

Stained burr veneer on early 18th century Dutch long-case clocks

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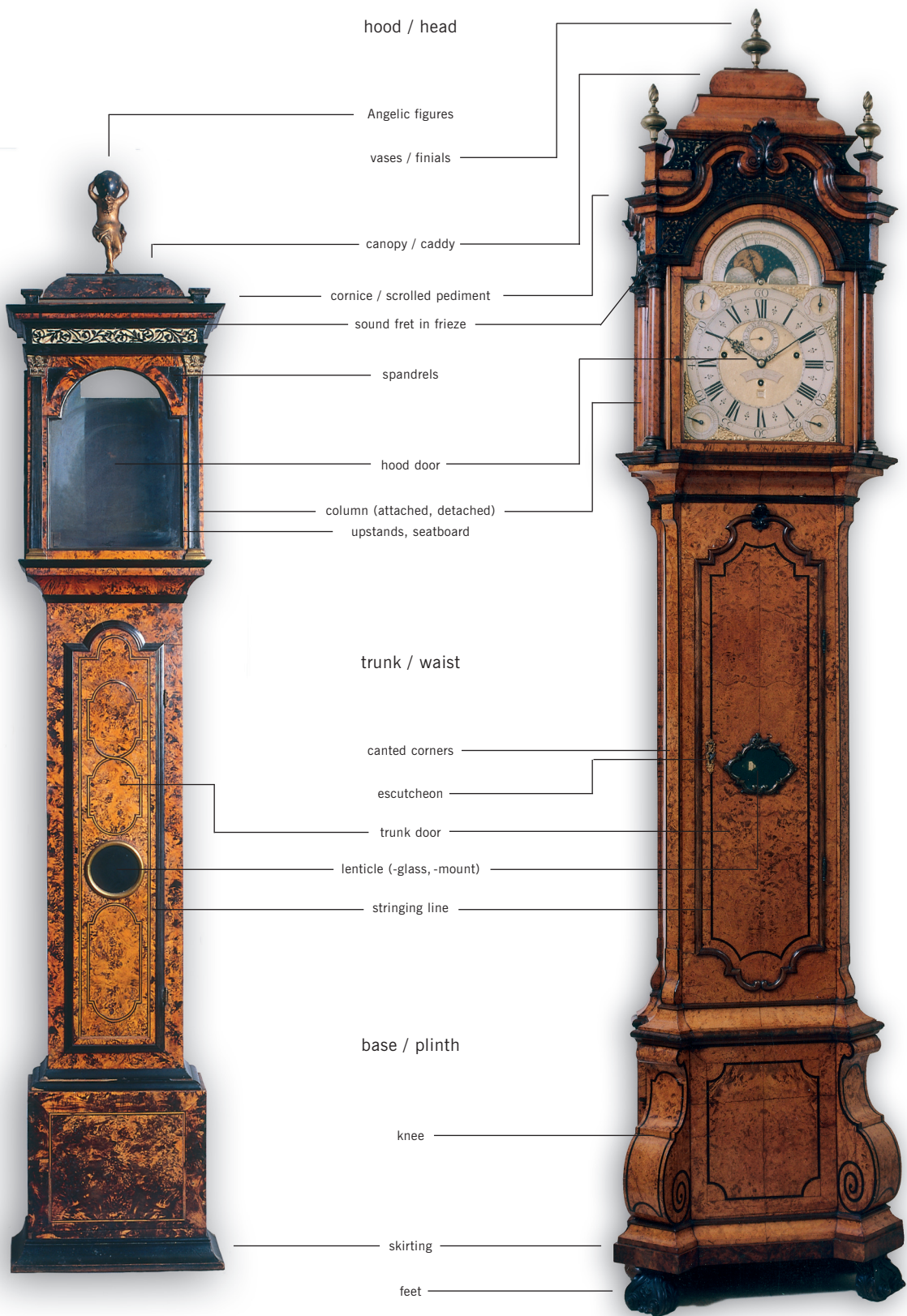
1 Introduction

Among early 18th century Dutch long-case clocks, a few stand out for their unusual veneering. Veneered with light coloured burr woods artificially stained to produce a mottled brown-black effect, their contrasting colours generally survive surprisingly well.¹

fig.1 (Left)
long case clock c.1715 (Fromanteel & Clarke);
replaced plinth mouldings, bun-feet and section of caddy missing
(no. 15, table 1).

fig.2 (Right)
long case clock of c.1735 (R. Dunster); stained veneer with extensive
loss of contrast probably due to refinishing the surface (no. 11, table 1).

Terminology of various parts is given between the two figures.



hood / head

Angelic figures

vases / finials

canopy / caddy

cornice / scrolled pediment

sound fret in frieze

spandrels

hood door

column (attached, detached)

upstands, seatboard

trunk / waist

canted corners

escutcheon

trunk door

lenticle (-glass, -mount)

stringing line

base / plinth

knee

skirting

feet

Although Dutch two-door cabinets with similar veneers were made in the late seventeenth century², contemporary counterparts are mostly found abroad. In England, for instance, chests of drawers and desk-and-bookcases as well as clock cases were decorated with partly stained maple burr.³ Interestingly, many clockmakers in the Netherlands at the time came from England and retained business connections with that country (see, for examples of this strong Anglo-Dutch connection, nos. 7–12, 14–22 in table 1). As this type of decoration is relatively rare in Dutch furniture, the wood used is often mistaken for some exotic species. In fact, it is usually indigenous; so far, stained maple, poplar, alder, elm and ash have been identified, maple — or sycamore — being the most common. This small group of pieces of similar origin and date seemed suitable for an investigation of the stain composition and the staining technique. The research follows up on earlier findings on two seventeenth century cabinets and one early-eighteenth century Dutch doll's house cabinet, where iron-gallic complexes and iron components were identified in association with the dark brown staining of the burr veneers.⁴ Our method has been to use analytical results as the starting point of a search for contemporary recipes and references. The aim was to write stain formulas based on eighteenth century techniques and materials, which would give credible visual results on replica sample boards, and leave the same chemical trace patterns as those found on historic furniture.

2 Early-eighteenth century Dutch long-case clocks

Wooden cases for clocks appeared in the second half of the seventeenth century, in connection with the development of pendulum clocks with longer-duration movements and heavier driving weights. The long-case clocks with stained burr veneer belong almost exclusively to the early type of pendulum clock with a strong frontal design, as shown in figure 1. This type dates mainly from the beginning of the eighteenth century. After 1700 the severe Dutch classicist or early English style gave way to a more baroque 'Louis XIV' type (fig. 2).⁵ This was a gradual process, which means that the incorporation of a domed frieze, chamfered corners, a bombe base and so on, can be used today to date a clock with some accuracy.

• Construction and decoration

The general case construction is comparable to the

methods and principles applied in chests of drawers and cabinets of this period in the Low Countries. The rather crude box-like carcass is constructed of oak and veneered on the outside. The usual thickness of the oak boards is 8–10 mm for the back panel, 13–20 mm for the trunk and 18–21 mm for the trunk door. These are probably the standard sizes cut by the sawmills, as their typical regular saw marks can still be found on inconspicuous places in the case. The various parts are glued together and the main joints reinforced by nails and/or glue blocks. The trunk door usually consists of two vertical boards simply glued together; this may simplify the mirror imaging of the veneers on the outside. A moulding covers the gap between door and trunk. True joints are used in the back panel, which consists of two thin boards joined by tongue-and-groove, and sits in a rebate or is simply nailed to the sides. The extra joinery involved was apparently cheaper than purchasing a single board of the full width. The back panel may be strengthened with a clamp. The hood door corners are lap jointed or open mortise-and-tenons.

Since the general design is tall and slender, the grain direction of the carcass is predominantly vertical, with the exception of the front board and bottom of the base, and some mouldings. The slightly wider base rests on bun- or bracket-feet. The back panel continues right up to the hood, and usually has a convenient central hole for fixing the case to the wall, for greater stability. Typical of clock-case construction is that the upper parts are easily removable. The seat board for the clock is nailed or bolted to the up stands of the case — the sides, which are slightly higher than the front. A sliding hood protects the clockwork and is topped by a loose canopy or caddy and loose vases, balls or angelic figurines.

The light construction of the hood makes it easy to lift and remove. The textile covers applied to the back of the canopy and behind the fretwork of the frieze and side panels (the so-called 'sound fret') allow the bells to be heard. As to the hardware: the hood door opens on small pivoting pins; the trunk door has brass strap hinges with base-plates; the hood door locks with a spring latch which is unlocked by pulling a piece of string from inside the trunk; the trunk in its turn is accessible through the trunk door, which is secured with a tumbler lock. Runners on the up stands guide the horizontally sliding hood, which is held in place with simple wooden turnbuckles. The trunk door usually has a round or oval lenticle glass with a brass rim. The stained burr veneer on clock cases is applied on the

front and sides. The leaves of veneer are randomly pieced together depending on the dimension of the burr growth.⁶ On the base and trunk door, however, the veneers are often book-matched. In this ground veneer, grooves may be cut, following a rather restricted repertoire of straight lines and cartouches. These grooves are then filled with ebonised or ebony linings; sometimes a composite strip of dark and lightwoods is used. The mouldings of cornice, body and plinth may be partially burr-veneered, or ebonised. The stained veneer is finished with a clear varnish or wax coat.

