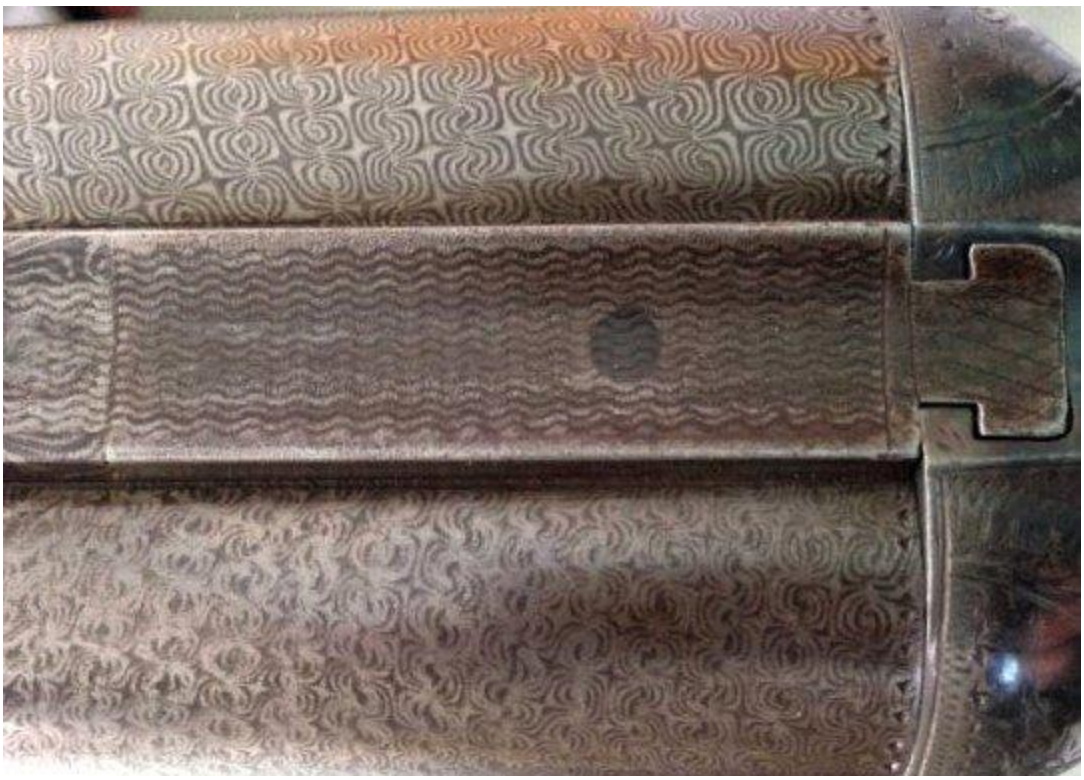
Iron, Steel & Alloy Staining
http://www.doublegunshop.com/forums/ubbthreads.php?ubb=showflat&Number=437513#Post437513

Steel with manganese (AISI 10XX Carbon Steel or 15XX Carbon Steels) will typically **etch black**. Nickel will produce silver, and chromium gray.
http://knifedogs.com/archive/index.php/t-42359.html

"The Journal of the Iron and Steel Institute", 1889
http://books.google.com/books?id=6xoAAAAAMAAJ&pg=RA1-PA353&dq
There are black, brown, and yellow damaskeenings, which are produced in the following manner: Several bars of steel of different hardness, or of iron, cast steel, and steel, are welded together, hardened, and formed into blades. They are then treated with acids, whereby **the harder portions acquire a dark colour, whilst the softer portions remain bright.** (*For non-alloy steels*)

