VITRUVIUS AND ACOUSTIC JARS IN ENGLAND DURING THE MIDDLE AGES

By Kenneth Harrison, F.S.A.

WRITERS on ecclesiastical architecture have discoursed often enough on the fitness of mediaeval church planning for the rites and ceremonies of religion, and the processions and pageantries that accompanied them. We have been reminded, too, of the instruction provided by statuary and fresco and painted glass; we realise that churches then combined the functions which are spread over a variety of buildings today—theatre, assembly room and picture gallery, and on occasion (I fear) barn, brewery, or dance-hall. But in treating of churches as vehicles (so to speak) of the Liturgy, not enough has been said about two subsidiary aspects of worship—preaching and music. It is unlikely that medieval man would have enjoyed a sermon he could not hear, or the sound of singing and chanting in a "dead" building. Some effort will have been made to ensure that the human voice reached its destination in an intelligible and agreeable form; or at least, the advantages of audibility and resonance would not pass without notice. I am not pretending that there was any organised corpus of knowledge in this branch of architecture: the masons themselves have left little in the way of writings or drawings; there was next to nothing that we should now call "criticism". We can only collect the scattered hints from a variety of sources.

It is fortunate that the most gifted of mediaeval English poets was also a scientist. The nature of sound was well understood by Chaucer, and illustrated with a homely example:

> The rumbling of a fart, and every soun,
> Nis but of air reverberacioun.[1]

[1] Somnour's Tale, ed. Skeat, 2233–34.

In the House of Fame he explains how speech and musical sounds are akin:

> Soun is noght but air y-broken,
> And every speche that is spoken,
> Loud or privee, foul or fair,
> In his substance is but air . . . (765–68)
> But this may be in many wyse,
> Of which I will thee two devyse,
> As soun that comth of pype or harpe.
> For whan a pype is blowen sharpe
> The air is twist with violence,
> And rent; lo, this is my sentence;
> Eek, whan men harpe-stringes smyte
> Whether hit be moch or lyte
> Lo, with the strook the air to-breketh;
> Right so it breketh whan men speketh. (771–80)

He goes on to discuss the analogy between sound and water waves, and their spherical propagation, first laying emphasis on the experimental evidence:

> I preve hit thus—take hede now—
> By experience; for if that thou
> Throwe on water now a stoon,
> Well wost thou, hit will make anoon
> A litel roundel as a cercle . . . (787–91)
> And right thus every word, y-wis,
> That loud or privee spoken is,
> Moveth first an air aboute,
> And of this moving, out of doute,
> Another air anoon is meved,
> As I have of the water preved,
> That every circle causeth other;
> Right so of air, my leve brother. (809–16)

I have quoted from Chaucer at length because, unlike most literary men of his time (or any other), he could assimilate and

express the scientific notions that were then current. So far as I know, only a few more scraps can be gleaned from his contemporaries, none of which greatly advance our understanding. We must therefore turn to the practical side, namely, the acoustic jars that were sometimes put into mediaeval churches. These jars are vessels of earthenware, with or without handles, in the customary fashion of cooking-pots, urns, or pitchers for domestic use. Nearly all the surviving examples are of modest size: about a foot high, and about five or six inches wide at the mouth.[2] The bulk of them appear to belong to the 15th century. They occur in churches all over England, monastic and secular, placed in such a variety of positions as to suggest that the masons, or their employers, were making experiments almost at random. The object of these jars is revealed by a French source, the Metz Chronicle (1432): "En cest année dessus dit, ou mois daoust le vigile de l'assumption Nostre Dame, aprez ceu que frère Ode le Roy, priour de seans, fuit retournez du chapitre général de dessus dit, il fit et ordonnoit de mettre les pots au cuer de l'église de seans, portant qu'il avoit vu altepart en aucune église et pensant qu'il y fesoit milleur chanter et que il ly resonneroit plusfort. . . . Mais je ne seay si on chante miez que on ne fasoit."
This passage[3] leaves no doubt of the ideas that were then floating round; but there seem to have been differences of opinion, at any rate in England, about translating these ideas into practice:

(a) Sometimes the jars were placed in the chancel of the church, in a pit or cavity below the choir stalls. Examples are: St. Nicholas, Ipswich (several jars); St. Peter Mancroft, Norwich (40); St. Peter Mountergate, Norwich (16); All Saints, Norwich (16); Fountains Abbey, Yorks. (9); St. George's Chapel, Windsor (2);[4] the Beauchamp Chapel, Warwick (no jars, but spaces left for

[2] Many are figured by G. M. Hills, *Transactions of the Royal Institute of British Architects*, 1882, p. 65. This paper summarises the literature before that date; later discoveries are also noted below.