• **Production: clockmaker-casemaker-client**

Little is known about Dutch cabinetmakers working for clockmakers, still less about specialist case makers. The only known written sources date from the second half of the eighteenth century.⁷ The cases themselves remained unsigned as a rule. In general it is to be expected that the design of the clock dictated the size of the case. For instance, the size and shape of the dial sets the hood door measurements; the length of the pendulum decides the position of the lenticle glass. When there is a second hand the pendulum will be about one metre in length, allowing the clock to tick 60 times a minute. But the fit is not necessarily very close: measurements were fairly standardised, and when necessary, adjustments could be made. Quite often, one finds trunks whose sides have been gouged out to allow for the full swing of the pendulum, or hoods that are extended to allow for the bells; this is not always proof of case swapping at a later date. It made economic sense for the larger cabinetmakers to stock a range of cases, which could be finished to suit the clock and the customer.

It is generally accepted that the ‘clockmaker’ who signed his name on the dial was often simply the dealer at the end of the assembly process and not an actual maker; all the parts of a clock could be ordered from specialists and complete works might be imported. The role of the casemaker could very well be organised along the same lines as the other tradesmen involved, depending for the initiative and the commissions on the wealthy clockmaker/dealer who provided the necessary financial backing. An advertisement of 1715 in the *Amsterdamse Courant*, in which the clockmaker P. Bramer advertises long case clocks for sale, seems to support this.⁸ As clockmakers/dealers in Amsterdam weren’t organised in a guild, it may have been easier for them to sell other craftsmen’s products.⁹ Cabinetmakers did belong to the St Joseph’s guild, which regulated the trade in cabinetmakers’ products; for instance, selling cabinetmakers’



fig.3 Signature of J. Hasius, Haarlem on dial of long case clock (no.23, table 1).

work from other cities was prohibited, except during certain yearly markets.¹⁰ It must have been convenient for a clockmaker to give orders and specifications to a casemaker working nearby. This makes the signature of the clock dealer on the dial an important clue to the origin of the case (see fig. 3).

3 Burr wood

Stump wood, burl- or burr wood, briarwood, pollard wood, burls and galls are names to indicate the part of the tree, generically called ‘burr’, from which the veneer is obtained. These veneers are characterised by an extremely irregular structure caused by varying grain directions and frequently occurring knots. This irregularity causes a varied reflection of light and therefore contrasting colours. Burr wood is formed during abnormal tree growth initiated by extremely high or low temperatures, insects, fungi or repeated mechanical damage, by which the cambium becomes in some way irritated and infected by bacteria. The stump wood that can occur at the base of a tree where trunk and roots meet is generally the largest kind of burr. The large round outgrowths known as burrs, which sometimes occur on tree trunks, can also yield wood of highly ornamental figuration; generally more regular and often of flower-bouquet-like structure, they usually have smaller dimensions than stump wood. Very large burrs are formed by trunks, which are completely covered by burr growth.

The clusters of small pin- or spike-knots, caused by (dormant) buds, which tend to grow on a damaged area or a wound on the trunk, are a typical feature. A closely

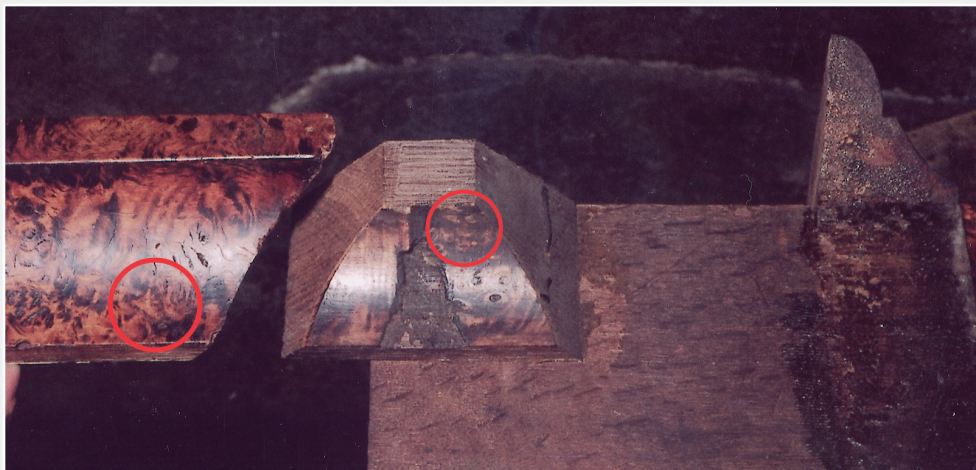
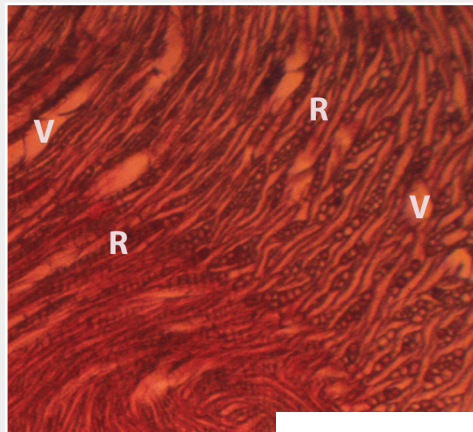
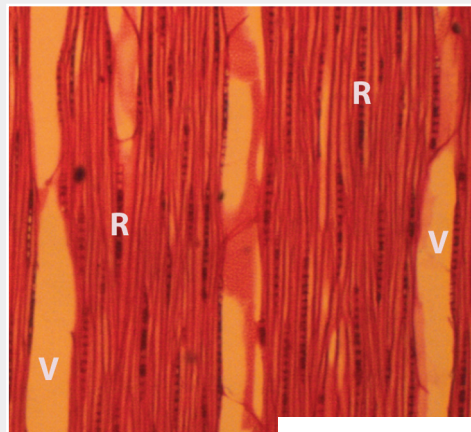
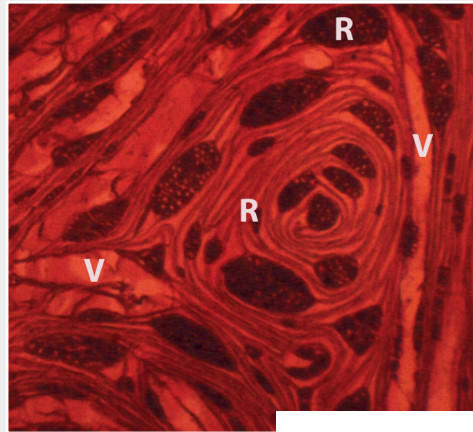
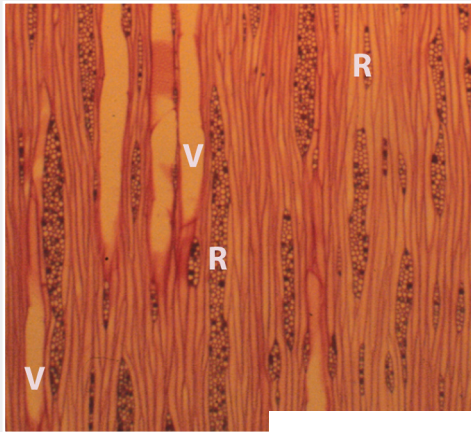


fig.4 -7 (Predominantly) tangential sections of maple normally grown (fig.4), burr variety (fig.5) – and poplar normally grown (fig.6), the burr varieties (fig.7) are photographed to illustrate differences in form and distribution of the rays (r) and vessels (v) in the two varieties of each wood species. White bar stands for 0.5 mm.

fig.8 Detail of case of clock by Fromanteel & Clarke (see fig.1) during restoration. Off cuts of previously stained and finished moulding were re-used as glue blocks supporting the front of the base. Note the minimal colour difference between exposed stained veneers on loose moulding (left) and the protected scrap moulding (right).

related type of veneer is produced from the swollen and distorted top of a tree that has been pollarded — a tree whose crown has been repeatedly trimmed back to the trunk every few years. Pollard veneers show a twisted figure with many small branch traces.¹¹ Although correctly diagnosed by some authors¹² as a stained veneer sawn from a burr wood of an indigenous species, the literature will often use the names of exotic species in descriptions: mulberry, amboina & thuya are the favourites. Even to the wood-anatomist, identifying these specimens can be difficult. R. Gale writes ‘When sectioning abnormal growth such as burr wood where no general orientation is evident, it is often a question of taking experimental sections in various planes in the hope that some diagnostic features will be visible. The development of some structures such as ray formation and vessel size and distribution will be strongly influenced by the cambial disruption, [compare figures 4 to 7-JB], and greater emphasis has to be placed on the more stable characteristics such as the presence of resin canals and cell wall details (pitting and perforation plates). Inclusions such as crystals, gums, tannins and resins are often a by-product of the abnormality itself and may not be characteristic of the general anatomy of the species.’¹³

Depending on its position on the tree, burr wood will possess more of the features of the branches, bole or roots. However, variability in the properties of normal wood among trees of the same species may be more or less than in those found within an individual tree. For the purposes of identification, it is advisable to sample from a relatively ‘tame’ area in the veneer, which doesn’t have the altered morphology of burr wood.¹⁴

4 Stains and colorants

One of the conclusions of previous studies on the use and preparation of stained burr woods was that; ‘[...] although recipes specifically recommended for staining burr wood are known from the historic literature, it is highly probable that burr woods were also treated with stains commonly applied to conventional woods. Therefore for future studies it is clearly desirable that stained burr wood should be considered within the context of more general investigations of historic wood stains and marquetry techniques.’¹⁵

It proved difficult to replicate satisfactorily the brownish-black colours often found on Dutch stained burr furniture by using the historic stain recipes such as

