

Of the master's dispersed leaves on the fabric of instruments: the drawing and the reasoning are his, in the mirror hand; the measures were reduced by a later student to the concert grand of nine feet, and noted in millimetres. The instrument is a bridge of wood strung against twenty tonnes of iron.

The Piano Maker's Manuscript

OFFICINA FORTEPIANI · ARCHIVUM CLAVIUM

TABULA I · CORPUS

Plate the First · the case, its woods and its scaling

MENSURA INTEGRA Principal measures

Longitudo <i>length</i>	2740
Latitudo <i>width</i>	1560
Claves <i>keys</i>	88
Pondus <i>weight, kg</i>	480

I. LIGNUM SONORUM

Woods of Sound · materials & density



A. Picea Abies
Norway spruce
Soundboard and ribs. Quartered, grain of 1-3 mm, laid at 45° to the spine.
0.35-0.45 g/cm³



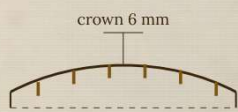
B. Acer Saccharum
Hard rock maple
Rim, bridges and action rails. Bent in one continuous lamination of some twenty plies.
0.63-0.75 g/cm³



C. Diospyros Crassiflora
Gaboon ebony
Sharp keys and the pedal lyre. Naturals faced in ivorine over basswood levers.
0.95-1.10 g/cm³

II. TABULA SONORA

The Soundboard · crown, ribs & taper



Sectio · cross-section

Area <i>m</i> ²	2.05
Crassitudo <i>thickness</i>	9-6
Costae <i>ribs</i>	12
Inter costas <i>spacing</i>	110
Corona <i>crown</i>	6.0
Impositio <i>down-bearing</i>	1°30'

The board is dried to six per cent and pressed onto crowned ribs, so that the strings press always into a curve and never onto a flat.

III. LIMBUS & TRABES

Rim, Plate & Struts · what carries the pull

Laminae limbi <i>rim laminations</i>	20
Limbus exterior <i>outer rim</i>	60
Limbus interior <i>inner rim</i>	15
Trabes laminæ <i>plate struts</i>	5
Lamina ferrea <i>plate weight, kg</i>	150
Agraffæ ad agraffes, up to	F5
Clavus capo tasto <i>capo bar, treble</i>	26

The rim is bent hot in one length about the form — twenty plies of maple — and left a year before the plate is fitted. The iron carries the pull; the wood keeps the shape.