[3] Quoted by Hills, *op. cit.*, from A. N. Didron, *Annales Archaeologiques*, 1862, Vol. 22, p. 296.

[4] M. F. Bond, *Report of the Society of the Friends of St. George's*, 1953, p. 8. This article mentions pots at Wimborne for 'wyndfylling' the church, which cannot however be acoustic, since 'wyndfylling' means stopping up holes (with clay, etc.) *Vide* O.E.D.

them).[5] To which may be added the old chapel of Pembroke College, Cambridge (7 jars, in niches under the floor);[6] and Howden (East Riding, Yorkshire).[7]

(b) Usually, however, the jars were fitted into the walls of the church above ground level, with their mouths opening inwards to the nave or choir. From their design and situation we may infer the following points:

(i) Some were specially manufactured: Leeds, Kent (about 50, with their bottoms perforated); Luppit, Devon (about 6, flattened on one side).

(ii) Some, though of the ordinary domestic type, were fitted very carefully, and not merely cemented into the wall: Denford, Northants. (4, behind openings in the stonework);[8] St. Mary Tower, Ipswich (1, behind a pierced slab of stone, carved into a quatrefoil).[9]

(iii) Others were placed in rough cavities, or embedded in the wall without any special preparation, or merely laid on the wall-plate: St. Andrew, Ashburton, Devon (about 10); Tarrant Rushton, Dorset (2);[10] St. Olave, Chichester (2); St. Clement, Sandwich (3); Newington, Kent (3); Bucklesham, Suffolk (3); East Harling, Norfolk (4); Lyddington, Rutland (10);[11] Upton (6) Notts;

[5] P. B. Chatwin, *Transactions of the Birmingham Archaeological Society*, 1928, Vol. 53, p. 155.

[6] T. McKenny Hughes, *Proceedings of the Cambridge Antiquarian Society*, 1915, Vol. 19, p. 63. This chapel was built before 1400.

[7] Henry Johnston's Yorkshire Tour, 1670: Bodleian MS. Top. Yorks. c. 14, f. 241b. I am grateful to Mr. John Harvey, who discovered this entry, for a copy of Johnston's two sketches. There will have been 16 pots in all, as in two of the Norwich churches.

[8] V. C. H., *Northamptonshire*, 1930, Vol. 3, p. 194. The work appears to be of the 13th century.

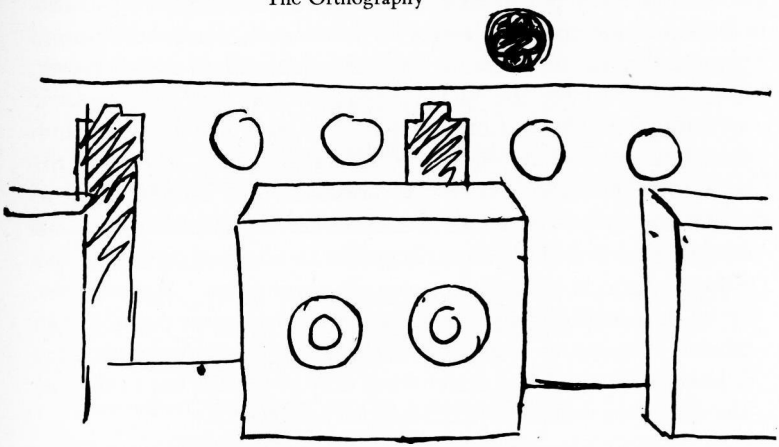
[9] And at St. Mary, Youghal, Co. Cork (10, also behind openings in the stonework). Acoustic jars from the Continent are not included in this list; they range from the South of France to Sweden and Russia. Cf. T. Wahlin, *Antikvariska Studier 3, Kungliga Vitterhets Hist. och Antik. Akad. Handl.*, 1948, Vol. 65, p. 187. The jars at Bosjökloster, 49 in number, date from the 12th century. I owe this reference to Mr. John Harvey.