Stalker & Parker’s ‘To stain a fine Yellow’ from 1688.¹⁶ This recipe instructs the reader to ‘Take Burr or knotty Ash, or any other wood that is white, curled, and knotty;[...]’ and then to colour the wood with ‘aqua fortis’ or alternatively dissolve ‘bits of metal’ in the nitric acid, which results in iron-, copper- and zinc nitrate solutions that stain the burr veneer. This was then partly sanded away, treated with oil and varnished. Almost a century later, the German J.M. Cröker in ‘Der wohl anführende Mahler’¹⁷ wrote essentially the same, being a little more specific about quantities of the ingredients. All these metal salt stains give a positive colouring effect, making naturally dark areas darker still. End grain areas, where most stain is absorbed, turn out darkest, and the colours appear to be quite stable. Although some darkening can be observed, especially in the iron stains, they show only small shifts in chromaticity with ageing. The stain solutions need only low concentrations to be effective, and generally result in greenish-grey, grey and brownish colours.¹⁸

The penetration rate of stains made from these recipes was significantly less than that found in the historic samples.¹⁹

Dutch recipe literature of the period is unfortunately very limited, and silent on the topic of staining burr wood. If one widens the search a little, there are a few Dutch sources on staining that mention at least some of the materials and methods described above. In a mid-seventeenth century manuscript, Jacoba van Veen notes how to imitate ebony by using a black stain which essentially contains all the ingredients of iron-gallic ink: vinegar, gallnuts, iron-‘dust’, Arabic gum and iron sulphate. She also advises pre-treatment of the wood with a tannic acid solution of gallnuts or a solution of nitric acid.²⁰

The late eighteenth century article ‘Om houten te verwen’ (to stain woods) in the *Oeconomische Courant* (Economics Newspaper) states that all woods to be stained should be prepared by putting them in strong vinegar or alum-solution. It mentions aqua fortis for staining yellow or brown.²¹ For a black stain it advocates a sequence of logwood in alum-solution, a warm decoction of gallnuts in vinegar or beer, iron solution and lastly a finish of wax or soot and linseed oil.²² The early nineteenth century housepainter’s manual by L. Simis states that ‘Aqua fortis [...] is also used to colour fine woods for cabinet makers’ work.’²³ It advises ‘To colour wood dark brown [...] put some copper in aqua fortis and apply this on what you intend to colour. Hold it above a

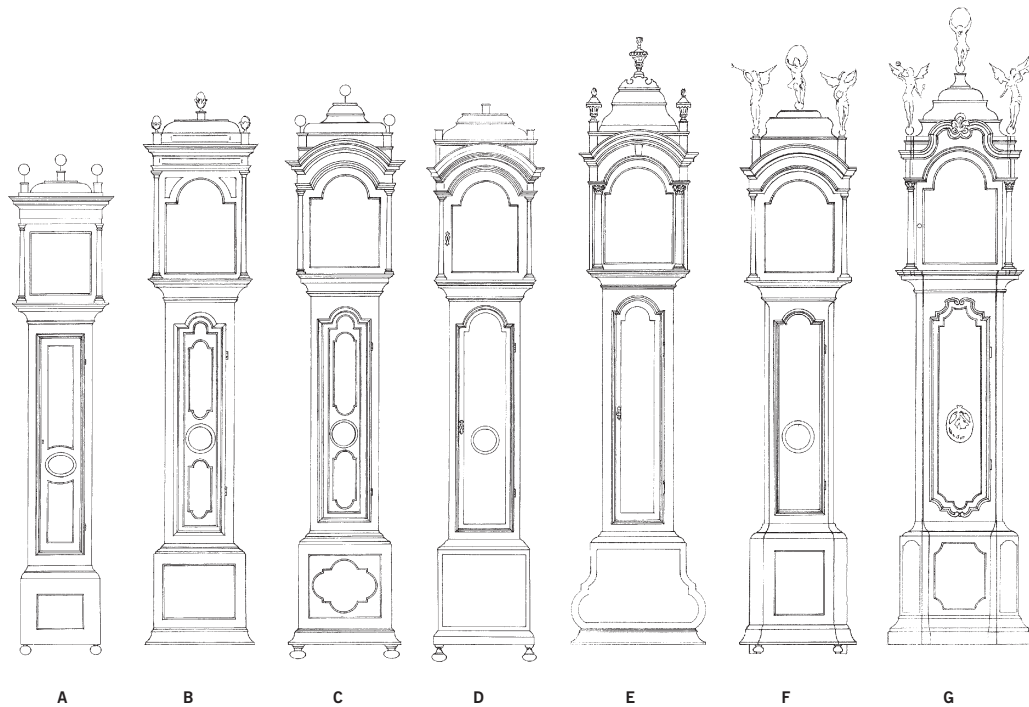


fig.9 The seven most common case types (A-G) veneered with stained burr veneer.

fire and when dry, put it in chalk or chalk water over night, after which it'll be thoroughly brown. Rinse it and rub it with boiled linseed oil or varnish to your liking.'²⁴

The main difference between these Dutch sources and those English and German stain recipes that specifically mention burr wood is the stress on the importance of pre-staining with vinegar, alum or gallnut solutions, and the mention of logwood and the after-treatment with chalk water, which also has a neutralising effect on the acids used. Vinegar is said to enhance penetration in the wood, alum is widely used by the textile industry as a mordant for various colorants, and gallic acid forms insoluble blue-black and dark-brown complexes with iron and copper. Logwood is a natural dyestuff in the blue-black range, and chalk produces a light brown tint. Straightforward but not very specific, these Dutch recipes seem to reflect general traditions and common methods for staining black. Iron-gallic colorants were widely used for dyeing textiles and producing inks. With practice they can be used to produce the brown-black colour observable on historic veneer surfaces. Usually the veneer from historic sample material has been stained on one side only, which implies that the solu-

tion was applied after the veneer had been glued onto the carcass. An illustration of this practice was found during the restoration of a Fromanteel & Clarke clock case, where a scrap piece of moulding had been re-used as a glue block on the inside of the base.²⁵ Here it was obvious that a veneered then stained and finished length of moulding had been cut to the right length when constructing the case. Figure 8 shows that when comparing the colours of the protected scrap piece to the light-exposed and refinished veneers on the outside of the case, very little has changed in the overall look of the stained veneer, apart from a slightly more reddish tone probably due to a coat of shellac applied later.

5 Stained burr veneered cases

In the search for stained burr veneered clock cases, a limited number of case types were found, as illustrated in figure 9. Type A is the earliest, with restrained decoration, a square hood door and a straight cornice moulding. Type B is taller than type A and shows more decorative inlaid stringing; the hood is extended to fit an arched door, and while the frieze and cornice are still straight the trunk door is now shaped. In type C the

N ^o	signature of clockmaker & place	Date	Case type	Burr veneer species		The approximate dating of the cases is based on stylistic characteristics and literature. The letter code of 'Case type' refers to fig. 9. Burr maple (<i>Acer</i> sp.), poplar (<i>Populus</i> sp.) and elm were identified on the clock cases. ⁶² Transmitted light microscopy needed to be used to differentiate between the first two species, since the staining further obscured the quite similar macroscopic characteristics already altered by the abnormalities of burr growth. P = photographic recognition. Identification of wood species was not possible, as the actual clock case was not closely inspected or sampled. N = identification or recognition by naked eye. No distinction is made between stained maple, poplar, alder, birch or linden; the stained and finished burr variety can be practically impossible to distinguish without magnification. Woods like elm, mulberry, thuya, and amboina can be identified much more easily. M = microscopic identification. Usually a wood sample the size of one-third of a matchstick suffices. This is then cut in radial, tangential and axial thin sections. Permission to perform this type of destructive analysis was not always obtained. ? = uncertain.
				Unknown	Known	
1	None ²⁶	c. 1725	D		<i>Tilia</i> sp.? (M)	
2	None ²⁷	c. 1725	D		<i>Acer</i> sp. (M)	
3	J. Basmoine, The Hague ²⁸	1700–1750	E	P		
4	G. Bramer, Amsterdam ²⁹	c. 1745	E, G		<i>Acer</i> sp. (M)	
5	W. Bramer, Campen ³⁰	c. 1705	A	P		
6	I. van Brussel, Amsterdam ³¹	c. 1725	F		<i>Acer</i> sp. (M)	
7	C. du Chesne, London ³²	c. 1705	A	P		
8	Clarke & Dunster, Amsterdam ³³	c. 1730	G		<i>Acer</i> sp. (M)	
9	R. Dunster, Amsterdam ³⁴	c. 1720	E, G	N		
10	Id. ³⁵	c. 1730	C, E	N		
11	Id. ³⁶	c. 1735	G	P		
12	Dupuis, London? ³⁷	c. 1730	E	N		
13	P. Egter, Dordrecht ³⁸	c. 1730	D	P		
14	Fromanteel, Amsterdam ³⁹	c. 1690	A	N		
15	Fromanteel & Clarke ⁴⁰	c. 1715	B		<i>Populus</i> sp. (M)	
16	Id. ⁴¹	c. 1720	-		<i>Populus</i> sp. (M)	
17	Fromanteel & Clarke, Amsterdam ⁴²	c. 1715	B	P		
18	Id. ⁴³	c. 1715	B		<i>Acer</i> sp. (M)	
19	W. Gib, Rotterdam ⁴⁴	c. 1725	D	N		
20	Id. ⁴⁵	c. 1725	C, D	P		
21	Id. ⁴⁶	c. 1725	D	P		
22	Id. ⁴⁷	c. 1740	-	P		
23	I. Hasius, Haarlem ⁴⁸	c. 1705	A	P		
24	J. Hasius, Amsterdam ⁴⁹	c. 1730	C	N		
25	S. Hoogendijk, Rotterdam ⁵⁰	c. 1730	E, F	N		
26	Id. ⁵¹	c. 1730	F	P		
27	Id. ⁵²	c. 1730	E, F	P		
28	S. Huygens, Amsterdam ⁵³	c. 1705	A	N		
29	P.J. de Vries, Oost-Zaandijk ⁵⁴	1700–1725		P		
30	P. Klock, Amsterdam? ⁵⁵	c. 1719	D	P		
31	P. Klok, Amsterdam (?) ⁵⁶	1700–1725	C		Elm (N)	
32	Id. ⁵⁷	c. 1730	D, E	P		
33	W. Stampioen, Rotterdam ⁵⁸	c. 1695	A	P		
34	P. Tielekinck, Amsterdam ⁵⁹	1700–1725	D	P		
35	B. Thijmen, Gouda ⁶⁰	c. 1730	D?	P		
36	J. ter Veen, Haarlem ⁶¹	c. 1715	F		<i>Acer</i> sp. (M)	