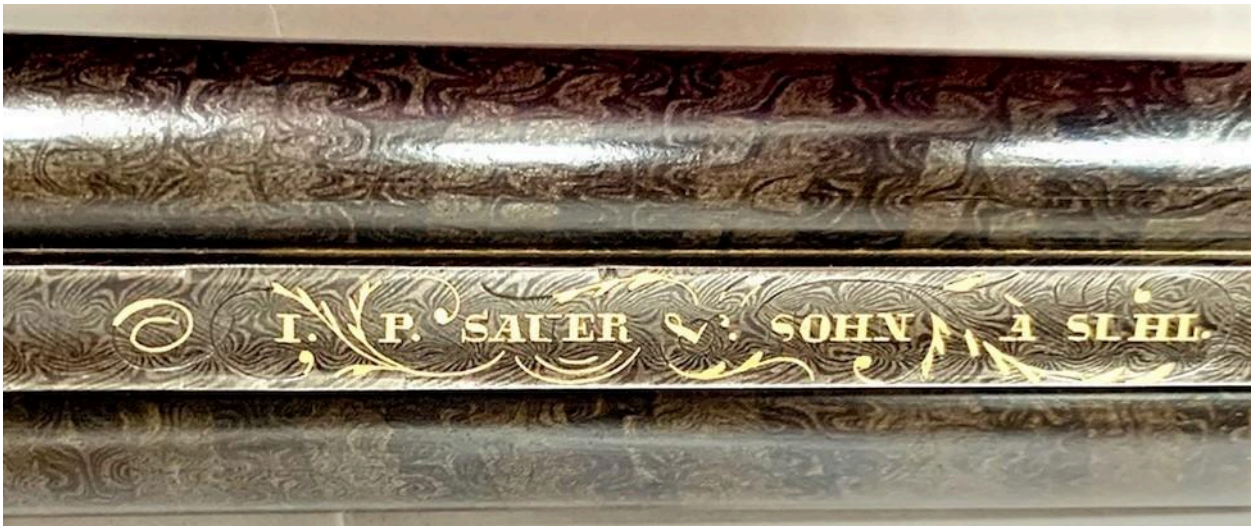
Rockwell Hardness	**Brinell**
Grey Cast Iron - 63	100
Wrought Iron - 65	
AISI 1020 - 68	121
AISI 1030 - 80	149
AISI 1040 - 93	201

Interesting Parker GH with non-matching Parker Dam4 that was “browned”. The head of the screw that indexes the top rib extension has stained much darker and is very likely a higher carbon steel

