Traditional wire-strung Irish harp

construction drawings

Based on a harp
made by John Egan
for the Belfast
Irish Harp Society
in the early 1820s

Simon Chadwick, 2024

The drawings on the next page are 1/8 scale. The gradation marks down the left side and across the top are at 10cm intervals.

The full size drawing, and also this commentary booklet, are available to download for free from:

https://simonchadwick.net/egan-wire-strung-irish-harp-plans

PRINCIPAL FUNDER

THE NATIONAL LOTTERY

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Thanks to the National Museum of Ireland for giving access to the harp in the Museum, and to Sarah Nolan for facilitating the visit. Thanks to Paul McCann of 3D Printing Ireland for scanning the original. Thanks to Brenda Malloy for helping with measurements and photography. The scans and the drawings were funded by the UK National Lottery through the Arts Council of Northern Ireland.

Traditional wire-strung Irish harp

Original design by John Egan, Dublin, early 1820s

This full-sized drawing, and a commentary booklet with photographs, measurements and stringchart, are available to download for free from https://simonchadwick.net/egan-wire-strung-irish-harp-plans

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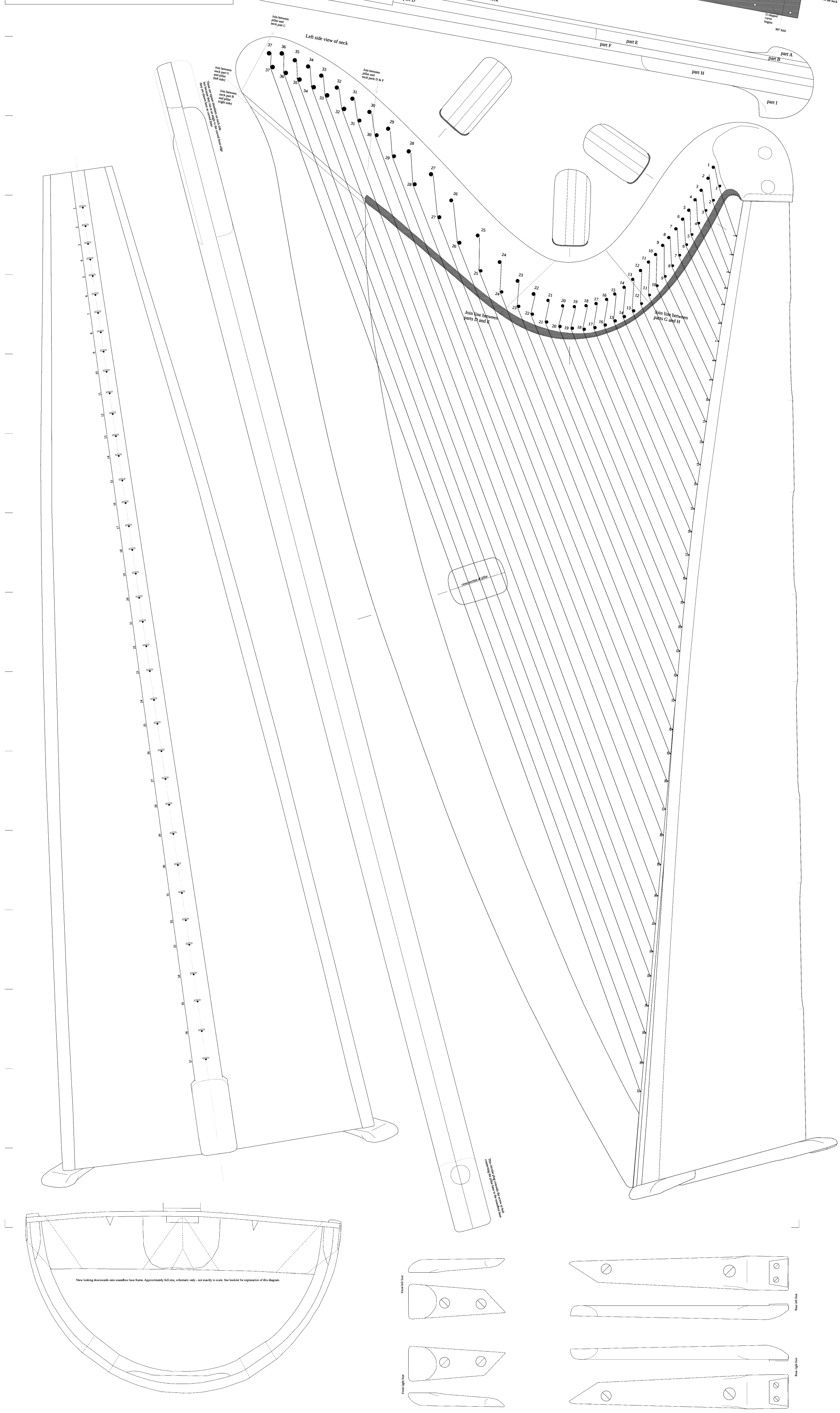


Overview

John Egan harp no.1933 is a traditional wire-strung Irish harp. It was apparently made in the early 1820s, and it was made for the Irish Harp Society which ran a harp school in Belfast from 1820 through to 1840.

At the beginning of the 20th Century, Egan no.1933 was owned by the historian Robert Bruce Armstrong, and the frontispiece of his book *The Irish and the Highland Harps* (David Douglas, Edinburgh, 1904) shows him posing with it. He gave the harp to the National Museum of Ireland and it has the acquisition number DF:1913.381. More recently a brief discussion of it and the other traditional wire-strung Irish harps made by Egan in the 1820s is in Nancy Hurrell, *The Egan Irish Harps* (Four Courts, Dublin, 2019 p. 91-2)

I became seriously interested in these early 19th century traditional wire-strung Irish harps after starting my "Long 19th Century" research project, which aimed to find out about the life and music of traditional Irish harpers playing on wire-strung harps in the inherited tradition from 1792 through until 1909. I realised that most of the traditional harpers at this time were playing harps either made by Egan to this design, or made by other harpmakers copying Egan's design more or less closely. I asked the harpmaker Tim Hampson to make me a copy, as a prototype or proof-of-concept, to find out how (and if) they worked for the traditional Irish harp playing techniques and way of playing. Tim used Egan no.2044 (Fitzwilliam Museum Cambridge, M.10-1941), and he photographed it and measured it by hand. He completed the prototype copy in April 2023, and I found that it worked extremely well, to the point that I would recommend John Egan's design for anyone wanting to play traditional wire-strung Irish harp.