frieze and cornice adopt an arched shape and the caddy is taller. Type D is a more austere version of C with less stringing. Type E introduces the bombe-shaped base and a very decorative caddy. Type F shows chamfered or canted corners along base and trunk and a reverse ogee-shaped caddy. Type G is the final development, with its strongly protruding corners and a scrolled pediment, which is repeated in the shaped trunk door. Finials, feet and lenticle mounts are omitted from this comparison, as changes in fashion and normal wear-and-tear make them subject to frequent renewal.

The following selection lists all cases found in alphabetical order of clockmaker's name: those which were sampled; those inspected but not sampled; and those cases that were illustrated in literature. The results in this table suggest that in the period between 1715–30 this

decorative technique was popular with some well-known clock makers/dealers, from Amsterdam (Fromanteel, Clarke, Dunster and Klo(c)k) and from Rotterdam (Hoogendijk and Gib). These were all active, well-known businesses, which produced clocks for the top end of the market.

Each maker/dealer tended to often use a single type of case, for example (from table 1 and figure 9): Fromanteel & Clarke, type B; Gib, type D; and Hoogendijk, types E and F. On the other hand, certain types of case appear from several makers/dealers. This suggests that clockmaker and casemaker were independent, and that different casemakers were producing the same popular case types. Maple burr appears to have been the most popular choice for the partial staining technique.⁶³

6 Scientific investigations

• Sampling

The eight clock cases of which sample material could be obtained were analysed by Scanning Electron Microscopy-Energy Dispersive X-ray Spectrometry (SEM-EDS) to determine the element composition, and High Performance Liquid Chromatography (HPLC) for the analysis of organic colorants and ellagic acid, which is a degradation product of tannins. For stain identification, dark stained sections of the veneer on relatively inconspicuous locations on eight clock cases were selected. Samples were taken that would show an undisturbed historic build-up of stain and finish layers without compromising the integrity of the object. Removed sample-material commonly had the full veneer thickness of 1–2 mm. The sample material was then divided and prepared for SEM-EDS and reflected light microscopy and for HPLC-PDA. The selected cases are listed in table 2.

• Organic colorant and tannin analysis

Organic colorants and tannin analysis was performed with High Performance Liquid Chromatography coupled to Photo Diode Array detection (HPLC-PDA) according to ICN standard operation procedure (SOP) no. 36⁶⁴, which was derived from Wouters and Rosario-Chiniros.⁶⁵ Organic compounds were identified by comparison of the UV-VIS spectra and retention time with (known) reference material, which data was stored in an HPLC-library. At the ICN, spectra of reference material are available of most common natural colorants. Unfortunately, identification is not always possible, due to low concentration in the sample or lack of reference material. However, from the UV-VIS spectra the colour of the unknown compound can be deduced unless the unknown compound is a degradation product, which has undergone a change of colour.

7 Results and discussion

The results of the SEM-EDS and HPLC-PDA analysis of the clock case samples are given in table 2. The results of the SEM-EDS line scans of the historic samples will be discussed in section 8.

The staining of wood results in a penetration of inorganic elements and colorants into the wood rather than a layer on top of the wood, which is the case when, for example, a paint layer is applied. During the sampling

All SEM-EDS analyses were done on embedded cross-sections, with the exception of samples 15-1, 2 and 3, when analysis was performed directly on the surface.				
No*	Signature	Date	SEM-EDS result	HPLC result
—	Untreated poplar burr (as a control)	2001	Sodium	No response
—	Untreated maple burr (as a control)	2001	No response	Ellagic acid
2_1	None	c. 1725	Sulphur Calcium	Ellagic acid Unknown flavonoid Crocein orange Unknown red compound
4_1	G. Bramer Amsterdam	c. 1745	Sulphur, Calcium, Chloride, Iron	No response
6_1	I. van Brussel Amsterdam	c. 1725	Silicon Potassium	No response
6_2	Id.		Sodium	No response
6_3	Id.		Sodium	Trace of ellagic acid
8_1	Clarke & Dunster	c. 1730	Sulphur, Calcium, Iron, Silicon, Chloride	No response
8_2	Id.	c. 1730	Sulphur, Calcium, Iron, Silicon Chloride	Trace of ellagic acid
15_1	Fromanteel & Clarke	c. 1715	Sulphur, Calcium, Iron, Silicon, Sodium, Potassium, Chloride	No response
15_2	Id.		Sulphur, Calcium, Iron, Silicon, Sodium, Potassium, Chloride	No respons
15_3	Id.		Sulphur, Calcium Iron, Silicon Sodium, Potassium Chloride	No response
15_4	Id.		Sulphur, Calcium Iron	Not Analysed
16_1	Fromanteel & Clarke.	c. 1720	Sodium	Ellagic acid Rhamnetin, 3 unknown flavonoids 2 unknown red compounds, proba- bly synthetic 3 unknown blue- purple compounds, probably synthetic.
16_2	Id.	c. 1720	Sulphur, Calcium, Iron, Potassium	Unknown flavonoid
18_1	Fromanteel & Clarke.	c. 1715	Sulphur, Calcium, Iron, Chloride	Unknown flavonoid Unknown orange compound
36_1	J. ter Veen Haarlem	c. 1715	Sulphur, Calcium Iron, Potassium	No response

* The first digit relates to clock case numbers in table 1 and the second digit to the sample number.

of the stains, wood is sampled as well. In order to evaluate the influence of the natural colorants and the ash content of the wood, burr wood controls, i.e. unstained samples of maple and poplar, were analysed. With the exception of a trace of sodium in poplar, no significant amounts of inorganic elements were found in the controls. The inorganic elements found in stained samples could therefore be attributed to sanding with pumice powder (aluminium, silicon and sodium) and staining.

With the use of HPLC-PDA, several organic compounds were found in the controls, absorbing in the UV range.⁶⁶ These compounds therefore occur naturally in the wood. The same components were often found in the stained samples, but since they probably originate from the wood they are not listed in the table. The presence of ellagic acid, however, is slightly more complicated as it can originate from both the natural wood and from an iron-gallic stain. Only a relatively large amount of it, in proportion to the size of the sample, could make identification as a stain component possible.

Iron-gallic colorants were previously analysed in the stained burr veneer on late seventeenth century Dutch cabinets.⁶⁷ In six clock cases out of eight analysed in this study, traces of iron were found with SEM-EDS, usually in combination with other elements, such as sulphur, calcium and potassium. Although in several samples ellagic acid was found, in only one the combination of iron and ellagic acid was found, indicating the presence of an iron-gallic colorant. If iron was detected but the amount of ellagic acid is below the detection limit, it is still possible that an iron-gallic colorant was used.

• Sulphur, calcium, potassium & other elements

Sulphur and calcium were found in all samples except the controls and in samples from clock case 6 and sample 16_1. The presence of sulphur in the samples might be connected with the eighteenth century production process of nitric acid in the Netherlands. The so-called 'Dutch method' to make aqua fortis or nitric acid used saltpetre, $K(NO_3)$ which was caused to react with iron sulphate. This produced a strong acid, but if the proportions of the reacting substances or the reaction temperature were not right, the resulting nitric acid could be heavily contaminated with vitriol oil. The simplified reaction is:

Saltpetre + iron vitriol+ water \rightarrow aqua fortis + red ferric oxide +
vitriolised tartaric acid



The presence of sulphur, potassium and iron could be explained by this procedure, and that of calcium by the neutralisation with chalk water, as mentioned in the Simis recipe.⁶⁹ Sodium might be present in pumice powder, whereas chloride is quite often observed to be a general contaminant.⁷⁰

• Other organic colorants

In addition to ellagic acid, several other organic colorants were found indicating other treatments than staining with iron-gallic complexes alone. These results will be discussed shortly. In one sample, 16_1, signed Fromanteel & Clarke, rhamnetin, a flavonoid, and several other unknown flavonoids were found in addition to ellagic acid. Rhamnetin indicates the use of Buckthorn or Persian berries (*Rhamnus species*). The other flavonoids could be side products or degradation products from these colorants. There are several *Rhamnus* species with rhamnetin as main compound; however, based on this result, it is not possible to determine which species was used. In three other samples, i.e. 2_1, 16_2 and 18_1, unknown flavonoids were detected. The response was very low and identification was therefore not possible. Flavonoids can be used to dye yellow if aluminium is used as mordant. When iron is used, a darker brown colour is obtained.⁷¹ So far, no mention of the use of flavonoids to stain wood brown or black has been found in historical recipes.