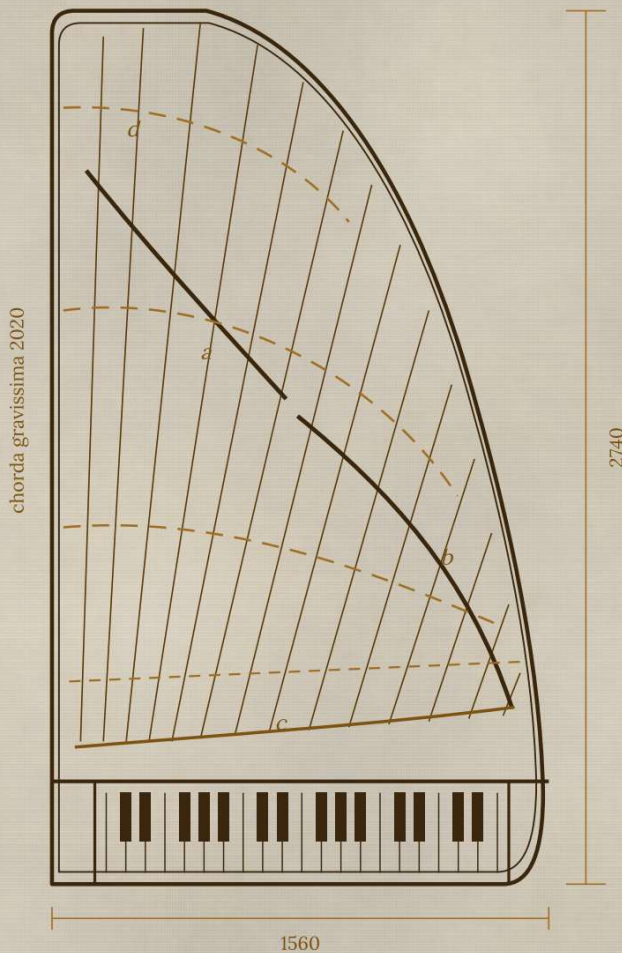
DE FORMA

Of the Case

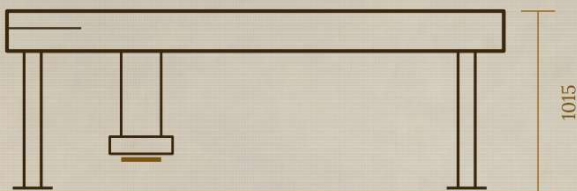
The rim is not a box that happens to hold a piano; it is the piano. Bent hot in one length and left to settle, it fixes the plan, the bearing of the board and the seat of the plate before a single string is drawn. Everything afterwards is fitted to a shape that has already stopped arguing.

IV. STRUCTURA FORTEPIANI

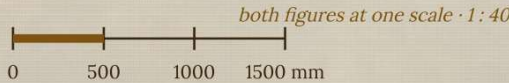
The Plan of the Grand · case, plate & string band



Planum · plan, keyboard to the foot of the plate



Elevatio lateralis · side elevation



a pons gravis, the bass bridge · b pons longus, the long bridge

c clavus capo tasto · d trabes laminæ, the plate struts

243 chordae <i>strings on the plate</i>	≈ 20 000 kgf <i>total tension</i>	2020 : 51 mm <i>longest to shortest</i>
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V. MENSURAE CORPORIS

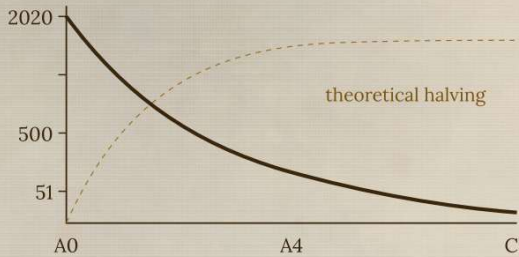
Measures of the Case · in millimetres

Longitudo tota <i>overall length</i>	2740
Latitudo ad claves <i>width at keyboard</i>	1560
Latitudo caudae <i>width at tail</i>	380
Altitudo cum pedibus <i>height on legs</i>	1015
Limbus, crassitudo <i>rim thickness</i>	60 + 15
Laminae limbi <i>rim laminations</i>	20
Lamina ferrea <i>iron plate, kg</i>	150
Trabes laminæ <i>plate struts</i>	5
Operculum <i>lid, full stick</i>	62°
Tabula sonora <i>soundboard, m</i> ²	2.05
Longitudo clavis <i>key lever, bass</i>	480
Pondus totum <i>total weight, kg</i>	480

The spine is straight, the bentside a single curve; the tail closes them. Nothing in the case is symmetrical, and nothing in it is accidental.

VI. RATIO CHORDARUM

The Scale · speaking lengths across the compass



A0 27.5 Hz, wound	2020
C2 65.4 Hz, wound	1240
C4 261.6 Hz, trichord	620
C6 1046.5 Hz	210
C8 4186.0 Hz	51

Perfect halving would ask a bass of five metres; the maker foreshortens it and pays the debt in copper winding.

VII. OPERCULUM & FULCRA

Lid, Legs & Bearing · how the tone leaves the case

Statio plena <i>lid, full stick</i>	62°
Statio dimidia <i>lid, half stick</i>	24°
Fulcra <i>legs</i>	3
Fulcrum, diameter <i>leg at the top</i>	120
Rotulæ <i>castors</i>	100
Onus in fulcro antico <i>load, front leg, kg</i>	190

At the full stick the lid throws the tone forward off its inner face; at the half stick the instrument speaks to the room and not past it.