This project to produce freely available plans and drawings for harpmakers was originally proposed in the Autumn of 2023. The Arts Council of Northern Ireland awarded me a grant to over the costs of producing the plans. I commissioned 3D Printing Ireland to come with me into the National Museum in Dublin where Egan no.1933 is kept, to make a 3D scan in February 2024. I then used the scan to generate renderings of the parts of the harp, and I have traced the renderings to create these drawings. The drawings were finished and released in May 2024.

The 3D scan produces a very accurate dimensional record of the visible outer surfaces of the harp. However the scanner was not able to image the interior of the harp (except for a few fragments inside the bass end of the soundbox), and so I took a set of hand-measurements of the thicknesses of the parts of the soundbox. These are not as accurate as the scan, and I have not drawn in these components on the plan.

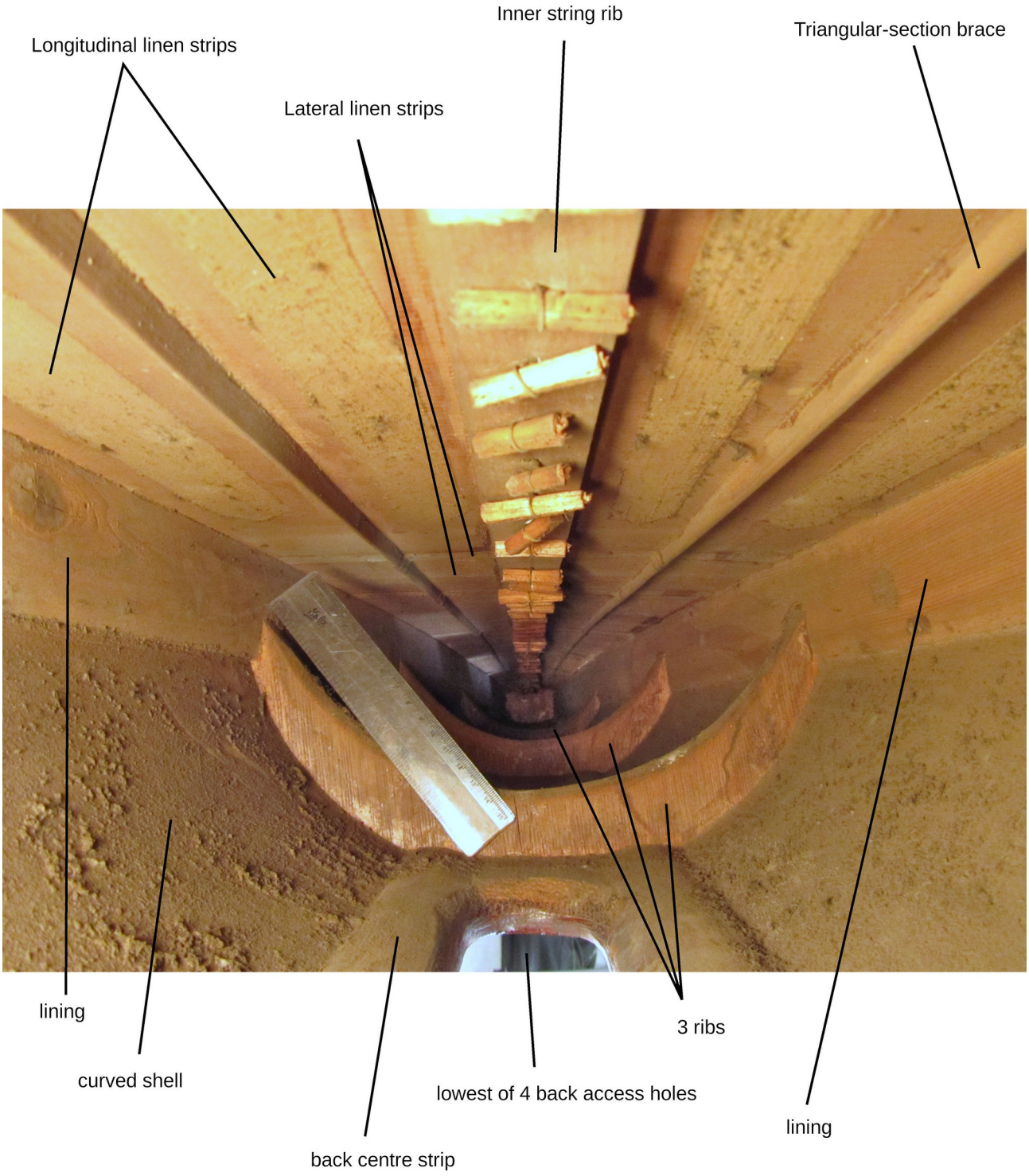
The scanner also captures imagery of the surface of the harp, which colours the finished 3D model of the harp. The imagery is not as accurate as the surface dimensions but I have used the imagery to trace the join lines of the various parts of the neck and pillar of the harp. The 3D model produced by the scan is available to view and download for free on Sketchfab, at https://skfb.ly/oTzwG . The image of the right side of the harp on the next page was generated from the 3D model, using the Meshlab software[1].

In this document, the harp is described from the player's point of view; front, back, left, right, up and down are as viewed from behind the harp. The traditional Irish harp was played on the left shoulder, and so the right side of the harp is the "display" side with the best finish and decoration.