In addition to the flavonoids, two unknown red and three unknown blue compounds were found in the same sample in which rhamnetin was found. The unknown red and blue-purple compounds are presumably synthetic; they were therefore applied after 1850 and are not original.

Another synthetic colorant was found in sample 2_1 from an unsigned clock case. This colorant was identified as crocein orange G (C.I. name: acid orange G, C.I. number 15970) a dye which was discovered by P. Griess in 1878. Due to the dating of the object, around 1720, it can be concluded that this is not an original staining. In the same clock case, an unknown red compound was found, presumably from a natural source. Identification of this red component was not possible due to the low concentration.

8 Reconstructions

The results described above were not conclusive. Although in several samples iron was found and in other samples ellagic acid, the combination of the two was only found in sample 8_2, a clock case from Clarke & Dunster. Only in this sample was the use of an iron-gallic colorant positively identified. However, iron was found in five other cases, and previous research had indicated the presence of iron-gallic colorants in two occasions.⁷² Based on this research and on literature — as summarized in paragraph 4 —, historic staining recipes were formulated. Reconstructions were then made in order to view the effects the recipes produced, to compare the chemical fingerprint of the replica with that of the historical original and to study the influence of the wood structure on stain penetration.

• Recipe

The following recipe formulation gave recognisable results, both visually and instrumentally; a pre-stain of 2–4 % w/w tannin solution in water or strong vinegar (10% acetic acid) is applied to the wood and left to dry for half a day. The iron nitrate-iron sulphate solution of 2–4% (w/w) iron in 6–15% (v/v) nitric acid and sulphuric acid (3:1) is then applied, giving an immediate colour shift from light brown to blue-black. The acidic stain is neutralised with a wash of chalk milk, a saturated solution of calcium hydroxide. The wood is then scraped and sanded to partially remove the stain and enhance the colour contrasts. A finish of oil and varnish improves the saturation of the colours. Figure 10 shows the effect of the recipe, with slight variations in the materials. This can be compared to the historic veneer surface shown in figure 11.

• Reconstructions

Reconstructions were made for different purposes. The first were sample boards with burr veneers, stained to show the visual effect of the recipes (fig. 10) and to determine the similarity of the chemical make-up of the replica to the historic original with SEM-EDS and HPLC-PDA. The second type, intended to ascertain the influence of the wood structure on stain penetration, were carefully cut sample blocks of 1 cm³ of regular growth and with their grain directions taken parallel to the faces of the blocks that were immersed for 1 minute in various pre-stain solutions, followed by treatment of 2% iron nitrate. In fig. 12, a schematic representation is given of such a block, with the magnified structural elements of maple. The axial- (A) and lateral staining

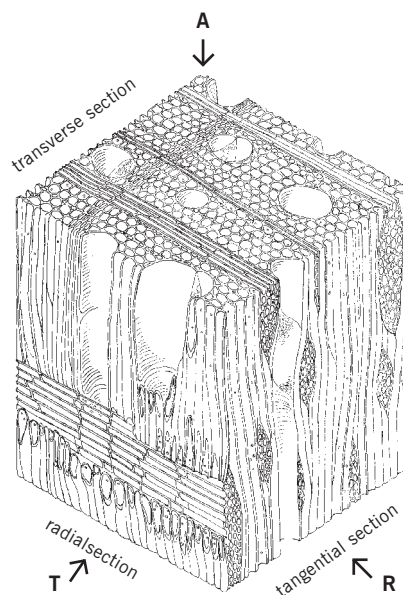


fig.12 Schematic three-dimensional representation of magnified cube of maple. The three relevant sectioning planes of wood (transverse, radial, tangential) are depicted parallel to the faces of the cube. The stain penetration directions are coded A, R and T.

directions (T, R) are indicated. Stain penetration was measured perpendicular to the surfaces. As the radial and tangential planes are oriented at right angles to each other, the direction of penetration of stain applied on a radial surface is coded 'T' and on a tangential surface 'R' respectively, see table 3.

• Analytical results

Transverse, radial and tangential sections of these reconstructions were prepared and analysed with SEM-EDS and HPLC-PDA according to the procedures described previously. The distribution of the chemical elements over the cross-sections is visualised by element maps, see figure 13. Iron is concentrated at the uppermost layer of the wood.

It appears that the iron enrichment is present only in the uppermost layer of the wood. The penetration depth of the staining material is then measured by line scans. The diameter of the beam was around 1 µm and the step size varies from 5 to 10 µm; the counting time per point 5 seconds. First, line scans of cross-sections of untreated wood, both poplar and maple, were made, to serve as a background measurement. Next, the penetration depth of the stain in the cross-sections of the reconstructions was measured with the SEM and compared with observations by naked eye and a light microscope. In a number of ways the staining procedure, structural elements

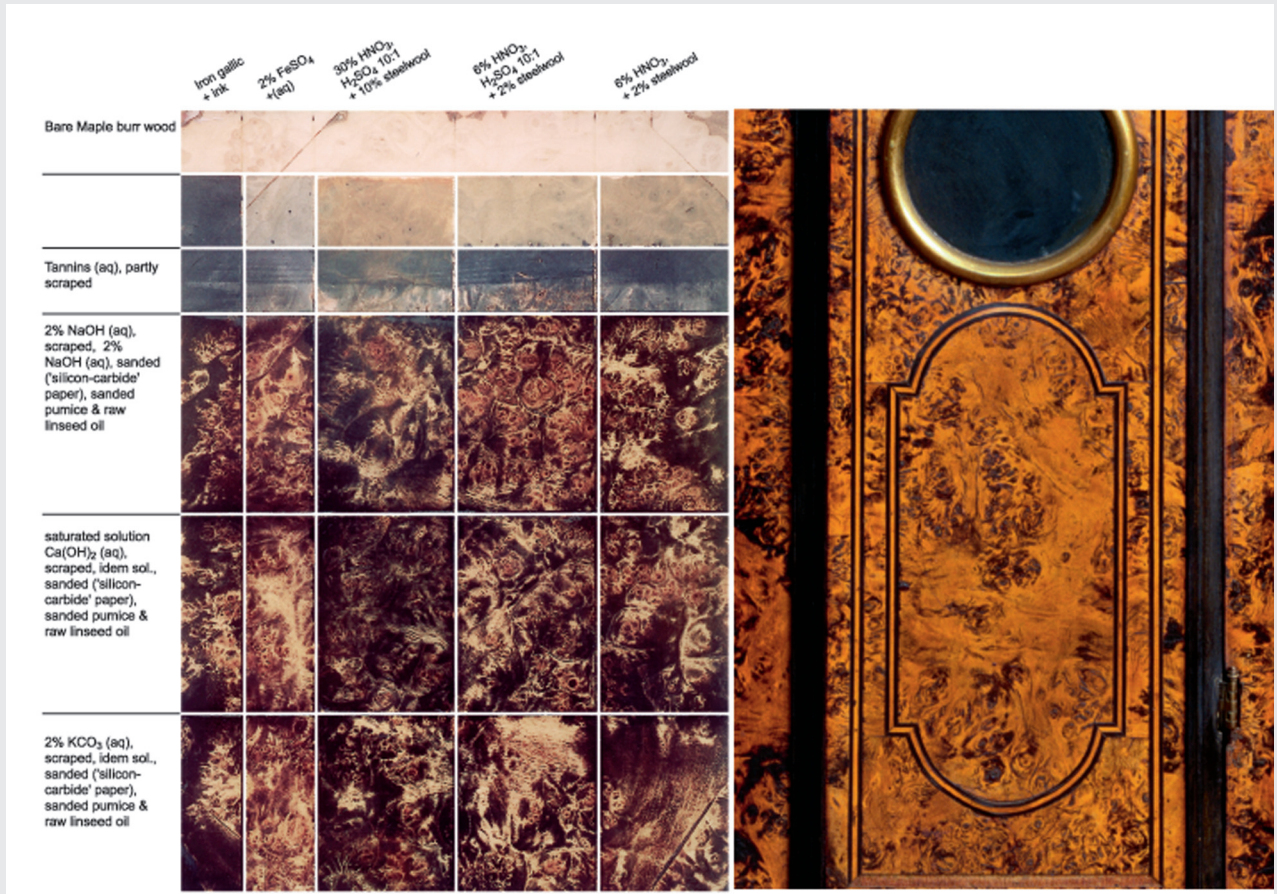


fig.10 A maple burr veneered sample board with different stages of the staining process and varied stain solutions.
fig.11 A detail of historic stained and varnished burr veneer from the clock shown in fig. 1 (no. 15, table 1).

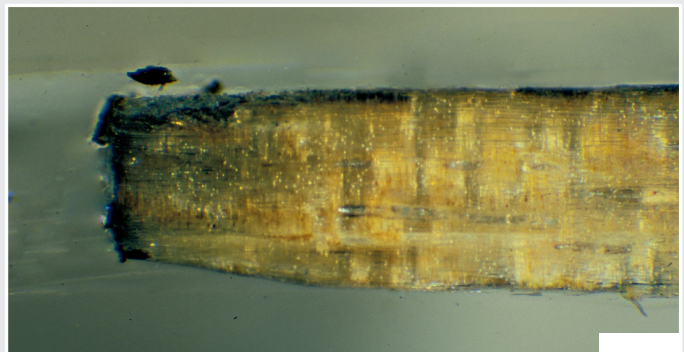


fig.17 Radial section of maple stained with vinegar, alum, tannin and iron nitrate on the end grain (left) and the tangential side (top), reflected light. White bar stands for 0.5 mm.