[10] [The Rev.] J. H. W[ard], *Somerset and Dorset Notes and Queries*, 1895, Vol. 4, p. 30.

[11] V. C. H., *Rutland*, 1935, Vol. 2, p. 193.

"After this manner folowing stand the remains of some Earthen potts in the Quire at Hoveden wch were under the seats [of the stalls] for the advantage of sound having a hole open from them in to the Quire after this manner

The Orthography



The diamiter of the mouth of one of the potts is $5\frac{1}{4}$ Inches and 2 Inches & $\frac{1}{2}$ from the mouth the diam is $10\frac{1}{2}$. The bottom 9 Ins. the Inside length $17\frac{1}{2}$ Inches. The greatest Inside Diam. is 12 Inches

4 frames wth 2 pots apeice on one side

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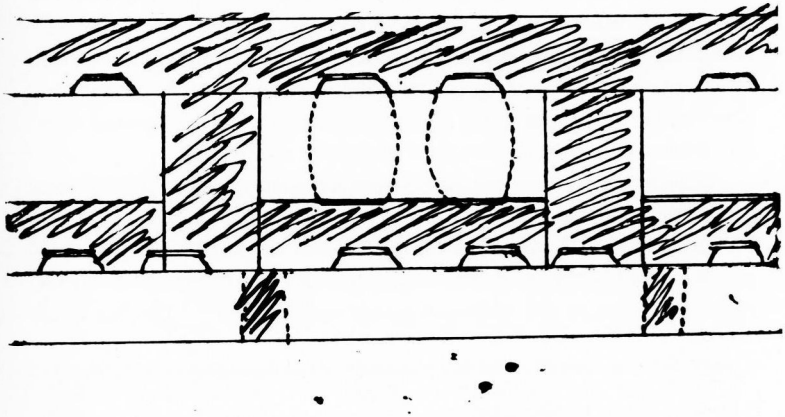

ACOUSTIC JARS: SKETCHES MADE AT HOWDEN, 1670, BY HENRY JOHNSTON.

Great Milton, Oxon. (1);[12] Fairwell (or Farewell), Staffs. (numerous jars, in several rows); and, doubtfully, Ford, Sussex (1 or 2).

Occasionally the mouths of this third class of jar, when discovered in the course of repair or restoration, have been found plastered over or even, as at Sandwich, filled with mortar. Generally speaking, the evidence suggests that they were covered up long after they had been fixed. We may dismiss the notion that they were introduced for structural purposes, to lighten the walls; the intention was to add resonance and amplification to speech and music. That the intention failed is clear from the last doubting remark of the Metz chronicler; a marginal comment, in a different hand, is downright rude—*Ecce risu digna.* Nevertheless, for all their ineffectiveness, acoustic jars are a valuable pointer to an attitude of mind, as showing what some medieval designers were in search of—a building grateful not only to the eye but to the ear. The Pardoner would have relished such a one:

> "Lordings" quod he "in churches whan I preche
> I peyne me to have an hauteyn speche
> And ring it out as round as gooth a belle."[13]

It is precisely at this ringing, resonant quality, as opposed to echo and reverberation, that the masons may be supposed to have aimed. And they were not deceived by that useless appendage, the flat sounding-board,[14] so frequently added to pulpits in post-Reformation times. Where canopies occur over medieval pulpits—and they are uncommon—their function is purely decorative.

Hitherto, acoustic jars have been considered to represent the last remnants of a tradition going back to Vitruvius, who in his *De Architectura* (V. 5) refers to the brazen or earthenware vessels (ἠχεῖα) which were built into Greek and Roman theatres in order to lend support to the voices of actors and singers.[15] But we need

[12] Sir H. E. L. Dryden, *Report of the Oxfordshire Archaeological Society*, 1895, No. 35, p. 23.

[13] Pardoner's Tale, ed. Skeat, 329–31.

[14] F. P. Whitman, *Science*, 1913, Vol. 38, p. 707; 1915, Vol. 42, p. 191.