DE MENSURA

Of Measurement

The figures on this sheet are those of the nine-foot concert grand and are nominal. Scale, bearing and touch weight differ between makers, and between two instruments of one maker, by more than the decimal place suggests. Read them as the bounds within which the design is known to work, not as a specification: the same numbers were reached independently in Vienna, in London and in New York, which is the only argument for them worth having.

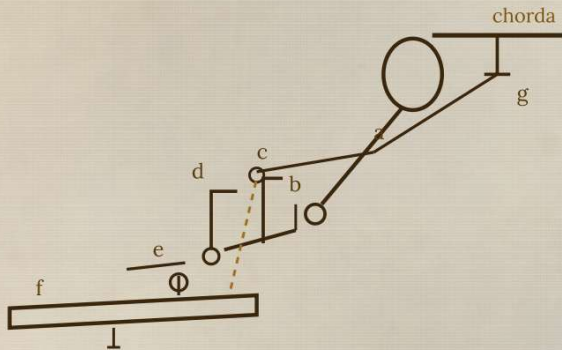
Tabula II · The Sounding Parts

Plate the Second · the double escapement, the touch, the pedals, the tuning and the wire

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VIII. MACHINA CLAVIUM

The Action · double escapement after Érard, 1821



- a Malleus · hammer, felt over pear
b Repetitionis levamen · repetition lever
c Retinaculum · back check
d Cuneus · jack, or escapement
e Pilotus · capstan on the key
f Clavis · key lever on its balance pin
g Sordinum · damper and its wire

IX. REGULATIO TACTUS

Regulation & Touch · the eight settings

Regula	Gloss	mm
Ictus mallei	blow distance	47
Descensus clavis	key dip	10.0
Effugium	let-off	1.5
Lapsus	drop	1.5
Retentio	check height	15
Levatio sordini	damper lift	at ½ dip

Pondus descendens downweight	50 g
Pondus ascendens upweight	25 g
Ratio ictus strike ratio	5.5 : 1
Velocitas mallei hammer, fortissimo	5 m/s

X. MALLEUS & FELTRUM

Hammer & Felt · the striking body

Pondus in cauda hammer, bass, g	11.5
Pondus in acutis hammer, treble, g	4.5
Feltrum, crassitudo felt thickness	9–5
Cauda mallei hammer tail	22
Angulus foraminis bore angle	18°
Vestigium in chorda string mark	1.5

Felt is pressed onto the moulding under great weight and never afterwards cut for tone. Voicing is done with the needle — three shallow, one deep.

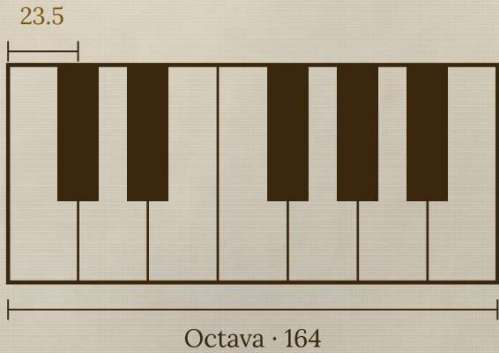
DE TACTU

Of the Touch

What the player calls touch is a ratio and a weight: some fifty grams to set the key down, five and a half millimetres of hammer travel for every one of key dip. Change either and the instrument answers differently under the same hand.