1 P. Cignoni, M. Callieri, M. Corsini, M. Dellepiane, F. Ganovelli, G. Ranzuglia 'MeshLab: an Open-Source Mesh Processing Tool' *Sixth Eurographics Italian Chapter Conference*, p 129-136, 2008; G. Ranzuglia, M. Callieri, M. Dellepiane, P. Cignoni, R. Scopigno 'MeshLab as a complete tool for the integration of photos and color with high resolution 3D geometry data' *CAA 2012 Conference Proceedings*, p 406-416, 2013

Soundbox

My drawing only shows the side view and front view of the soundbox. I did not try to draw accurate full size drawings of the internal structure, partly because the scanner was not able to image the interior (apart from a few fragments of the curved interior near the base, which were not included on the 3D model on Sketchfab). The other reason is that I think the normal workshop practice would be to start with making the curved shell, and then to fit the internal components into the shell and onto each other, rather than cutting the components from a drawing. So for the soundbox I thought some photographs and approximate measurements would be more useful to makers.



The **soundbox curved shell** is made from just two laminations. The shell tapers from about 6mm thickness at the top, to about 8mm thickness at the bottom. The shell runs the full length of the soundbox from the very top to the very bottom.

The **back centre strip** also frames the four back access holes. It tapers from about 10mm thick at the top to about 13mm thick at the bottom. You can see on the photo that it is not flat inside, but has a flat central panel (where the access holes are cut) and slightly rounded raised flanks. The back centre strip runs the full length of the interior of the soundbox, butting against the insides of the top block and the bottom frame.

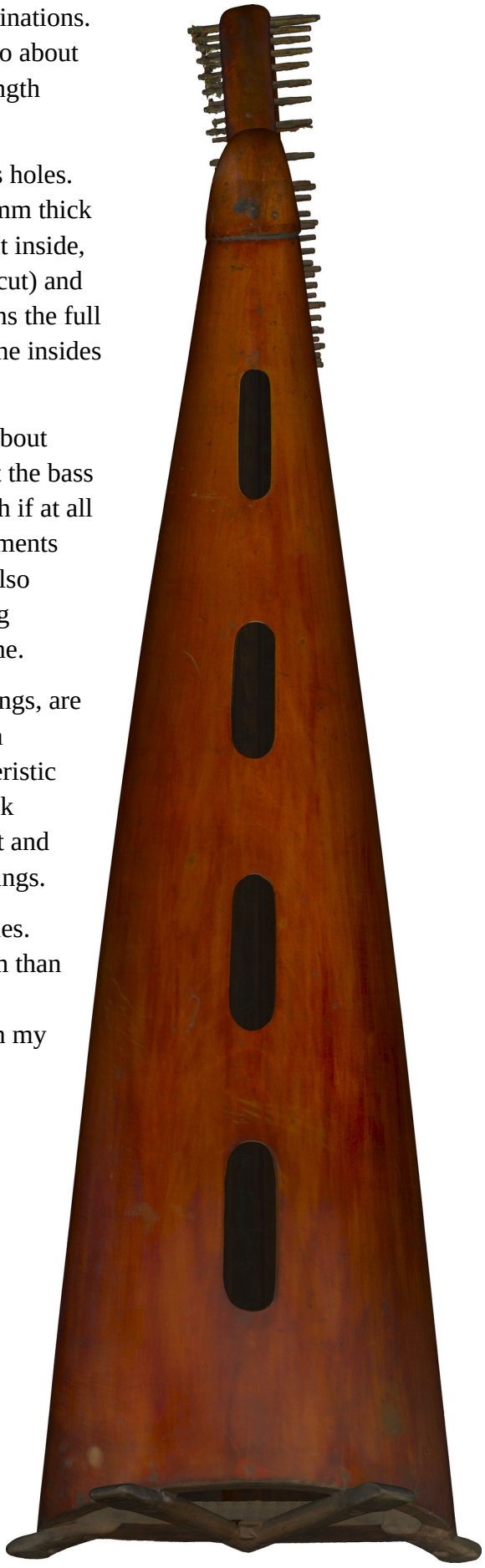
The **linings** taper from about 9mm thick at the top, to about 12mm thick at the bottom. They are about 47mm tall at the bass end of the soundbox, and they don't seem to taper much if at all towards the top of the soundbox (I don't have measurements for their depth toward the top of the soundbox). They also run the full length of the inside of the soundbox, butting against the insides of the top block and the bottom frame.

Note that both the edge of the curved shell, and the linings, are curved. This is a part of the original design, and gives a longitudinal curve to the soundboard. This is a characteristic design feature of traditional Irish wire-strung harps back through the 18th and 17th centuries. I think it helps resist and control the tension and vibrational force of the wire strings.

The three **ribs** are fitted in between the back access holes. I think they are somewhat closer to the hole above them than to the hole below. I don't have accurate measurements of them. But I placed my ruler against the lowest one in my photo so you can see the approximate size.

This image (rendered from the 3D model) shows the harp tipped forwards so that the back is vertical. It shows the flat-sawn grain of the wood in the outer lamination of the curved shell.

It also shows the sizes and positions of the **back access holes**. The locations of the holes are shown on the full-size side drawing. The top hole is about 30mm wide; the second is about 40mm; the third is about 43mm and the bottom access hole is about 49mm wide.