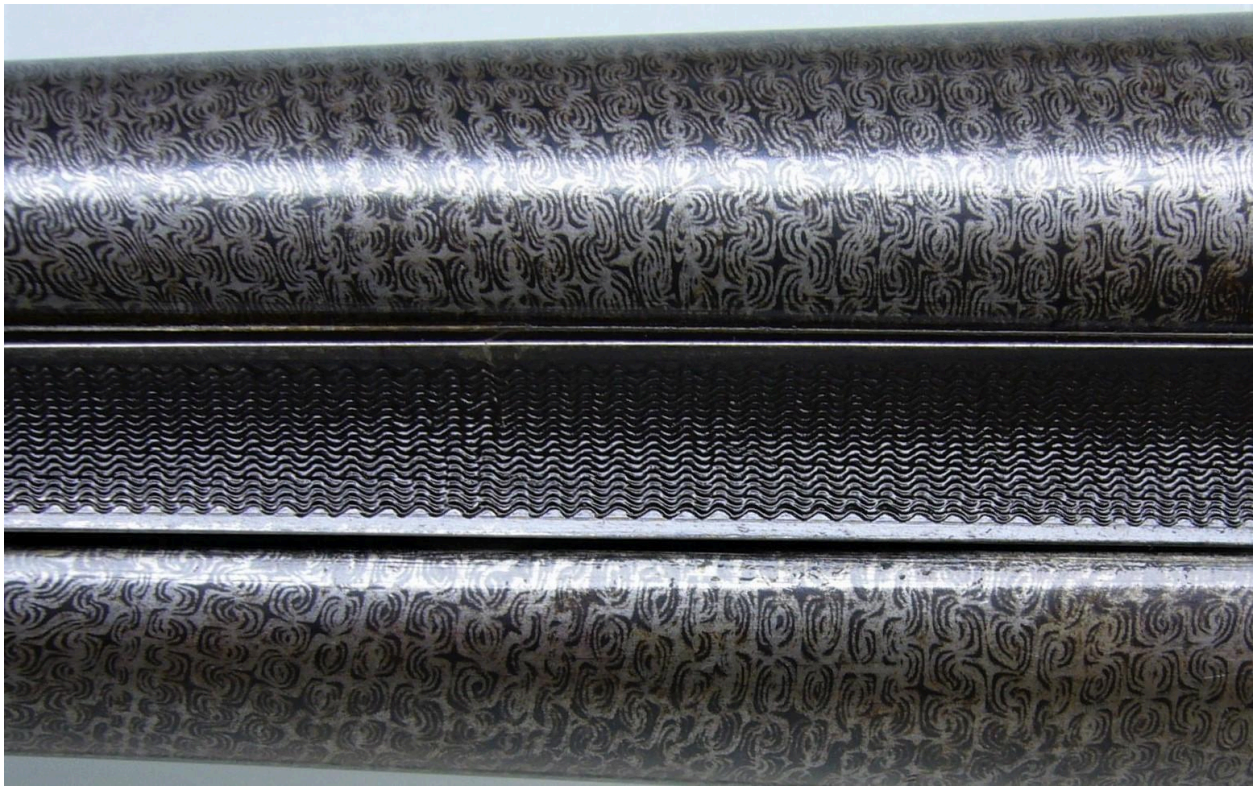


2 Iron Crolle Sauer percussion ML recolored by Breck Gorman, with a presumed purposefully striking contrast between the 2 rods used to fabricate the tubes.

E. Heuse-Lemoine of Liege wrote in 1884 that the pattern coloring and contrast was dependent on the source of the coal, the source of the iron (and alloys present), and whether charcoal, coke, or coal was used by the smelter.



Baker Paragon with original 4 Iron “black & white”



Over time, black ferrous oxide (FeO) is converted to reddish brown ferric oxide (Fe2O3) and barrels will turn ‘plum’. The original ‘black & white’ finish of these Parker D3 barrels is apparent underneath the forend.

Cleaning, Enhancing, and Protecting Damascus Barrels

Courtesy of Roy Hebbes-Smith
An old trade process for polishing metal used white black-board chalk sticks in combination with oil. First coat the barrels with a light film of gun oil or **KleenBore Formula 3 Gun Conditioner**. Then rub the barrels with the chalk stick, focusing on the rusted areas, but to include the entire surface. The rust is lifted by the chalk sticks without damage to the damascus pattern. Wipe clean with a soft rag and repeat as required until all the rust is removed.

After cleaning all residual from the barrels with **G-96 Brand Triple Action Gun Treatment** or **Ballistol**, consider a coat of **Flitz Rifle & Gun Wax** or **Renaissance Wax Polish**.

Scotch-Brite and Orange Palmolive cleaning courtesy of Leighton Stallones

Scotch-Brite™ pad abrasive levels

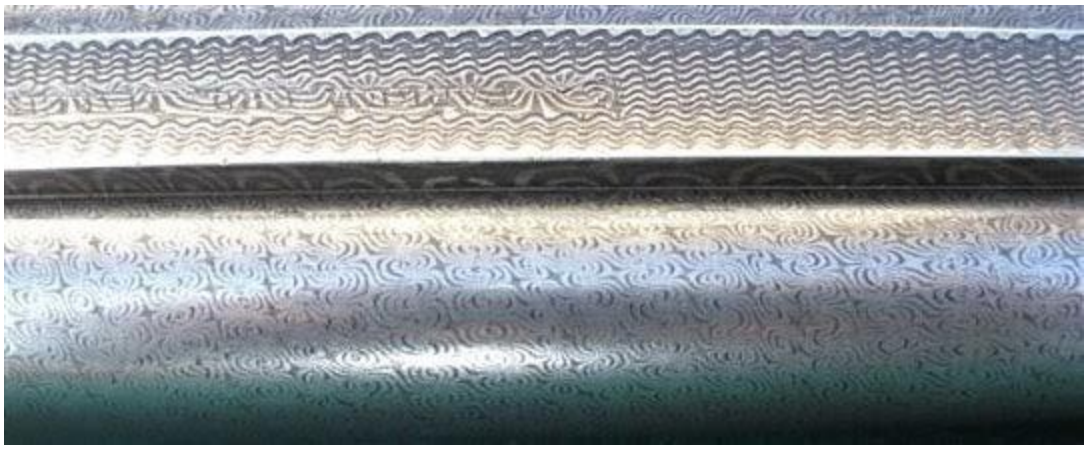
EEZOX® has been recommended for protecting both the bore and exterior of the barrels.