[15] Hills, *op. cit.*, Hughes, *op. cit.* A recent writer says that "though the work of Vitruvius was supposedly lost during the Middle Ages . . . perhaps some copies of his work . . . were still known and referred to" (L. Arnaud, in T. F. Hamlin, *Forms and Functions of 20th Century Architecture*, Oxford, 1952, Vol. 1, p. ix). The Vitruvian theory is carefully explored by J. G. Landels, 1967, *Greece and Rome*, Vol. 14, p. 80.

not rely upon anything so shadowy or uncertain as tradition. Although it cannot be said that Vitruvius was a popular author during the Middle Ages, his treatise was to be found in a good many libraries in England. Of copies that can be identified as belonging to particular institutions there are six surviving:

1. Canterbury, St. Augustine, 11th century.[16]
2. Canterbury, St. Augustine, dated 1316.[17]
3. Canterbury, St. Augustine, 14th century (extracts only).[18]
4. Canterbury, Christ Church, 14th century (extracts only).[19]
5. Winchester, 13th century (extracts only).[20]
6. Malmesbury (or Glastonbury), extracts copied from a St. Augustine's, Canterbury, version by William of Malmesbury, *circa* 1130; B. M. Harl. 3969.

Six others, now lost, can be accounted for:

7. Canterbury, Christ Church, recorded *circa* 1300.[21]
8. York Austin Friars, catalogue of 1372.[22]
9. Bury St. Edmunds, recorded in the 14th century and *circa* 1540.[23]
10. Ely, recorded *circa* 1540.[24]
11. Oxford University Library, given by Duke Humphrey, *circa* 1440.[25]
12. King's College, Cambridge, recorded 1452.[26]

[16] N. R. Ker, *Medieval Libraries of Great Britain*, London, 1941, p. 28. I have not tried to list MSS of uncertain provenance; several appear to be based on this oldest Canterbury MS.

[17] Ker, *op. cit.*, p. 30.

[18] Ker, *op. cit.*, p. 26.

[19] Ker, *op. cit.*, p. 21.

[20] K. A. De Meyeir, *Transactions of the Cambridge Bibliographical Society*, 1952, Vol. 1, p. 358.

[21] M. R. James, *Ancient Libraries of Canterbury and Dover*, Cambridge, 1903, No. 267.

[22] M. R. James, *Fasciculus J. W. Clark dicatus*, Cambridge, 1909, No. 469.

[23] M. R. James, *Cambridge Antiquarian Society's Publications*, 1895, Vol. 28, p. 29; J. Leland, *Collectanea*, ed. Hearne, London, 1770, Vol. 4, p. 163.

[24] Leland, *op. cit.*

[25] [Sir] H. H. E. C[raster], *Bodleian Quarterly Record*, 1915, Vol. 1, p. 135. If Duke Humphrey thought that Vitruvius was a novelty in England he was mistaken.

[26] M. R. James, *Catalogue of the MSS, King's College*, Cambridge, 1895, p. 74. I owe this reference to Mr. N. R. Ker.

We may therefore infer that many of the larger religious houses would have had a copy of Vitruvius, sometimes more than one; and it is not difficult to realise how the knowledge of ἠχεῖα would be noised about, from monk to master-mason, and so through the fraternity. Indeed, some of the masons could have read Vitruvius for themselves. The concentration of Vitruvian MSS and acoustic pottery in Kent and East Anglia may or may not be significant; the survival of both has been too haphazard to allow of any firm conclusions.

In the *Problemata* attributed to Aristotle there is a curious passage (XI. 8) which has been thought to have a bearing on the medieval use of acoustic jars:[27]

'Why is it that if one buries a large jar or empty pot with a lid on, the building echoes more, and also if there is a well or cistern in the house? Is it because, since echo is refraction, the air must be compactly enclosed, and have something from which it can be refracted, when it strikes on what is thick and smooth? For in these conditions the echo is most noticeable. So the well and the cistern combine the qualities of narrowness and compactness, but jars and pots have thickness in their sides, so that the same result occurs in both cases. For hollow bodies produce more echo; and for this reason bronze produces more echo than other metals. It is not strange that this happens when they are dug in; for the voice carries downwards no less than in any other direction.'[28] At most these remarks would serve to explain why jars were placed beneath the pavement, whereas (we have seen) the majority in England are sited above ground level. Besides, this pseudo-Aristotelian work was not translated from the Greek until 1438, and then in Italy: the first printed edition appears at Mantua in 1473, far too late to have influenced architectural practice in 15th-century England, let alone earlier. And very few scholars in the Middle Ages could read Greek, whereas the Latin text of Vitruvius had been established in English libraries since Norman times, and he ranks among 'the scientific and technical authors of all kinds, whose works found their way into even the remotest monastic

[27] W. Reusch, *Trierer Zeitschrift für Geschichte*, 1949, Vol. 18, p. 226. I owe this reference to Mr. Harvey.