Table 3		Penetration depth (μm)					
		Transverse			Tangential		Radial
Sections		R	T	A	T	A	R
Staining direction		R	T	A	T	A	R
Species	treatment	Ray					
Poplar	untreated	Nd	nd	-	-	-	-
Poplar	iron nitrate	80	120	60	-	-	-
Poplar	acetic acid	110	-	75	-	-	-
Poplar	iron nitrate						
Poplar	acetic acid alum, tannins iron nitrate	120	290	80	-	-	1300
Maple	untreated	-	-	-	-	nd	-
Maple	iron nitrate	-	-	-	110	-	-
Maple	acetic acid iron nitrate	30	100	100	-	-	-
Maple	tannins iron nitrate	-	-	90	-	-	-
Maple	acetic acid alum, tannins iron nitrate	-	-	-	400	90	-
Maple	tannins iron sulphate	110	145	-	-	180	-

Table 3: Penetration depths measured by line scans at 20 kV and a counting time of 5 seconds. The sections: Transverse, in cross-section to the axial alignment of cells; Tangential, at a tangent to growth increments; Radial, radial plane from pith to bark. The two lateral directions of stain penetration: r, radial (Ray: measured over a ray); and t, tangential. The axial stain penetration is coded a. Nd: not detected - : not analysed.

of the wood and the shape of the line scans proved to be correlated.

The shape of the line scans can be described as follows:

- 1) A high iron peak at the surface of the wood if no vessels or rays are encountered (fig.14).
- 2) A gradual decrease of iron content after the first high peak if the measurement is done over a ray (fig.15).
- 3) After the high iron peak at the surface, more peaks may occur deeper into the wood in the proximity of a vessel (fig. 16).

The profiles of the line scans show that the staining matter is transported inside the wood by rays and vessels. The results of the measurements of the penetration depths are given in table 3.

The type of staining material used clearly influences the penetration depth. The combination of iron nitrate, acetic acid, tannin and alum penetrates furthest. The various pre-treatments create a chemically more homogeneous environment for the iron nitrate to react with.⁷³

Vessels and ray parenchyma cells can act as a means to transport the stain further into the wood. The vessels probably function by capillary action, while the thin walled, well-pitted parenchyma cells might be easier to penetrate than the xylem.

Since vessels are axially arranged, the penetration can be four times deeper when the stain is applied to the end-grain. The higher stain penetration rate of the poplar compared to the maple samples might be explained by a higher number of vessels per mm, and the lower wood density of poplar.

The penetration depth analysed by SEM is similar to that measured by naked eye and microscope, as shown in fig. 17.

The line scans and HPLC-PDA analysis of the reconstructions show that if stained veneer that hasn't been cut back by scraping and sanding is analysed, iron and ellagic acid are readily identified.

The iron profile of the line scans of the historic samples, however, differs from that of the reconstructions.

Although staining is clearly visible with the naked eye, the scan does not show the typical iron peak at the surface of the wood, even if the counting time per point is raised to 60 seconds to collect more signals (fig. 18). The minor iron peak visible below the surface of the wood is probably caused by the presence of a vessel.

It is probable that the iron content of the sample is mainly below the detection limit of the EDS system, i.e. 0.1 weight percentage. Only when a line scan is made over a ray is the typical profile of gradual decreasing iron content visible (fig. 19).

Study of the reconstructions made it possible to interpret the element distribution maps of a cross section of a Fromanteel & Clarke clock case (no. 15 of table 1). The maps clearly show an elevated iron content at the surface of the wood; in addition, iron is also concentrated along the rays and around the vessels (fig. 20).

The dramatic decrease of staining matter is probably caused by the finishing, i.e. scraping and/or sanding of the stained surface, as the line scans of the reconstructions show that the stain is mainly concentrated in the uppermost layer of the wood or on the surface. Consequently, samples from historic surfaces, which almost invariably have been through several finishing treatments, will show only minimal amounts of staining matter. Even these small amounts can produce a vis-

Table 4 ANALYTICAL TECHNIQUES	
Microscopy and SEM-EDS	
The samples were embedded in polyester casting resin (Polypol) and made into cross-sections. The samples were then polished on silicon-carbide paper and studied using reflected light microscopy and Energy Dispersive X-ray Spectrometry (EDS, Thermo Noran Vantage) in a JEOL 5910LV Scanning Electron Microscope (SEM). To prevent charging of the sample surface, the cross-sections were coated with carbon. The analyses were done in high vacuum at 20kV. The detection limit of the system at these operating conditions for iron is typically around 0.1 weight percentage. SEM-EDS was performed in three different modes, spot analyses (5 μm), line scans and element distribution maps.	
HPLC-PDA analysis	
Prior to HPLC-PDA analysis, the sample was hydrolysed by addition of 100 μl reagent (water/methanol/hydrochloric acid, 1/1/2) to the sample in a 250 μl small insert vial. The vial was heated for 10 minutes in a water bath at 100 °C to extract and dissolve the colorants. After the hydrolysis, the sample was evaporated to dryness and dissolved in 20 μl dimethyl formamide. Next, the samples were centrifuged for 2 minutes at 2000 rpm to remove precipitation. The sample was analysed by HPLC-PDA by injection of 10 μl sample. Separation of the organic components was done on a Phenomenex luna C18-2, 3 μm (100 x 2 mm) column with a water : methanol : phosphoric acid gradient. The gradient profile is given in table 5.	

Table 5	GRADIENT PROFILE						
	Start	15 min	20 min	23 min	27 min	30 min	45 min
% A methanol: water (10:90, v/v)	74	0	0	0	0	74	74
% B methanol	16	90	90	100	100	16	16
% C 5% w/v phosphoric acid in water	10	10	10	0	0	0	10
Detection was done with a Waters 996 PDA detector, scanning from 200 to 700 nm at a scan rate of 1 scan a second.							

ible effect; it seems that the amount of staining needed to obtain a visible effect may be lower than can be detected by the techniques used.

To examine this hypothesis, the minimum amount of staining material needed to affect the colour of the wood was determined experimentally by using staining solutions of low concentration. It appeared that, when pre-staining with a 1% tannin solution, a stain of 1% iron in 3% nitric acid still gave a black coloration. More dilution gave grey colorations, and only at 0,01% iron concentration was the tinting too pale to be visible to the naked eye. Considering that a 2% iron nitrate stain on veneer that was later scraped and sanded could be difficult to detect, a 1% concentration would probably result in amounts of iron well below the detection limit of SEM-EDS.

9 Conclusion

The present research leads to new suggestions about the staining techniques involved and materials used. From the collected material a trend in decoration techniques in a small group of early eighteenth century Dutch clock cases can be perceived as consistent with earlier findings on seventeenth century Dutch cabinets. Predominantly light coloured indigenous burr woods were used to produce veneers, which were frequently stained with iron nitrate solutions. These gave, in combination with a tannic acid pre-treatment and calcium hydroxide after-treatment, a black coloration that was partly sanded back to get the typical mottled effect. Absorption of the stain by the wood was limited. It usually resulted in a concentration gradient with higher concentrations near the wood surface and lower concentrations deeper within the wood. Consequently, sanding the wood would substantially diminish the stain concentration.

Examination of staining reconstructions by SEM and the optical microscope led to the conclusion that the penetration depth is affected by the pre-treatment on a micro-scale of 0.01 mm. The use of acetic acid results in a deeper penetration of the iron. Interestingly, the combination of several consecutive treatments such as acetic acid, alum and tannins increases the penetration even further.

By comparing clock case samples, reconstructions before and after finishing, and visual examination of sample boards treated with different staining concentrations, it can be concluded that the amount of iron-gallic colorant needed for a visual effect can be lower than the detection limits of HPLC-PDA and SEM-EDS. However, in absence of traces of log wood or other black stains or pigments, minute traces of iron and ellagic acid can be indicative of iron-gallic stains. The marked presence of sulphur and calcium is often observed, as these were probably part of the staining treatment.

Since most stain is absorbed by axially arranged vessels, samples should preferably be taken from end-grain areas in the wood.

The iron-gallic staining technique on burr wood seems to have been used for almost half a century in several workshops in Amsterdam and Rotterdam. To attribute this technique to particular clockworks or casemakers, further studies will be needed, considering staining techniques alongside the construction methods of cases, their dimensions and their decoration.

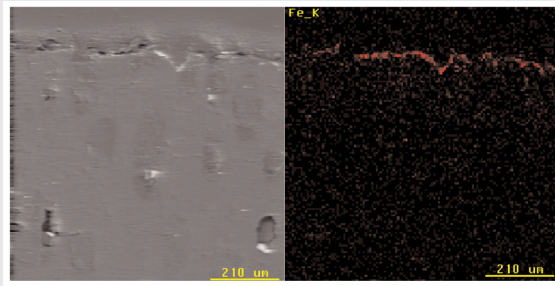


fig. 13 BE image and element map at 20 kV showing the distribution of iron in Poplar wood treated with acetic acid, alum, tannin and iron nitrate.

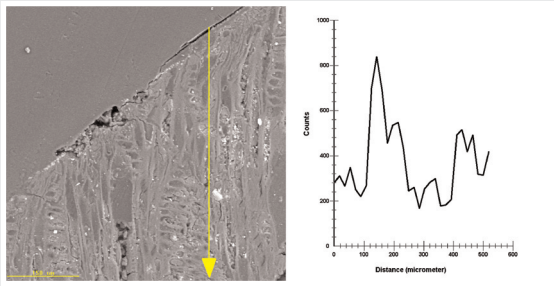


fig. 18 BE image and line scan at 20 kV with a counting time of 60 seconds per point over a sample of clock case (no. 36 of table 1).