Birchwood Casey Stock Sheen & Conditioner is reported to effectively clean, enhance the pattern, and protect damascus barrels

As does **Thompson/Center Natural Lube 1000 Plus Bore Butter**

Courtesy of Joe Wood for restoring and protecting damascus barrels after cleaning:
Formby's Tung Oil is by far the best metal finish I've used. It is very easy to apply (or remove), dries quickly, and seems to have "miracle" restorative properties when applied to faded damascus barrels.
Place a long wooden broom handle in the breech of one tube and tighten the handle in a vice so the barrels are horizontal. Wet a 4 inch square cloth patch with the oil and wipe it on, moving quickly. It might help to rotate the tubes using another wooden dowel in the muzzle of the other barrel. One patch should do both barrels. Let dry for 3 to 4 days then admire your work. The Tung Oil also can be used to protect case colors on the receiver.

Parker CHE 'before' Formby's courtesy of Bruce Day



After Formby's

Brad Bachelder recommended **Watco Danish Oil Finish**
http://parkerguns.org/forums/showthread.php?t=9779

Dr. Oscar Gaddy, 2003
“For some time, I have been using a clear-coat aerosol spray-on lacquer made and sold by **Behlens**. It is a true cellulose lacquer that you can spray on and have a very uniform coat without bubbles and running with just a little care in application. When you need to redo it, it can easily be removed by merely soaking the parts in acetone. I have been very pleased with its performance and I use it on all Damascus barrels that I refinish and on some guns that I color case harden if the owner wants a protective coating.”
https://www.shellac.net/behlen_spray_finishes.html

Vintage Colouring Techniques

PLEASE NOTE: The following documents are provided as historical references only and no attempt should be made to recreate the highly toxic and potentially lethal solutions.

Thomas Burgeland Johnson, ***The Shooter's Guide; Or, Complete Sportsman's Companion,*** 1816
http://books.google.com/books?id=5DQCAAAAYAAJ
p. 160
The last operation is that of colouring the barrel; previous to which it is polished with fine emery and oil, until it is perfectly smooth and equal. It was formerly the custom to colour barrels by exposing them to a degree of heat, which produced an elegant blue tinge; but as this effect arises from a degree of calcinations taking place upon the surface of the metal, the inside of the barrel consequently sustained considerable injury; and this practice therefore, has been discontinued for many years. It is now the custom to ***brown*** barrels; which is done by rubbing the barrel over with aqua-fortis, or spirit of salt, diluted with water, and laying it by until a complete coat of rust is formed upon it; a little oil is then applied, and the surface, being rubbed dry, is polished with a hard brush and bees-wax. This is not the only method to render barrels of a fine brown: there is another which may be practiced by the sportsman himself, if he thinks proper. It is this: - Having fitted a stick into the muzzle of the barrel to hold it, rub the barrel bright with sandpaper, to take off all greasiness; bruise half an ounce of stone-brimstone, and sprinkle it over a gentle fire; hold the barrel over the smoke, at the same time moving it about, until all parts are equally tinged; then place it in a damp situation until the next day, when you will find a fine rust thrown out, over which you may draw your finger, to spread it even over the barrel; let is remain another day, and then polish…