[28] *The Problems of Aristotle*, tr. W. S. Hett, London, 1953, p. 259.

book-cupboard.'[29] There cannot be much doubt that acoustic jars in England derive from Vitruvius, and from him alone.

Finally, it is worth noticing certain trends in the development of medieval architecture that led to improved acoustics. The barrel vaults of Romanesque construction bring sound waves to a focus, and locally intensify an echo, 'the rebounding of noyse';[30] they were superseded by coffered roofs, of which the fan-vaulted type was the latest to arrive and the most efficient in diffusing sound. Apses likewise yielded to square-ended chancels and chapels. The most significant advance, however, was that great expanses of wall, which only reflect sound, gave place to huge resonant windows. It is easy to feel the sympathetic vibration of leaded panes in a church window by putting a finger on the glass while the 32 ft. pedal notes of the organ are being played. And large panels of leaded glass resemble wood panelling in having a relatively high absorption for the lower frequencies of sound waves and a relatively low absorption for the higher frequencies —a property that contributes to brilliance of tone.[31] An early example of the increasing ratio of window-space to wall is to be seen in the Lady Chapel at Ely, built between 1320 and 1340; it is very resonant, and its excellence as a concert room has often been remarked.[32] Constructions of this sort, more glass than wall, behave rather like violins. The Chapel of King's College, Cambridge, planned by the master-mason Reginald of Ely in the

[29] Dom David Knowles, *The Religious Orders in England*, Cambridge, 1955, Vol. 2, p. 338. A printed copy of the *Problemata*, most likely the Aldine edition of 1497, appears among the books of Henry Bullock, the Cambridge humanist, who died in 1526 (cf. E. P. Goldschmidt, *The First Cambridge Press*, Cambridge, 1955, pp. 69–70). Another copy was preserved at Syon *circa* 1520 (cf. M. Bateson, *Catalogue of the Library of Syon Monastery*, Cambridge, 1898, p. 23). The only MS copy of the *Problemata* known to me is that recorded at the Cambridge University Library in 1424; presumably it was in Greek (cf. H. Bradshaw, *Cambridge Antiquarian Communications*, 1864, Vol. 2, p. 252).

[30] O.E.D., under Echo (1485).

[31] Glass also transmits sound and therefore helps to keep reverberation at a low level.

[32] Dr. Sidney Campbell, lately organist of Ely, tells me that the reverberation time of this Chapel when empty is just over $4\frac{1}{2}$ seconds, a figure that would be about halved by the usual medieval practice of hanging tapestries, and strewing rushes on the floor, and thus admirably adapted to slow and solemn Gregorian strains. Those who object to the over-reverberant qualities of a Gothic cathedral today should bear in mind that we seldom hear such buildings as contemporaries heard them.

middle of the 15th century, appears to be a 'blown-up' version of the Ely Lady Chapel. When the windows were taken out during the war of 1939–45, and roofing-felt was put in their place, the building became 'dead'.

Thus before the Reformation churches were being designed which to the ear compare very favourably with many a modern concert hall. It would be as foolish to suppose that new methods of building were introduced primarily for acoustic reasons as to attribute our present knowledge of the theory of sound to a set of horny-handed masons. But we may be confident that gains in audibility and resonance would not have been overlooked; and the mere existence of acoustic jars is enough to prove that deliberate policy was sometimes at work, even in remote villages, when others beside Chaucer had a working acquaintance with the properties of sound. Perhaps there was more musical refinement amid the rough-and-tumble of the Middle Ages than we ordinarily make allowance for. For the relation between Chaucer and Vitruvius, see J. A. W. Bennett, *Chaucer's Book of Fame*, Oxford, 1968, p. 79, where the relation between Chaucer and Vitruvius is discussed.