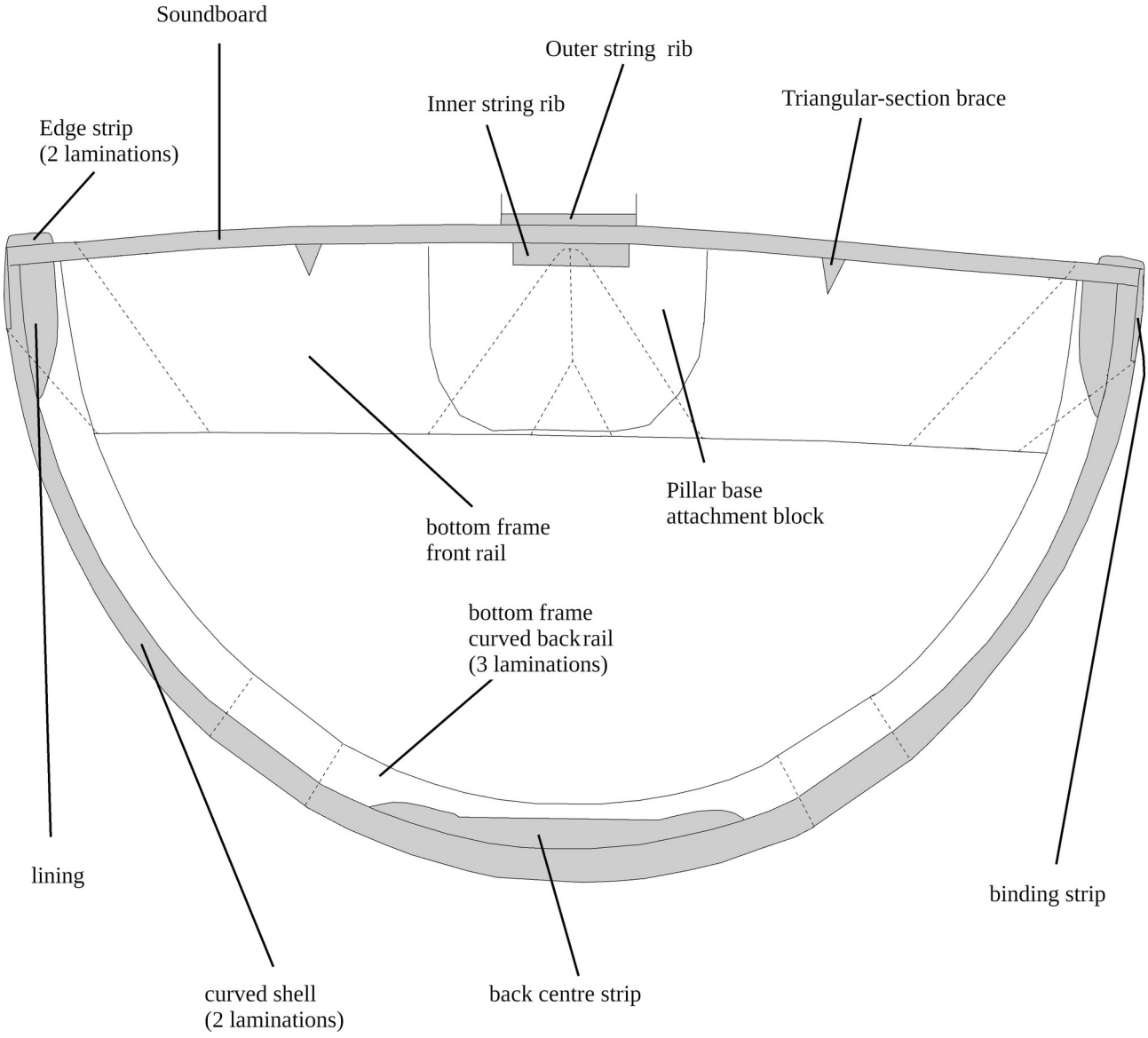


Soundbox top block

The top end of the curved soundbox shell is closed by the **top block**. This is a block of wood that is fitted to the inside of the curved shell. Its front face is rebated for the inner string rib. I don't have any dimensions for the top block.

Soundbox base frame

The bottom end of the soundbox is not closed by a solid bottom block. There is a large opening at the bottom end of the soundbox, which is created by the **soundbox base frame**. My drawing (also on the full sized drawing) shows the different parts of the base of the soundbox.



This drawing (and the full-sized version) is traced from the scans, but it is only schematic and is not to scale.

The bottom frame is made from three components.

The **back rail** is laminated from three layers, and is curved around the inside of the soundbox shell, along the lower edge. Because the lower edge of the soundbox is angled, the back rail is kind of crescent-shaped. It is about 14mm thick (three laminations of about 4.6mm each). It is about 40mm wide. The back rail runs right to the front edge of the soundbox shell, and the lining strips and the back centre strip butt up against its upper edge.

The **front rail** is a single piece of wood. It is about 34mm thick. You can see from the drawing how it fits in between the ends of the curved back rail. Its back edge is about straight, but its front edge is curved. This means that when the soundboard is glued down onto the soundbox shell, the bass end of the soundboard will be bent into a gentle arch.

The front edge of the front rail is also angled (because the soundbox base is angled), and has rebates for the inner string rib and the triangular-section braces to fit into.

The **pillar base attachment block** is fixed onto the upper surface of the front beam (inside the soundbox) by two screws drive upwards through the front beam. The front surface of the attachment block is also rebated for the inner string rib. A large screw or bolt is driven from the front of the pillar, through the string ribs and soundboard and right through the attachment block.

I don’t have dimensions for this block, but you can see it in my photo on the next page. On the photo, the inner end of the pillar screw is visible at the lower centre of the block. You can also see that the block comes right up to stringhole no.37.

This drawing also shows the **binding strips** which run the whole length of the outside of the soundbox. They are also indicated on the full size side view. They are rebated into the soundbox shell, and cover the edge of the soundboard. I have no information about how thick they are.

Soundboard

The soundboard is made from boards of spruce or similar wood, joined edge to edge with the grain running across the width of the soundboard. I don't have good detailed measurements of the soundboard thickness, because the scanner was not able to image the interior surface. I took measurements with a large caliper. The soundboard seems to taper from perhaps 2 to 3mm at the treble, down to about 8mm at the lowest string position, and then it seems to reverse-taper down to about 6mm where it is visible at the very bottom edge. However these thickness measurements are only to within a couple of mm. The soundboard may also taper towards the sides.