John Holland, ***A treatise on the progressive improvement & present state of the manufactures in metal,*** Vol. 2, "Firearms", 1831

For browning iron, the following method has been published: Nitric acid, half an ounce; sweet spirits of nitre, half an ounce; spirit of wine, one ounce; blue vitriol, two ounces; tincture of steel, one ounce. These ingredients are mixed, the vitriol having been previously dissolved in a sufficient quantity of water, to make, with the other ingredients, one quart of mixture. Prior to commencing the operation of browning a gun barrel, it is necessary that it be well cleaned from all greasiness and other impurities, and that a plug of wood be run into the muzzle and the vent well stopped. The mixture is then to be applied with a clean sponge or brush, taking care that every part of the barrel be covered with the mixture, which must be exposed to the air for twenty-four hours, after which exposure the barrel must be rubbed with a hard brush, to remove the oxide from the surface. This operation must be performed a second and a third time (if requisite), by which the barrel will be made of a perfect brown colour. It must then be carefully brushed and wiped, and immersed in boiling water, in which is held in solution a quantity of alkaline matter, in order that the action of the acid upon the barrel may be destroyed. The barrel, when taken from the water, must, after being rendered perfectly dry, be rubbed smooth with a burnisher of hard wood, and then heated to about the temperature of boiling water. It will then be ready to receive a varnish black of the following materials: Spirit of wine, one quart; dragon's blood, pulverized, three drachms; shellac, bruised, one ounce; and after the varnish is perfectly dry upon the barrel, it must be rubbed with the burnisher to give it a smooth and glossy surface.

William Greener, ***The Gun, or a Treatise on the Various Descriptions of Small Fire-Arms,*** 1835 "On the Staining of Barrels"
There exists innumerable recipes, and in fact almost every maker has his own method. The first I have found to answer uncommonly well, and which it would be a difficult matter to excel. It consists of the following ingredients:
1 oz. Muriate Tincture of Steel (Red oxide of iron [Ferrous chloride] and muriatic acid)
1 oz. Sp. Wine (Methylated Spirits or methyl alcohol)
1/2 oz. Muriate of Mercury
1/2 oz. Strong Nitric Acid
1/8 oz. Blue Stone (Copper sulfate or Blue Vitriol)
1 quart Water
These are well mixed, and allowed to stand a month to amalgamate. After the oil or grease has been removed from the barrels by lime, the mixture is laid with a sponge, every two hours, and scratched off with a steel-wire brush every morning, until the barrels are dark enough; and then the acid is destroyed by pouring on the barrels boiling water, and continuing to rub them until nearly cool.

Also see W. Greener ***The Science of Gunnery,*** 1841
http://books.google.com/books?id=ThYkeKlemD8C&pg=PA132&source