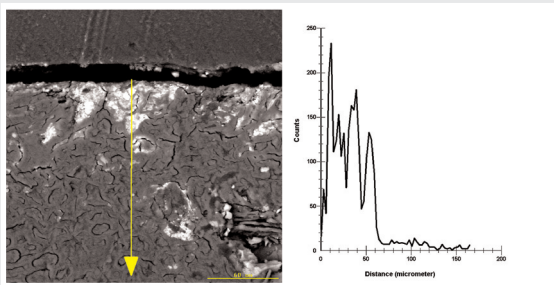
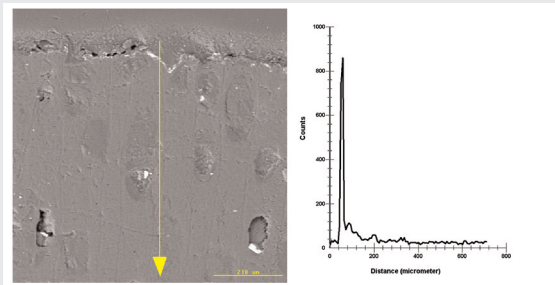


fig. 19 BE image and line scan at 20 kV with a counting time of 60 seconds per point over clock case (no. 16 of table 1).

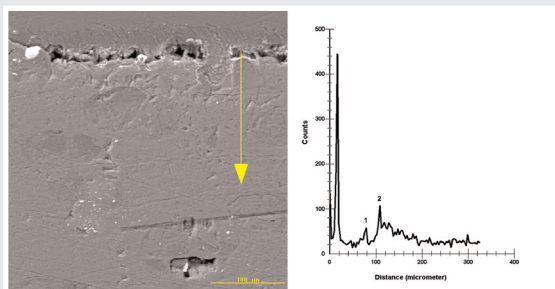
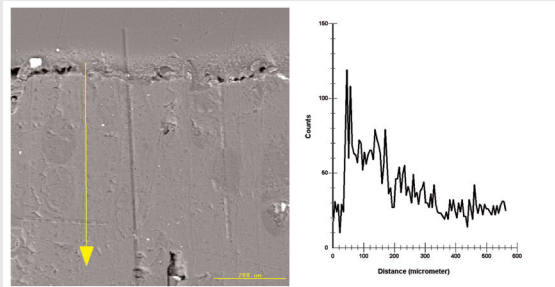


fig. 14, 15 and 16 Backscattered Electron Images (BEI) and line scans at 20kV with a counting time of 5 seconds per point of a Poplar sample treated with acetic acid, alum, tannin and iron nitrate. The arrow indicates the trace of the electron beam. The shape of the iron profile is influenced by the presence of rays (15) and vessels (16: points 1 and 2) in the wood.

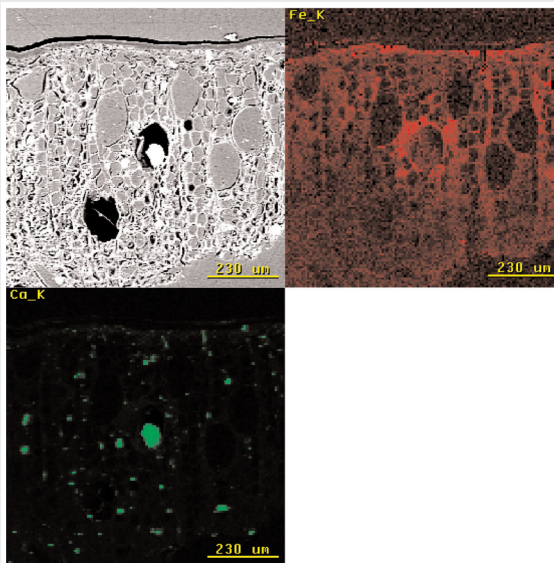


fig. 20 BE image and element distribution map at 20 kV (no.15 of table 1).

Acknowledgements

Many thanks are due to the colleagues, restorers, private owners and dealers who allowed clock cases to be researched, sampled and photographed, and without whose help this project would not have been possible.

Notes

1 J. Zeeman, *De Nederlandse staande klok*, (Zwolle, 1996), 158. This author mentions the decorative technique while describing a clock by J. ter Veen, though misidentifies the maple veneer of this clock as elm (compare table 1). He names a few other Dutch makers who have also used this type of case — P. Klock, Fromanteel & Clarke, and J. Hasius — and assumes it is a type of decoration exclusively used in Amsterdam between 1710–20.

2 J. Boonstra, 'Stained burl veneer on 17th-century Dutch cabinets', in: *Dutch Furniture of the Seventeenth Century*, P. van Duin ed., (Amsterdam, 1994), 11–26.

3 A. Bowett, L. Lindey, 'Labelled furniture from the White Swan workshop in St Paul's Churchyard (1711–35)', *Furniture History*, XXXIX (2003), 71–98; P.G. Dawson et al., *Early English Clocks*, (Woodbridge, 1982), 274, 288. Here the veneer on an early English case for a clock by C. Gould (c. 1695–1700) is identified as pigmented maple burl. Several other English cases for clocks by Tompion show the same technique.

4 Dark coloured alder burl veneer of the Havezate Mensinge cabinet was analysed by C.-H. Fischer (Hahn-Meitner Institute Berlin); see M. Baumeister, J. Boonstra, R.A. Blanchette, C.-H. Fischer, D. Schorsch, 'Stained Burl Veneer on Historic Furniture', in: *Lacke des Barock und Rokoko/Baroque and Rococo Lacquers*, K. Walch, J. Koller eds., (München, 1997), 251–296. A burl maple marquetry veneer of a cabinet by van Santwijck from the Rijksmuseum Amsterdam (inv. no. RBK 1954-5) was analysed by M. van Bommel (ICN Amsterdam); report no. 2001/188, object no. 2862 (unpublished). A burl wood surface veneer on drawer fronts of a cabinet by J. Meijer, 1743, from the Gemeentemuseum, The Hague, (inv. no. OH 1–1924), was analysed in 1994 by M. Wypyski, Metropolitan Museum, New York

(unpublished).

5 C. Spierdijk, *Klokken en Klokkenmakers, zes eeuwen uurwerk 1300–1900*, (Amsterdam, 1967), 100–107.

6 A balanced look was often achieved by using two consecutive leaves of veneer opposite one another. Most clock cases show 'butt-jointed' or straight edges between the leaves. Some show an attempt to create a 'seamless' background by using a wavy joint to blend in with the swirling pattern of the burl.

7 Spierdijk 1967, 232. R. Baarsen, *De Amsterdamse Meubelloterijen en de geschiedenis van de meubelmakerij in de tweede helft van de achttiende eeuw*, (Zwolle, 1992), 20, 27–28, 51.

8 R. Baarsen, W. Keijser-Schuurman, 'The Furniture Drawings of Matthias Soiron', *Furniture History*, 36 (2000), 144, 149, 232–235.

9 M.G.A. Schipper — van Lottum, *Advertenties en Berichten in de Amsterdamse Courant etc.*, (Groningen, 2001), 663r: 22 juni, 1715 Paulus Bramer Mr Horlogiemaker, maakt en verkoopt alderh. srt. v. groote en kleine Horlogien, en staende Kassen, Maendwerken, Jaerwerken [...] etc.'

10 Spierdijk 1967, 208.

11 H. Noordkerk, *Handvesten [...] van Amsterdam*, (Amsterdam, 1748), vijfde deel, 1303. A ruling of the guild from 1741.

12 D.F. Cutler et al., *Root Identification Manual of Trees and Shrubs, a Guide to the anatomy of roots of trees and shrubs hardy in Britain and Northern Europe*, (London, 1987), 3. H. Gottwald, 'Maserwuchs — eine pittoreske Laune der Natur', *Holz Aktuell*, 4, (1983), 4–27. F.W. Jane et al., *The structure of wood*, (London, 1970), 82, 198, 199, 256.

13 See, for example, E.H. Pinto, 'The myth of the Mulberry Burr Veneer', *Country Life*, (October 2, 1969), 794–795. P.G. Dawson, C.B. Drover, D.W. Parkes, *Early English Clocks, A discussion of domestic clocks up to the beginning of the eighteenth century*, (Woodbridge, 1982), 274, 288. A. Bowett, 'Myths of English Furniture History: Mulberry Wood Furniture by Coxed and Woster', *Antique Collecting*, (1996–8?), 33–35.

14 R. Gale, 'Wood veneers and their identification', D. Catling et al., *Identification of Wood* (Course Handbook), (London, 1990), 38–41.

15 For this project was used E.A. Wheeler's *Computer-Aided Wood Identification*, North Carolina Agricultural Research Service Bulletin 474, (Raleigh, North Carolina, 1986). The results were checked against reference samples and reviewed by D. van Loosdrecht, senior furniture conservator at the Rijksmuseum Amsterdam.

16 Baumeister et al. 1997, 288.

17 J. Stalker & G. Parker, *A treatise of japanning and varnishing*, reprint of 1688 edition, (London, 1971), 82.

18 J.M. Cröker, *Der wohl anstehende Mahler*, (Jena, 1778), 470.

19 Baumeister et al. 1997, 274–280.

20 Baumeister et al. 1997, 280–282.

21 J. van Veen, manuscript, 'Enighe dingen nootsaekelijck voor de ijvoir draaijers, ende diergelijcke', in *De wetenschap en de manieren om alderhande couleuren van sij of sijjetten te verwen etc.*, (1650?), 281–2. 'Men moet voor eerst prepareren het hout daamen wilt swart verwen, dat het wel effen ende glat is om de swarte verwe op te leggen, daer naer salmen 't selve geprepareerde hout wasschen ende vrijven met galwaeter, [...] ofte segondewaeter (?) ofte hetwelck men vindt tot de goutsmits [...] and 'Om nu de swarte verwe te maecten tot dit schijn ebbenhout, soo neemtmen een pont vernis arde sol (?) ende dry pinten goeden wijnsijn, een pont stoff van ijsjer, . oncen galnooten, een once gomme van Arabien, wat gestooten groen Coperrroot ofte vitriool de Cipre; [...] Copy gratefully received from A. Stijnman, ICN, Art Technological Source Research (ATSR). Royal Library The Hague; KB, Ms. 135 K 44.

