

ON EARLY METHODS OF BELL-FOUNDING.¹

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The earliest instructions in bell-founding that I can find appear to be those contained in the third book of the *Essay of Theophilus on Various Arts*. Mr. Hendrik, who edited the work for Mr. Murray in 1847, considers it to belong to the early half of the eleventh century. It is remarkable that the use of crooks here laid down does not appear in the other treatises to which I shall have to refer. I have not the book at hand, but I have transcribed the part which refers to "crooking," and runs as follows:—

"Compositurus campanam primum incidet tibi lignum siccum de quercu, longum secundum quod vis habere campanam, ita, ut ex utraque parte extra formam emineat longitudine unius palmi, et quadrum in una summitate grossius, in aliam gracilius et rotundum, ut possit in foramine circumvolvi. Sitque deductum (? deductum) grossius et grossius, ut cum opus fuerit perfectum facile possit educi. Quod lignum in grossiori parte una palma ante summitatem incidatur in circuitu, ut fiat fossa duobus digitis lata, sitque lignum ibi rotundum, juxta quam fossam summitas ipsius ligni fiat tenuis, ut in aliud lignum curvum jungi possit, per quod valeat in modum runcinæ circumverti. Fiant etiam duo asseres longitudini et latitudini æquales qui altrinsecus conjungantur et confirmentur quatuor lignis, ita ut sint ampli (ampla in cod.) inter se secundum longitudinem prædicti ligni; ut in uno assere fiat foramen in quo convertatur rotunda summitas et in altero e contra æqualiter fiat incisura duobus digitis profunda, in qua volvatur rotunda incisura. Quo facto, sume ipsum lignum et circumpone ei argillam fortiter maceratam, imprimis duobus digitis spissam, qua diligenter siccata, suppone ei alteram, sicque facies donec forma

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compleatur quantam eam habere volueris, et cave ne unquam superponas argillam alteri nisi inferior omnino sicca fuerit. Deinde colloca ipsam formam inter asseres superscriptos, et sedente puero qui vertat, cum ferris, ad hoc opus aptis, tornabis eam sicut volueris et tenens pannum in aqua madefactum eam æquabis."

Next in order come directions found in a treatise by Walter of Odyngton, a monk of Evesham, in the time of Henry III.¹

This manuscript, which through Archbishop Parker's care escaped the destruction attending on the Dissolution of the Monasteries, is No. 410 in his collection at Corpus Christi College, Cambridge. Mr. Lewis considers the copy to have been made in the fifteenth century. The Chapter on bells, headed in red ink, *De symbalis faciendis*, contains only eleven lines of text, and is to the following effect (recto of f. 17):

"Ad simbola facienda tota vis et difficultas extat in appensione ceræ ex qua formantur et primo sciendi quod quanto densius est tintinnabulum tanto acutius sonat tenuius vero gravius. Unam appensam ceram quantamlibet ex qua formandum primum cimbelum divides in octo partes et octavam partem addes tantæ ceræ sicut integra fuit, et fiet tibi cera secundi simbali. Et cetera facies ad eundem modum a gravioribus inchoando. Sed cave ne forma interior argillæ cui aptanda est cera alio mutetur, ne etiam aliquid de cera appensa addat ad spiramina, proinde et ut quinta vel sexta pars metalli sit stannum purificatum a plumbo, reliquum de cupra similiter mundato propter sonoritatem. Si autem in aliquo deficeris, cum cote vel lima potest rectificari."

He begins by saying that for making bells, the whole difficulty consists in estimating the models from which they are formed, and first in understanding that the thicker a bell is, the higher is its note, and the reverse. From the use of the word "cera" for a model, some might be inclined to infer that the bells of that time were cast in moulds formed by wax models, but no such instances are known to exist in England. When a bell is to be made, a core or central block is first formed, to which is fitted a model, or "thickness" of the bell that is to be. Outside

¹ Summus fratris Walteri monachi Eveshamie musici de speculatione musica.

the model comes the cope. These models seem to have been made at one time from wax. When complete, the outer earth, forming a cope, was rammed tightly round them. A fire was lighted, and the melted wax allowed to escape, the cavity being afterwards filled by the metal from the furnace. There was an easy way of ornamenting the outer earth, or cope, by laying on the model extra strips of wax in the form of letters, &c., which would have their imprint lighted on the cope. We have no instances of this kind in England, nor does there seem any probability of such a discovery. Mr. Lynam, in his *Church Bells of Staffordshire* (plates 3a and 3b), gives an interesting and well-executed drawing of what appears to be an inscription thus formed, from a bell at Fontenailles in Normandy, dated 1211, but he tells us nothing more about it. He also mentions similar lettering at Moissac, with the date 1273, recorded by Viollet le Duc. Our earliest inscriptions are set in separate letters, each in its own patera; and this would be impracticable, save by stamping the cope itself. In castings from wax models the cope is inaccessible. Hence we conclude that loam models were used in England while these instructions remained in the letter.