Two **triangular-section braces** run from the very bottom edge of the soundboard, up to the treble, but I don't think they go as far as the top block. They taper from about 5mm deep in the treble to about 10mm deep at the very bottom edge where they are visible, rebated into the soundbox base front rail. They are about 8mm wide at that point.

The butt joints between the separate boards that make up the soundboard are reinforced on the inside of the soundboard by narrow **lateral linen strips** glued over the join line. You can see one of the thin lateral linen strips clearly on this photo. The strips are also glued over the triangular-section braces.

The **outer string rib** is shown on my full size drawing. It runs from the very top edge of the soundboard to the very bottom edge. It tapers in width from the treble to the bass. It suddenly widens at the bottom end to pass under the pillar, and it is visible at the very bottom of the harp between the pillar and the soundboard. It tapers in thickness from about 1.6mm in the treble, to about 4.2mm at the lowest string position, and then it thins down again to about 3.7mm at the very botom edge of the soundboard.

The **inner string rib** runs from the very top edge of the soundboard to the very bottom edge. It is rebated into the top block and into the front rail of the bottom frame. It tapers from perhaps about 5mm thick in the treble, to about 7 or 8mm in the bass. I don't have any measurements for its width, except at the very bottom end where it is visible, and is the same width as the inner stringband at that point, about 40mm. I presume it does not step in around the pillar base like the outer one does, and so it presumably is a bit wider than the outer string band all the way up.

The four **wide linen strips** are visible on my interior photograph. They run from the bottom of the soundboard up to about level with the upper edge of the lowest soundhole. The missing toggle in this photo is string no.30.

The soundboard is glued down onto the soundboard shell, linings and end blocks. The soundbox shell has a curved edge, along the linings and across the bottom front rail, so that the soundbox (though made flat) has a curve in both directions once it is fixed to the soundbox shell. I think that the soundboard is also screwed down into the linings, through the edge strips.

The **edge strips** are in two laminations, I am pretty sure the lower layer is screwed down through the soundboard into the linings, and the upper layer covers the screws. The edge strips are shown on my full size drawing. They taper from about 2mm thick in the treble to about 4mm in the bass.

Bottom view of the base of the harp. Note the brass plates on the rear feet, the screws attaching the pillar block, the ends of the soundboard centre strips (inner and outer) and triangular-section braces, and the lamination of the back rail.

View through the lower rear access hole showing the front rail and the pillar attachment block. The tip of the pillar bolt is visible at the back of the block. You can also just see the backs of the front feet.

Soundbox-neck joint

These photos show how there is a strip of wood glued and nailed around the back of the neck, to overlap the top of the soundbox. Here the neck is tilted away from the soundbox so we can see into the joint, but if the joint was closed and flush then the strip of wood would hide the joint.

You can see that there are two iron or steel **dowels** which locate the neck onto the end block of the soundboard. Its my guess that these two dowels, plus the pillar base bolt, are the only things holding the neck-pillar assembly to the soundbox.

The iron strap

You can also see the iron strap very clearly, how it is rebated into the under side of the neck, and how it is bent up into a channel shape and screwed to the neck.

On my full size drawing, I tried to make an approximate rendering of the iron strap flattened and straightened. I think the strap is quite thin, perhaps only 1mm or up to 2mm thick. The edges being curved up as well as the strap being curved longitudinally means that it has to be hammered and dished into shape, so my cutting guide can only be approximate.

This curved and dished iron strap will be very strong and will be an important part of reinforcing and strengthening the neck.

Neck and pillar laminations

The full sized drawings shows the joint lines of the different parts of the neck and pillar. You can see these joint lines on the 3D model. There are two circles on the left side of the neck knee block in the treble (part I on my drawing). I think these are wooden caps to cover the heads of screws running across the neck, to firmly fix the knee block to the rest of the neck.

I don’t know if the pillar really passes right to the top of the neck like I have drawn, or if a thin veneer is used to cap this piece.

The thicknesses of the individual components as shown on my full size drawings are only approximate because the joint lines are not 100% accurate on the coloured rendering of the 3D model. The 3D model is much more accurate at showing the external dimensions of the completed components of the harp.

Feet

The **feet** are shown on my full size drawing. The dotted lines on the base frame drawing shows the locations of where the feet fix to the base of the harp.

The front feet are short, and are attached only to the front rail by two screws each. They don’t usually take the weight of the harp, but only stabilise it when it is standing upright. The rear feet are much stronger and longer, because they take the entire weight of the harp when it is being played. They are attached by one screw each driven into the front rail and probably also through and into the pillar base attachment block. This allows the rear feet to transmit the vibrations of the bass strings from the pillar base direct to the ground, a bit like the projecting foot of an 18th century Irish harp. The rear feet are also attached by one screw each into the back rail.

The rear feet also each have a brass plate attached with two screws, to protect the wood of the foot from being worn away by the floor or ground.

Decoration and finishing

John Egan always finished his traditional wire-strung Irish harps with a varnish, so that the wood remains visible all over. Sometimes he seems to have used a clear varnish, and other times he seems to have used a tinted or coloured varnish to deepen the natural colour of the wood.

The three strips down the front of the soundboard (the centre string band, and the two edge strips) were almost always gilded.

In the 19th century, the traditional wire-strung harps were almost always decorated with painted shamrocks on the soundboard. On Egan no.1933, the soundboard is the only decorated part.

Some of the other Egan wire-strung harps have much more decoration all over, typically gilded shamrocks on the neck and pillar, and gilded shamrocks or borders on the body.

On the left is a rendering of the soundboard decoration, made from the 3D model. There is a registration error caused by multiple takes being mis-aligned in the imagery, and the left side of the soundboard decoration (right on the image) has a double-exposure effect. But I think it is still useful if you want to lay out a similar decorative scheme.