22 Anonymus, 'Om HOUTEN te verwen' *Oeconomische Courant ter bevordering van nationale huishoudkunde, etc.*, 61 (1 april 1801), 278: 'Alle Houten die gevervd zullen worden, moeten vooraf daartoe vóórbeid worden, door dezelve in scherp Azyn, of Aluinwater, te leggen; echter dringt de verw, wegens hun sterk weefzel nooit diep in. Hier tegen laet zich het hout, na dat men het vooraf warm gemaakt heeft, met Sterkwater, dat noch in zichzelf te sterk zyn, noch te nat opgelegd moet worden, schoon geel en bruin verwen, [...] kooft men het eerst met blaauw-houmar, waarin men wat Aluin gedaan heeft, bestrykt het dan 3 of

4 maal na elkander met warmen Azyn, of zuur Bier, waarin men Galnooten gekookt heeft, en laetstelyk nog 3 of 4 maal met eene oplossing van Yzer, dan krygt het inzonderheid enig rood hout, als by voorbeeld van den Palm-, Boeken-, Appel- en Peerenboom, eene zwarte kleur, en als men naderhand het wryven met een met wit Wasch bestreken Leder, of met Lyn-oly en Koolenstof, te baat neemt, een glans als het schoonste Ebbenhout[...].'

23 I. Simis, *Grondig Onderwys in de Schilder- en Verw-kunst etc.*, (Amsterdam, 1801), 100: 'Aqua fortis, of, sterk water. Dit dient voornaamlyk in de verwkunst: ook wordt het gebruikt ter kleuring van eenige fyne houten voor Kastemaakers-werk, en dergelyken [...].'

24 Simis 1801, 346: 'Om harde, lichtgekleurde, gedraaide of gesneden houtwerken, 't zy van castanje, mispel, kerse-, pruime- of peere-boomen, taxes- of noote-boomen-hout, enz. donkerbruin te kleuren. Leg eenig rood koper in sterk water en bestryk daarmee het geen gy kleuren wilt: houdt het een weinig over 't vuur, en leg het, droog zynde, een nacht in kalk of kalkwater, waarna het wel bruin zal weezen: wasch het af, en wryf er een weinig gekookte lyn-oly over, of lakt het naar goedvinden.'

25 The restoration was performed by M. Bierenbroodspot of Hoving & Klusener, Amsterdam.

26 Collection Rijksmuseum Amsterdam. Inv. no. RBK 1961–16.

27 Private ownership.

28 J. Zeeman 1996, 212, Ill. no. 27a.

29 Collection Gemeente Museum Maassluis. Inv. no. 3185.

30 Zeeman 1996, 354.

31 Collection Museum Simon van Gijn, Dordrecht. Inv. no. 3.145.

32 D. Roberts, *British Longcase Clocks*, (West Chester, 1990), 37.

33 Zeeman 1996, 79, Ill. 65d.

34 Collection Victoria & Albert Museum, London. Inv. no. Circ. 197–1955.

35 Private ownership.

36 J. Zeeman, *De Nederlandse staande klok*, (Zwolle, 1996), 130.

37 Anonymus, *Furniture, Clocks, Sculpture and Works of Art*, [sales cat. Christie's], (Amsterdam, 20 December 1995), 28–29, no. 172. The clock is described as London made, the case is very Dutch in appearance.

- 38 C. Gilbert, *Furniture at Temple Newsham*, vol. 2, (Bradford, 1978), 425-6.
- 39 Anonymous, *Clocks, Watches and Wristwatches*, [sales cat. Sotheby's], (Amsterdam, 20 May 2003), 86, no. 201.
- 40 Private ownership.
- 41 Private ownership.
- 42 Zeeman 1996, 65, Ill. 44c.
- 43 Private ownership.
- 44 Anonymous, *Selected Furniture, Important Clocks and Watches, etc.*, [sales cat. Sotheby's], (Amsterdam, 1994), no. G319, 40.
- 45 Anonymous, *Furniture, Clocks, Sculpture and Works of Art*, [sales cat. Christie's], (Amsterdam, 21 December 1990), 29, Ill. 515.
- 46 Zeeman 1996, 229.
- 47 Velemeyer, H.M., *Antieke Uurwerken, Een familieverzameling*, (Hes uitgevers, 1994), 508, no. 177.
- 48 Documentation A. Roest.
- 49 Zeeman 1996, 72, Ill. no. 57b.
- 50 Collection Museum van het Nederlandse Uurwerk.
- 51 Documentation Mario Crijns.
- 52 Advertisement S. van Leeuwen, *The Hague*, 2002.
- 53 Private ownership.
- 54 Documentation Mario Crijns.
- 55 Clock and case don't belong together, but are of matching period/style. Zeeman 1996, 51.
- 56 Anonymous, *Belangrijke klokken en horloges*, [sales cat. Sotheby's], (Amsterdam, 21 February 1995), 88-89, Ill. 402.
- 57 Private ownership.
- 58 W.F.J. Hana, *Nederlandse Klokken*, (Haarlem, 1980), 38
- 59 Anonymous, *Clocks, Watches and Wristwatches*, [sales cat. Sotheby's], (Amsterdam, 3 November 1998), 51, no. 276.
- 60 Zeeman 1996, 272.
- 61 Zeeman 1996, 157-158.
- 62 Both maple and poplar are light coloured woods with a fine structure. Maple is much denser and harder than poplar. When stained, the denser structure of maple sometimes shows up when narrow late wood zones remain uncoloured. The Acer family contains about 150 species and is present in all countries of the northern hemisphere with a moderate climate. Poplar is present all over Europe; it is white to greyish brown with darker streaks, often lustrous. It is fairly light and soft. Poplar burr regularly shows cavities and ingrowths of bark. Elm is more easily identified than the other two because of its porosity and characteristic paratracheal parenchyma bands. It is also of a darker more reddish-brown colour.
- 63 An article devoted to the various uses of maple wood in a late-eighteenth century newspaper might serve as a 'contemporary' comment on its popularity; 'The boards sawn from maple trees, are very useful for the production of all sorts of furniture, for instance tables, chairs, cabinets, benches etc., as one can give this wood all kinds of pretty colours by means of lye or staining liquids. [...] When Maplewood [...] is knotty, as frequently happens, it's much sought after by cabinetmakers and joiners who cut thin sheets of it, that are very beautifully veined or figured and are coloured and used for veneering; it's then known as 'Peacock wood'.
- Anonymous, 'I. Oeconomische Kundigheden. Eenige Byzonderheden nopends de eigenschappen en het voordeel gebruik des Ahorns of Eschdoorns', in *Oeconomische Courant*, 49, (24 July 1799), 385-7; 'De planken van van Eschdoornboomen gezaagd, zyn zeer goed tot het fabricceeren van allerlei huisraad, b.v. Tafels, Stoelen, Kasten, Banken enz. konnende men dit hout door middel van loogen of bytvogten allerlei fraaië couleuren geeven. [...] Eschdoornhout [...] wanneer hetzelfde, gelyk dikwyls het geval is, veele knoesten heeft, wordt het door de Kastenmakers en Schrymwerkers gretig opgekogt, die daarvan dunne platen snyden, welke, zeer fraai geäderd of gevlamd zynde, gecouleurd en tot inlegwerk gebruikt worden; zynde bekend onder den naam van Paauwenstaarten-hout.'
- 64 *Standard Operation Procedure* no. 36: Identification of natural dyestuff with HPLC, Instituut Collectie Nederland, (Amsterdam, 1997), 1-8.
- 65 J. Wouters, N. Rosario-Chineros, Dye analysis of pre-Columbian Peruvian textiles with High Performance Liquid Chromatography, *JATC*, 31 (1992), 237-255.
- 66 In untreated poplar and maple burr, several components were found which absorb in the UV range. These components have the following retention time (Tr) and absorption optimums (abs):
Tr = 15.17 min., abs = 310 nm.
Tr = 16.61 min., abs = 324 nm.
Tr = 17.16 min., abs = 329 nm.
Tr = 17.28 min., abs = 329 nm.
Tr = 20.17 min., abs 357 nm.
Tr = 25.69 min., abs = 409 nm.
- 67 See note 4. The analyses were performed with the same techniques as described in the present paper.
- 68 E. Homburg, '9. Zwavelzuur', in *Geschiedenis van de Techniek in Nederland. De wording van een moderne samenleving 1800-1890. DEEL IV Delfstoffen, machine- en scheepsbouw, Stoom, Chemie, Telegrafie en telefonie*, H.W. Lintsen et al eds., (Zutphen, 1993), 181-184, 314.
- 69 See note 24.
- 70 Personal communications Mark T. Wypyski, New York.
- 71 H. Schweppe, *Handbuch der Naturfarbstoffe*, (Landsberg/Lech 1992), 378-382.
- 72 See note 4.
- 73 C.P. van Hoek, Beitsen, Klauen en Oppervlakte-behandeling van Hout, (Deventer, 1944).

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