W.W. Greener, ***The Gun and It's Development,*** 1907
http://books.google.com/books?id=3HMCAAAAYAAJ&pg=PA270&source
The bronzed appearance of the finished gun barrel is obtained by a process of rusting the barrels, the rust being cultivated, then stopped; the complete oxidation of the surface renders the barrels less liable to rust by natural means.
The beautiful figure of the fine Damascus and laminated steel twist barrels is not surface-deep only; the figure runs completely through the barrel, as will be made clear by referring to the description of the process of making the iron for, and the methods of welding, the barrels. Consequently, it is impossible to get by browning any finer or more beautiful figure than is already in the barrel; it is possible, by inferior browning, to hide that figure, or so obscure it that recognition is barely possible. That fine gloss, seemingly the effect of lacquer or copal varnish, is nothing more than the highly-burnished surface of the barrel,
which before browning was as highly polished as a silver mirror.
"Browning" according to the statement of a technical writer, "is a dirty, a long, and a tiresome process." **It should not therefore be attempted by amateurs**, and the *best* results are only obtainable when there are facilities for maintaining variable temperatures for any length of time by night and day.
The method of colouring figured barrels usually followed may be shortly described. The barrels, highly polished, are plugged with tightly-fitting pegs. During the processes of browning they are handled entirely by these pegs, and are not touched by the hand. Double barrels have usually one barrel corked at the breech, the other at the muzzle; the wooden plug projects also from each barrel about four inches. The barrels are coated with damped whitening; this is brushed off when dry, and removes all grease. A browning mixture is then applied with a piece of flannel, and the barrels are put by in a moist atmosphere at about 50° F. This coating of mixture will rust the barrel if allowed to remain for twelve or eighteen hours. It must then be scratched off by energetically scrubbing with a brush of steel wire; the barrels are then again coated with the browning mixture, which may remain on ten to twelve hours; the removal of the second coating of rust is effected in the same way; the coating and scratching processes are repeated time after time, until the barrel is completely rusted. The barrel is brought into a warmer temperature with each succeeding coating, and a shorter time allowed to elapse before it is removed, as the acid acts more quickly when once a start is obtained and the oxidation of the surface proceeds. If the rust is not removed by the scratch-brush on every part of the barrel before it is re-coated, that untouched, or partly scoured, portion will be streaky when the browning process is completed. So, too, the barrel must be coated evenly—a thinly-spread coat; no over-wetting so

that the acid runs, or lighter patches and half-browned surfaces will appear, not to mention ugly spots where the acid has collected. The barrel being dark enough, it is boiled for a few minutes in a trough of soft-water in which a few logwood chips and a little soda have been placed. Sulphate of copper is sometimes preferred to soda. The barrels are then wiped dry, and should show distinctly every curl in the figure, the grains of the steel lighter than those of the iron, the welds darker than either.

There are many recipes for browning mixtures; a good one is as follows : 1 oz. muriate tincture of steel; 1 oz. spirits of wine; 1/4 oz. muriate of mercury; 1/4 oz. strong nitric acid; 1/8 oz. sulphate of copper; 1 quart of distilled water. This mixture should be allowed to stand for some days, in order that the ingredients may properly amalgamate.

Hard barrels, those in which there is much steel, require longer time and the browning mixture should be still further diluted. Soft barrels may be more quickly browned, and a stronger mixture used. Where the figure is bold and the iron and steel threads large there is less difficulty in browning.

The colours which can be obtained vary from a light yellowish-brown, through various red-browns, to a deep Vandyck-brown. A rich plum brown is obtained if time is taken and a little black brimstone, say 1/4 oz., added to the above mixture. Spirits of nitre and nitric ether are sometimes used in lieu of spirits of wine.

The black-and-white brown may be obtained by using a much diluted mixture, and touching up the barrel before boiling by sponging with water in which a little muriate of steel has been stirred. The colours can be heightened also by plunging the barrels in cold water immediately they are taken from the boiling trough. In all fine-figured barrels the coating of rust is necessarily very thin, or the figure could not be distinguished. This coating of brown soon wears off. The only remedy is to have a greater body of brown, hiding the figure, or to use the black-brown, as in military rifle barrels. This last brown is much more durable, and effectually protects the barrels from rusting by salt air, hence is much used on ducking, punt, and wild-fowling guns.

Steel shot barrels, when black-browned, show no tendency to rust, however much exposed to atmospheric changes. The black-brown is obtained in a shorter time, and a much stronger mixture may be used—as, for instance: 1 1/2 oz. spirits of wine; 1 1/2 oz. tincture of iron; 1 1/2 oz. corrosive sublimate; 1 1/2 oz. sweet spirits of nitre; 1 oz. sulphate of copper; 3/4 oz. strong nitric acid; 1 quart of water. Before re-browning any figured barrel it is essential that the old brown be effectually removed. The barrel must be well polished again before re-browning, if that fine sheen so much desired is required; otherwise, simply rubbing off the brown with emery cloth, with fine emery in water, or by sponging the barrel with

strong vinegar, will answer the purpose.