The top half of each side has a shamrock vine in green paint. Then in the centre of each side is the Royal Arms of George IV. Then below that is another shamrock vine, and at the bottom is lettering in red paint.

On the left of the picture (harp right):
MANUFACTURED for / the BELFAST. / IRISH-HARP / SOCIETY. / No.1933

on the right (harp left):
By I. EGAN / DUBLIN / HARP MAKER / to His M[AJESTY] / [GEORGE the 4th] / [& THE ROYAL FAMILY]


DIEU ET MON DROIT

Bridge pins

The harp has 37 brass bridge pins of about four different sizes, small for the treble strings and large for the bass strings.

Positions (approx)	1 – 12	13 – 25	26 – 31	32 – 37
Bridge pin dia (approx)	3.3mm	4mm	4.8mm	5.5mm

The bridge pins are parallel-sided, and are inserted into interference-fit drilled holes in the left side of the neck. They are adjusted so that they project enough so that the string does not touch the neck. The pins project about 6.5mm in the treble, down as far as position no.16, and then they gradually increase the projection, to about 9mm at position 23, about 13mm at position 30, and about 21mm at position 37, to allow the long bass strings to clear the neck and pillar. The groove in the bridge pin which the string runs in is perhaps 3mm from the end, so the string clearance to the neck will be about 3mm less than the bridge pin projection.

John Egan's harp workshop on Dawson Street, Dublin, normally made pedal harps, and also miniature mechanised gut-strung "portable" harps. Egan made comparatively few traditional wire-strung Irish harps, apparently all as special orders for the Irish Harp Society in Belfast, either for use in the Harp School (as I assume no.1933 was), or as presentation gifts to pupils when they were discharged from the school and became professional harpers.

Egan apparently made a design error in the laying out and manufacturing of these traditional wire-strung harps. The string spacing seems to have been originally set following the norms for gut-strung pedal harps, with the bass strings wider apart than the treble strings, to allow the long gut bass strings on the pedal harp space to vibrate. This wide bass spacing is not needed with monofilament wire strings, and it also makes the traditional way of playing the wire-strung harp more difficult because of the wide reach for the bass hand positions. To correct this error, on some of these harps, the bridge pins were pulled out, and the holes plugged, and new bridge pin holes drilled, to make the string spacing at the top more even (by moving the mid-range bridge pins incrementally towards the bass of the harp). Egan no.1933 has had this done, as has no.1244 (the one in Cambridge). I am not sure if any of the others have also been re-pinned, or if they were done with better string spacings to start with. We need more study of the other harps to compare.

In any case, the re-positioning of the bridge pins is clearly to correct a design flaw in Egan's original design, and so my drawings show the bridge pins in their new, shifted positions. I have adjusted some of them slightly to correct obvious spacing errors.

Note that the string-shoe spacing on the soundboard was not changed (this would probably require a new soundboard) and so my drawing shows the harp with the wider bass spacing at the soundboard.

Further development of this design could involve experimenting with an even string spacing all the way down on both neck and soundboard; this would also change the shape of the neck and possibly also change the voicing of the bass strings. I'm sure that if the inherited tradition had not been suppressed in the mid / late 19th century we would have seen this kind of development of the design happening through the 19th and 20th century as it did with other traditional instruments. After John Egan died, in the 1840s his nephew Francis Hewson made similar traditional wire-strung harps for traditional harpers. I would like to do a similar study of one of these instruments.

Tuning pins

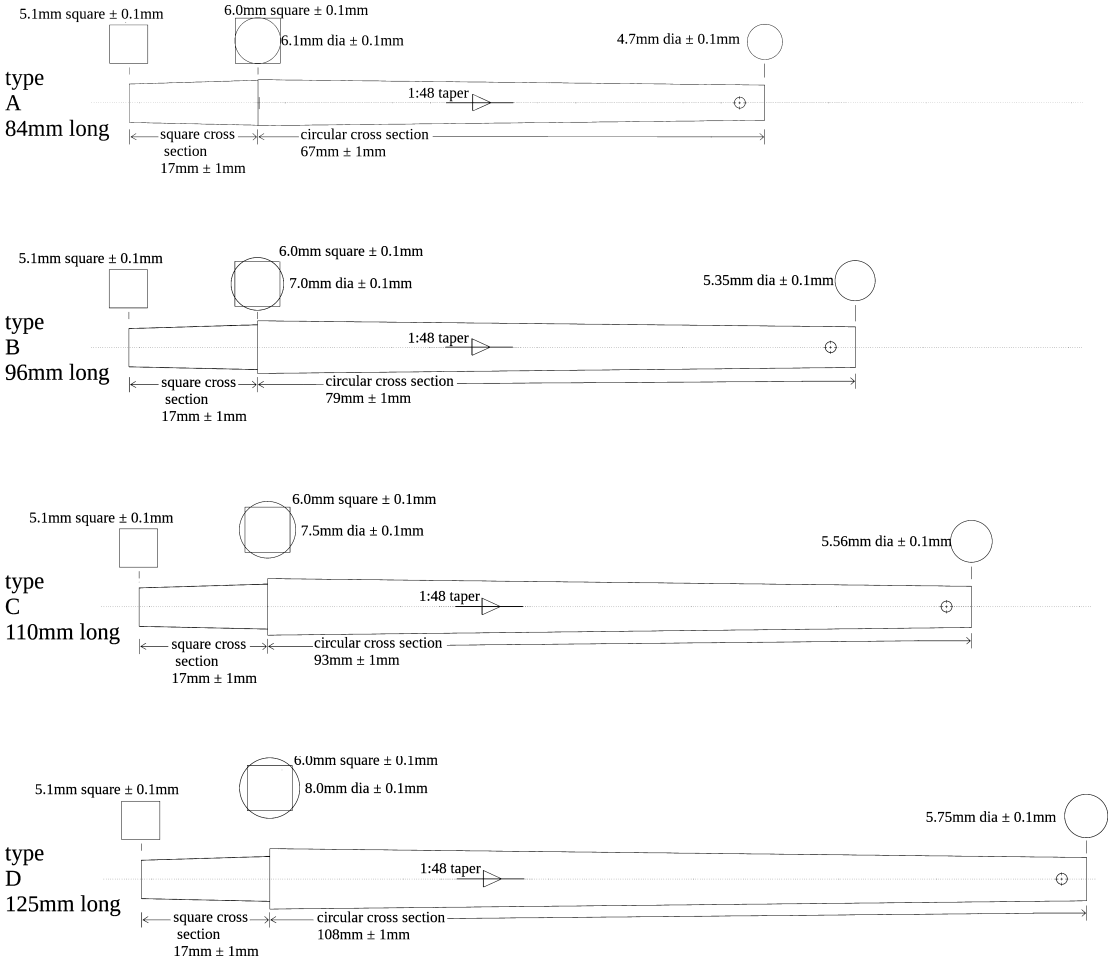
The 37 iron or steel tapered tuning pins are of four different sizes, thinner and shorter in the treble, and thicker and longer in the bass. The reason the pins get gradually longer is to match the increase in bridge pin projection. The lowest two are extra-long to also project more on the drive side.