XI. CLAVIATURA

The Keyboard · the octave and its measures



Octava octave span	164.0
Clavis alba natural width	23.5
Clavis nigra sharp width	11.0
Longitudo albae natural, seen	150.0
Longitudo nigrae sharp, seen	93.0
Altitudo nigrae sharp height	12.5
Ambitus compass, A0–C8	1225

XII. SORDINÆ

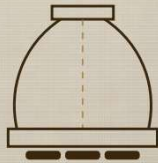
Dampers · felts, wedges & the undamped treble

Sordinæ dampers	68
Ultima sordina topmost damper	F6
Cunei ad wedge dampers, to	F3
Feltrum planum ab flat felt, from	F#3
Feltrum, crassitudo felt thickness	8.0
Levatio plena full lift	12.0

Above F6 the strings are left undamped: their sound dies sooner than a hand can lift a felt from them.

XIII. PEDALIA

The Pedals · the lyre and its three offices



- I Una corda · the action shifts 9 mm to the right, and the hammer strikes two of three
II Sostenuto · a rod holds only those dampers already raised
III Forte · all dampers lift; the whole board is left to ring

DE SONO

Of the Sound

A piano note is a struck string that nobody afterwards controls; the whole art of the instrument is in what happens in the first thousandth of a second and in the moment the felt returns. Hence the maker's concern with the hardness of the hammer and the exactness of the damper, and hence the pedals: the only means the player has of governing a sound already let go. Half the character of a fine instrument lies in how it stops.

XIV. TEMPERAMENTUM

Tuning · equal temperament, A = 440, with stretch

A4 the fork	440.0 Hz
Quinta temperata tempered fifth	–2 cents
Tensio in cauda stretch, bass	–30 cents
Tensio in acutis stretch, treble	+30 cents
Unisonus, chordae strings per note	3 · 2 · 1
Verticilli tuning pins	243

Because a struck string is stiff, its partials run sharp; the tuner therefore widens the octaves outward from the middle so the instrument agrees with itself rather than with the arithmetic.

XV. CURA & CONSERVATIO

Care of the Instrument · air before tuner

Humiditas relative humidity	42–48%
Temperatura temperature	18–22°C
Temperandum tuning interval	2–4 mens.
Regulatio regulation	2–5 anni
Feltra renovanda hammers renewed	10–20 anni

Wood answers the air before it answers the tuner. Keep the room steady and the instrument will keep its scale.

XVI. CATALOGUS MAGISTRORUM

Catalogue of Masters · Florence, Vienna, London, Paris, New York

B. Cristofori, Florence	1655–1731
G. Silbermann, Freiberg	1683–1753
J. Broadwood, London	1732–1812
S. Érard, Paris	1752–1831
I. Pleyel, Paris	1757–1831
H. E. Steinweg, Seesen	1797–1871
L. Bösendorfer, Vienna	1835–1919

Tabula humida, sonus mortuus: cave. — Beware a damp soundboard and a lost crown; the tone goes before the timber.



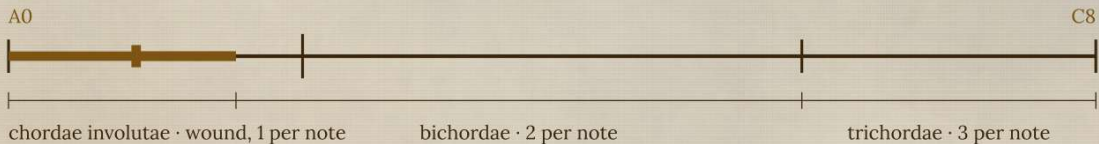
DE OFFICINA

Of the Workshop

Regulation is done in one order and never out of it: blow, dip, let-off, drop, check, damper. Each setting alters the one after it, so the technician goes around the compass twice and trusts the second pass. Felt is worked with the needle and the file, never with water, and the last judgement is made with the lid up and the hand playing.

XVII. CHORDAE

The Strings · drawn steel wire, and copper for the bass



Chordae count	243	Ø in acutis treble wire	0.775
Tensio una per string	75–90 kgf	Ø in medio plain bass	1.375
Tensio tota whole plate	≈ 20 t	Filum cupri copper winding	to 3.3