He proceeds to expound the estimation of the wax models of a ring of bells.

Starting with any given "model," for the first bell you take nine-eighths of it as a "model" for the second bell, and so on. If you start from the heavier bells and work on to the lighter ones you must use a like method, i.e., let each "model" be eight-ninths of the previous one. But take care lest the core to which the "model" is to be fitted be changed in a different proportion. Take care also that none of your allotted "model" get itself into the breathing holes. Then he gives directions about the metal—a fifth or sixth part of the metal to be tin purified from lead, and the rest copper, similarly cleansed, for sonorousness. Lastly, contemplating the abominable noise which would be sure to arise from these handiworks he says that if you fail in any point it can be set right with a whetstone or a file, of which the former would be used for sharpening purposes, grinding away the rim of the bell, and the latter for flattening, filing off the inner surface of the sound-bow.

Let us then imagine Walter of Odyngton attending to his own instructions. He starts by allotting a certain amount of wax for his first bell, makes his core by rule of thumb answerable to it, and then weighs both. By weight he gets his wax for the other bells, on the nine-eights system. The whole method is so obviously empiric that there is no ground for wonder at the necessity for burin, whetstone, hard chisel, file or any other tuning apparatus. Indeed the free use of these instruments may account for the almost total disappearance of bells of the Saxon and Norman periods.

We are next to consider an improved method. Unfortunately no date can be assigned to it. It is a little prose tract (C. II.), appended to an early poem called *Ars Musica*. The poem itself is attributed to Gerbertus Scholasticus, afterwards Pope Sylvester II., and if this be right we are carried as far as the poem is concerned beyond the Norman Conquest. But the chapter in which we are interested belongs to a much later time. It seems as though the unknown writer had known of Walter of Odyngton's method, had seen that his nine-eights made no difference between tones and semitones, and to have thus supplied a more workable plan :—

Should any one wish to regulate the sound of bells like that of organ-pipes he should know that thicker bells, like shorter pipes, have a higher note. But one must be careful in the weighing of the wax from which they are formed. He then proceeds to designate the various bells in a ring by letters :—

- The first, A.
- The second, B.
- The third, C.
- The fourth, D.
- The fifth, E.
- The sixth, F. and
- The eighth G.

It is needless to say that the absence of the mention of a seventh is very perplexing, and not at all to be accounted for by the first and eighth being in unison. Perhaps some master of mediæval music can solve the mystery. I am content to record the instruction as I find it.

B is formed from A, and C from B on Walter of Odyngton's nine-eighths system. But to get D, which is a "semitonium" from C, you take four-thirds of A. Then E is formed from D, and F from E on the nine-eighths system, but G from D (there being a "semitonium" between G and F) by taking four-thirds. It may be that the text requires emendation, but I am not bold enough to touch it.

The MS is Rawlinson c 720, in the Bodleian Library, and the passage, as follows, occurs on f. 13, recto and verso :—

"Sonitum Tintinnabulorum si quis rationabiliter juxta modum fistularum organicarum facere voluerit scire debet quia sicut fistule breviores altiozem sonum habent quam longiores, ita et unumquodque tintinnabulum quantum superat densitate alterum tantum excellit et sono. Quod caute providendum est in appensione ceræ qua formantur. Ad primum autem quod est A littera quali volueris pondere ceram appende, dividesque illam ipsam ceram æque in octo partes, ac recipiat sequens, B videlicet, ejusdem appensionis iterum octo partes alias, addita insuper nona parte. Illasque novem partes in unum collige, dividesque in octo, recipiat tertium quod est C. eadem appensione octo alias partes, addita etiam parte nona ejusdem ponderis. Tunc primi appensionem divide in tres partes, supereturque a quarto quod est D quarta parte, hoc est semitonium. Item divides quartum in octo supereturque a quinto quod est E. nona parte, dividesque similiter quintum in octo et recipiat sextum quod est F nonam partem amplius. Quartum nichilominus in tres partes æque appensum ab octavo quod est G superetur quarta parte, hoc est semitonium."

According to my calculation the models of the seven bells would be in this ratio

A	8
B	9
C	10·125
D	10·6
E	12
F	13·5
G	14·2

These calculations, though probably derived from Theophilus, do not seem altogether his; and though there are apparently no children of the *cire perdue* method remaining in England, and very few on the Continent, it is yet possible that a sequence of two or three may be found, to be compared practically with these various written directions.