Positions	1 – 21	22 – 27	28 – 35	36 – 37
No. of pins	**21**	**6**	**8**	**2**
Tuning pin size	type **A** (#4)	type **B** (#5)	type **C**	type **D**
Reamer size	use ¼″ reamer	Use $^{9}/_{32}$″ reamer	Use $^{5}/_{16}$″ reamer	Use $^{11}/_{32}$″ reamer

The squared drive heads are the same size on all pins. The square drive heads are also tapered, which is normal for traditional Irish harp tuning pin drives. It allows a more accurate registration of the tuning key onto the pin, to allow for more control in tuning the wire strings.

This drawing shows a normalised neatened version of the four sizes, using a standard modern Imperial 1:48 taper shaft.

The tips of the pins should be drilled across, to insert the end of the string. The drawing shows a 1.5mm hole drilled through, 3mm from the tip.



Strings

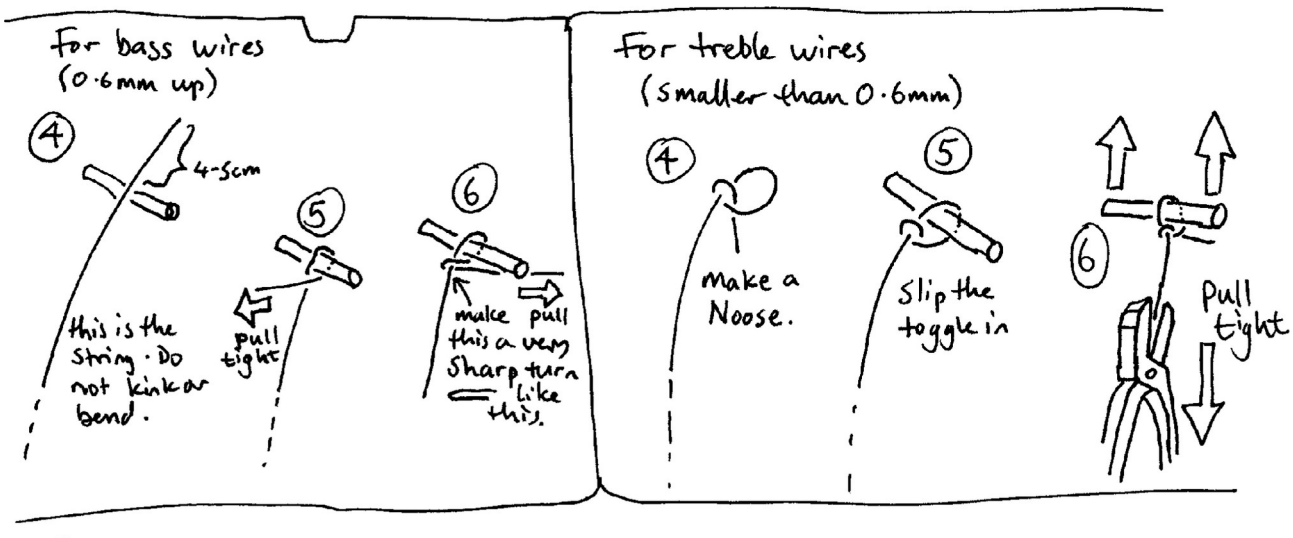
The harp has 37 brass wire strings. **My stringchart** is based on information from the harper and tradition-bearer Patrick Byrne, who had an Egan traditional wire-strung Irish harp very similar to this design. Byrne's harp apparently had 38 strings, yet his string list only gives 34. I think he left a few of his high treble string positions empty.

Egan no.1933 has **graffiti note names** scratched onto the soundboard. They are visible on the 3D scan, and on the soundboard rendering above on p.16. These are obviously later additions, and may relate to a later re-stringing using steel wire in the treble. They seem to be one note too high to work with brass wire strings, and so we can ignore them for now.