Breeder and Sportsman, January 13, 1912
"How To Brown Gun Barrels"
Breeder and sportsman : Free Download, Borrow, and Streaming : Internet Archive

Other mid-1800s browning formulae used Spirits of Nitre, Corrosive Sublimate, Blue Vitriol, Tincture of Steel, Tincture of Iron, Copperas, & Black Brimstone:

Spirits of Nitre = It is obtained by the distillation of alcohol with nitric and sulphuric acids.

Aqua Fortis = Nitric acid. Nitric acid is a strong oxidizing agent. It reacts with metals, oxides, and hydroxides, forming nitrate salts. Chief uses of nitric acid are in the preparation of fertilizers, e.g., ammonium nitrate, and explosives, e.g., nitroglycerin and trinitrotoluene (TNT).
Aqua Regia is a mixture of nitric and hydrochloric acids.

Corrosive Sublimate = BiChloride of Mercury. It is one of the most toxic forms of mercury because it is more soluble than most in water. It was used as a reagent in archaic photographic processes. **It can kill you**.

Blue Vitriol = Alum and copper sulfate

Tincture of Steel = Ferric or Iron Chloride in Grain Alcohol. The substance decomposes on heating above 200°C producing toxic and corrosive gases including hydrogen chloride.

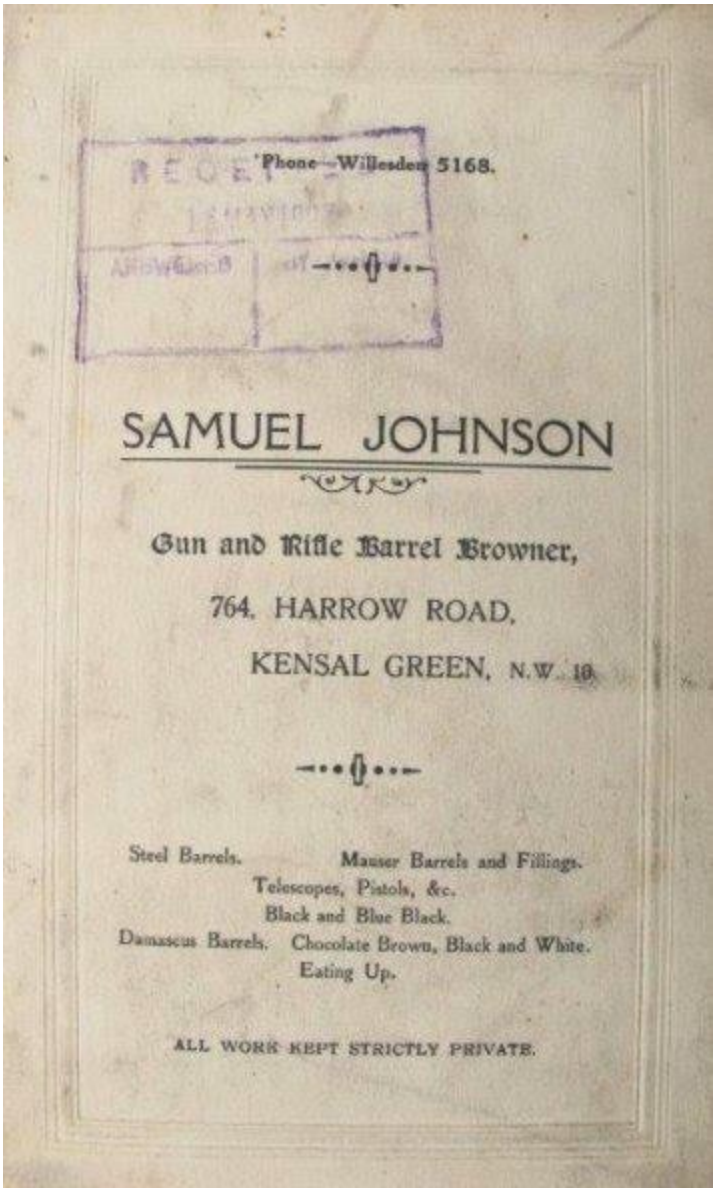
Tincture of Iron = Ferric Chloride, obtained as dark-green, lustrous crystals by heating iron in Chlorine. Process produces chlorine gas, which is highly toxic when inhaled.

Copperas = Ferrous Sulfate

Black Brimstone = Sulphur Vivum

Rust Browning Solution
From the U.S. Ordnance Manual of 1841
1 1/2 oz. Ethyl Alcohol
1 1/2 oz. Tincture of Ferric Chloride
1/2 oz. Mercuric Chloride **(CAUTION-deadly poison)**
1 1/2 oz. 4% Alcoholic Solution of Ethyl Nitrate
1 oz. Copper Sulfate
3/4 oz. Nitric Acid
1 Quart Distilled Water

Samuel Johnson, Barrel Browner c. 1925
Courtesy of Paul Stevens.
“Damascus Barrels. Chocolate Brown, Black & White, Eating Up.”



Best Birmingham Black courtesy of Hugh Lomas
https://www.doublegunshop.com/forums/ubbthreads.php?ubb=showflat&Number=560496

Nitre blueing courtesy of Michael Petrov

A. W. B., Chappaqua, N. Y.

[Learning from A. W. B., in later letters, that what he chiefly desires is the excellent bluing put on arms at our Government arsenals, we re-print the formula herewith. It is infallible when properly used, but depends on the absolute cleanliness of the metal to be treated. All old bluing must be removed. Wooden plugs should be used in handling barrels. The work must never be touched with the hands. The mixture should not be splashed on the person, and the Government rule is that all persons engaged must wear spectacles to assure protection of the eyes.

The method is as follows: A cast-iron pot or vessel, open to the air and heated from below, contains the nitre and oxide of manganese (100 pounds refined nitre-potas-

sium nitrate or salt-petre to 10 pounds black oxide of manganese) at a temperature sufficiently high to cause quick ignition of a pinch of sawdust thrown upon the surface of the mixture. The parts to be subjected to oxidation are suspended above the mixture in wire baskets, or on separate wires attached to a rope passing over a pulley, by which means the parts are immersed or removed from the mixture. The parts (when finished except as to color) are immersed when cold and lowered and raised into and out of the mixture several times to burn off any oil, and are then left in the mixture from three to five minutes, depending upon their size and the color desired. After a satisfactory color has been obtained, which can be determined by inspection after lifting the parts out of the mixture, the parts are plunged into a vessel of hot water to remove the adhering nitre, then into a vessel of sperm oil, and allowed to drain off; the parts are then plunged into a hot water bath and then wiped with oily waste, which completes the process. Before immersing the parts, it will be found advantageous to thoroughly stir the manganese from the bottom with a ladle.

Firearm Blueing and Browning by R.H. Angier is available as a reprint from Stackpole Books
http://books.google.com/books?id=IUtv4yDhl3MC&dq

Dr Gaddy's Damascus Refinishing Technique
See *Double Gun Journal* Vol 8, Issues 2 and 3, 1997 and Vol 14, Issue 1, 2003
http://www.doublegunshop.com/forums/ubbthreads.php?ubb=showflat&Number=6394&page=1&fpart=2

A tribute to Dr Gaddy from the University of Illinois
http://www.ece.uiuc.edu/news/alumninews/alumninews-win0506a.pdf

Larry Potterfield on rust blueing pattern welded barrels
https://www.youtube.com/watch?v=BDCPr3rmkOs

Damascus Restoration

Classic American 'Black & White' Parker D3 refinished by Brad Bachelder & Channing Will

Parker Grade 1 Toplever Hammergun 'before'

‘After’ by Dale Edmonds (now retired)

Parker D4 by Breck Gorman courtesy of Robert Deveer

‘Before’ with extensive superficial pitting

‘After’

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"Before and after browning" by Paul Stevens

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