I recommend Malcolm Rose yellow brass wire, but any yellow brass or cartridge brass (70% Cu, 30% Zn) can be used. The diameters are as follows:

positions	Gauge	Length required	Plus one extra spare of each gauge
1 – 11	0.40mm	3.5m	3.9m
12 – 16	0.48mm	2.2m	2.7m
17 – 23	0.6mm	4.3m	5.1m
24 – 29	0.7mm	5.8m	7m
30 – 32	0.8mm	3.9m	5.2m
33 – 37	1.0mm	7.4m	9m
	Totals:	*27.1m*	*33m*

The strings are fitted off the reel, by inserting the wire in through the front and pulling it out through the back access hole, and tying a simple toggle knot. The toggles are one-inch lengths of 6mm hardwood dowel. My cartoon shows the knot used; simpler for 0.6mm and below, slightly more complex for the thinner treble wires:



Recommended string chart for Egan wire-strung Irish harp
Simon Chadwick September 2023 (revised May 2024)

string	freq	note	Length (cm)	Length (in)	Gauge (mm)	Gauge (in)	Tension	Metal
1	1760	a‴	6.6	2.6	0.44	0.017	7	yellow brass
2	1568	g‴	7.3	2.9	0.44	0.017	7	yellow brass
3	1480	f♯‴/f‴	8.4	3.3	0.44	0.017	8	yellow brass
4	1318	e‴	8.9	3.5	0.44	0.017	7	yellow brass
5	1174	d‴	9.7	3.8	0.44	0.017	7	yellow brass
6	1046	c‴	10.8	4.3	0.44	0.017	7	yellow brass
7	986	b″	11.9	4.7	0.44	0.017	7	yellow brass
8	880	a″	13.1	5.2	0.44	0.017	7	yellow brass
9	784	g″	14.4	5.7	0.44	0.017	7	yellow brass
10	740	f♯″/f″	15.8	6.2	0.44	0.017	7	yellow brass
11	659	e″	17.4	6.9	0.44	0.017	7	yellow brass
12	587	d″	19.1	7.5	0.48	0.019	8	yellow brass
13	523	c″	21.1	8.3	0.48	0.019	8	yellow brass
14	493	b′	23.1	9.1	0.48	0.019	8	yellow brass
15	440	a′	25.6	10.1	0.48	0.019	8	yellow brass
16	392	g′	28.2	11.1	0.48	0.019	8	yellow brass
17	370	f♯′/f′	30.9	12.2	0.6	0.024	13	yellow brass
18	329.5	e′	33.9	13.4	0.6	0.024	12	yellow brass
19	293.5	d′	37.4	14.7	0.6	0.024	12	yellow brass
20	261.5	c′	40.8	16.1	0.6	0.024	11	yellow brass
21	246.5	b	44.8	17.7	0.6	0.024	12	yellow brass
22	220	a	49.1	19.3	0.6	0.024	12	yellow brass
23	196	g	53.4	21.0	0.6	0.024	11	yellow brass
24	196	g	59.2	23.3	0.7	0.028	18	yellow brass
25	185	f♯/f	65.3	25.7	0.7	0.028	20	yellow brass
26	164.75	e	72.7	28.6	0.7	0.028	19	yellow brass
27	146.75	d	79.8	31.4	0.7	0.028	19	yellow brass
28	130.75	c	87.7	34.6	0.7	0.028	18	yellow brass
29	123.25	B	95.3	37.5	0.7	0.028	19	yellow brass
30	110	A	102.1	40.2	0.8	0.032	22	yellow brass
31	98	G	107.8	42.5	0.8	0.032	20	yellow brass
32	82.375	E/F	113.1	44.6	0.8	0.032	15	yellow brass
33	73.375	D	118.2	46.6	1	0.039	21	yellow brass
34	65.375	C	123.1	48.5	1	0.039	18	yellow brass
35	61.625	BB	127.8	50.4	1	0.039	17	yellow brass
36	55	AA	132.6	52.2	1	0.039	15	yellow brass
37	49	GG	137.1	54.0	1	0.039	12	yellow brass
						TOTAL	454	

Patrick Byrne's string list written down in 1849 by John Bell (Glasgow University Library MS Farmer 332), and published by H.G. Farmer, 'Some Notes on the Irish Harp', Music & Letters vol XXIV, April 1943.

(f1v) (f89v)

34 in all

78 of the next say 8

Then there are 2 oz of course & 2 oz of fine treble wire. This constitutes the whole wire

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56 of the next say 5

67 of the next say 7

1/4lb of next which will string the tennor.

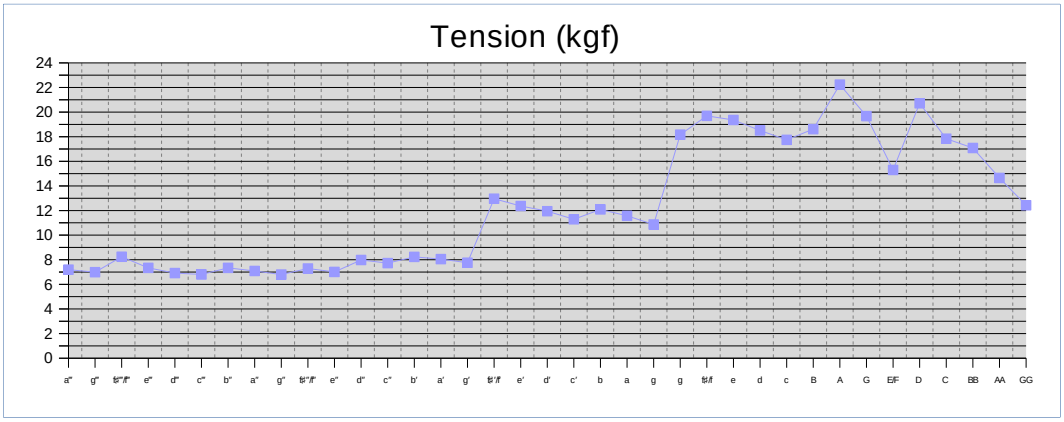
6 of the next

1/2 lib each of the 3 first numbers of brass wire.

3 wires of the next size

Longest wire / 5 wires of this / to be got in Flower the wire drawers Church St Dublin.

(read from bass to treble)



String lengths are measured from my full sized drawings, straightened and restored from a 3D scan of John Egan no.1933 (National Museum of Ireland, DF:1913.381) made in the 1820s for the Belfast Irish Harp Society