A Study of Cross-Hatched Gold Foils in Anglo-Saxon Jewellery

By RICHARD AVENT

Inspectorate of Ancient Monuments, Department of the Environment

and

DAVID LEIGH

Department of Archaeology, University College, Cardiff

IN THE last few years interest has focused increasingly on various aspects of the manufacture of migration period and early medieval jewellery. The gold content of this jewellery has been the subject of chemical analyses, the production and use of garnets has been reassessed, and casting techniques are being reviewed in the light of the workshop discoveries at Helgö, Sweden.[1] The present study is concerned with the wafer-thin pieces of cross-hatched gold foil used as backings for garnet and glass settings on jewellery of the 6th and 7th centuries. The foils give life and brilliance to the inlays by virtue of the glittering effect produced by their many-faceted surfaces; an effect which on jewellery would have been enhanced by the movement of the wearer.[2] It is a technique now replaced by the faceting of diamonds and other precious stones, and yet still employed, though to markedly different ends, in the rear reflectors of motor cars. The use of gold, although partly dictated by its technical properties[3] and its availability as foil[4] also adds a depth of colour to otherwise pale garnets and,

[1] On gold analyses, S. C. Hawkes, J. M. Merrick, D. M. Metcalf, 'x-ray fluorescent analysis of some dark age coins and jewellery', *Archaeometry*, IX (1966), 98–138; P. D. C. Brown and F. Schweizer, 'x-ray fluorescent analysis of Anglo-Saxon jewellery', *Archaeometry*, XV (1973), 175–92; W. Holmqvist, et al. *Excavations at Helgö*, IV, *Workshop*, pt. I (Stockholm, 1972); and for instance K. Lamm, 'The manufacture of jewellery during the migration period at Helgö in Sweden', *Bull. Historical Metallurgy Group*, VII (ii) (1973), 1–7; T. Capelle, H. Vierck, 'Modeln der Merovinger- und Wikingerzeit', *Frühmittelalterliche Studien*, V (1971), 42–100; T. Capelle, H. Vierck, 'Weitere Modeln der Merowinger- und Wikingerzeit', *Frümittelalterliche Studien*, IX (1975), 110–42. Of particular relevance to the present study, B. Arrhenius, *Granatschmuck und Gemmen aus Nordischen Funden des frühen Mittelalters* (Stockholm, 1971). See also S. C. Hawkes, 'The Monkton brooch', *Antiq. Jnl.*, LIV (1975), 244–56.

[2] Although most settings are of garnets, there is a small proportion in which pink or red glass has been used in imitation. For the purposes of the present study we have made no distinction between garnets and other settings. It may be asked what advantage garnets have for jewellery over glass. One answer may be the somewhat higher refractive index of the former (garnet *c.* 1.8; glass, *c.* 1.5). This results in greater refraction of incident light rays by the setting and thus a smaller critical angle for internal reflection, causing more light to be bounced back and forth between the foil and the top surface of the garnet; in short, creating more sparkle.

[3] See below, p. 3.

[4] See below, p. 3.

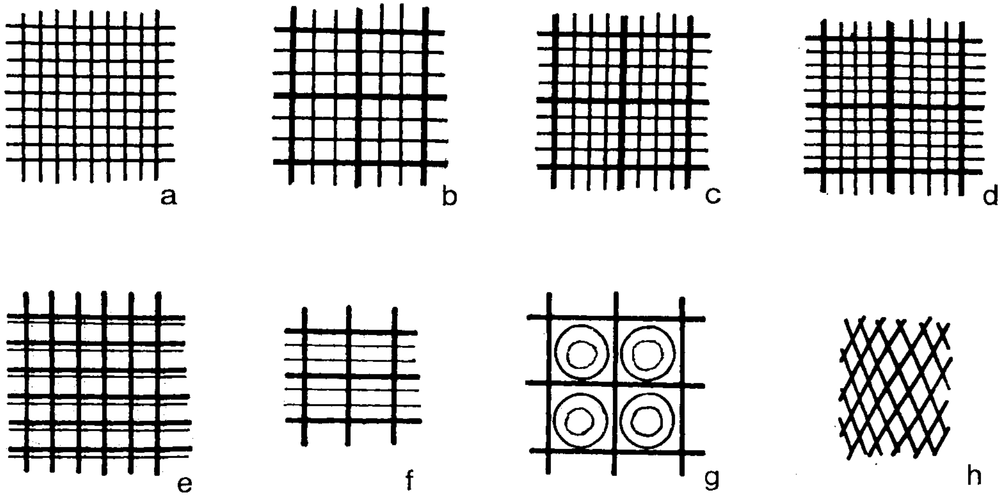

FIG. 1

FOIL PATTERNS (STYLIZED) Sc. *c.* 10:1

a, standard; *b*, boxed; *c*, *d*, special boxed; *e*, *f*, irregular patterns; *g*, ring-stamped; *h*, lozenge pattern

indeed, its absence on certain pieces of jewellery only serves to emphasize this. The inlays are found in settings formed either by raised cells cast in one with the object, or as the cells of a more elaborate cloisonné mosaic.

The foils have a thickness of about 0.03 mm. The ridges or grooves which make up the cross-hatched patterns are of a similar depth and are spaced at between 2 and 4.5 lines to the millimetre. These patterns may be divided into two main groups which we refer to as *standard* and *boxed*. The ridges (or grooves) of the standard foils (PL. I, A, B; FIG. 1, a) form a simple uniform pattern of squares. Boxed foils (PL. I, C; FIG. 1, b) have wider and deeper ridges (or grooves) surrounding a number of standard squares, so that the overall appearance is of large squares with smaller squares, usually nine in number, within them. Occasionally, however, sixteen or twenty squares appear within each box, and we call foils having such a pattern *special boxed* foils (PL. I, D; FIG. 1, c, d).

In this paper we present the results of a survey of over 500 pieces of foil on 181 objects and we seek to answer two questions. First, how were the foils produced? Secondly, is there any possibility of identifying individual foil patterns and, if so, of relating these to the objects, or groups of objects, which bear them? We hope that in answering these questions we may begin to approach an understanding of the workshop practice and organization of migration-period jewellers. However, before we can progress to a presentation of the survey evidence and its analysis and interpretation, we must attempt to establish the method of manufacture, for unless we can confine and unify our preconceptions on this score it will be difficult to draw reliable conclusions from the mass of accumulated data.

MANUFACTURE

Gold is an easily worked metal and from the earliest times must have presented little difficulty to smiths, who could have hammered it, without annealing, into a foil.[5] There are to our knowledge no published chemical analyses of the foils studied here, nor more than the occasional analysis of other types of gold foil such as brocading strips forming gold braids in head-dresses and on the borders of garments.[6] However, we may speculate that, at least in the later part of our period, the composition of the alloy used was similar to that used for the manufacture of solid gold jewellery of the same date, for which there is now an extensive body of analyses which indicates a silver content of generally about 10 to 40 per cent and a copper content of a few per cent.[7] This in turn is thought to reflect the composition of continental gold coinage of the late 6th and the 7th centuries.[8] Alloys of this sort, although intended primarily for coinage, not for jewellery, would have possessed the necessary properties for being beaten out into a thin foil and its subsequent working in one of the ways we postulate. That these mechanical properties were highly prized may perhaps be concluded from the observation that such gold foil was being used at a time (the 6th century) when gold was not readily available in England.[9] In fact, in the 6th century the only other principal use of gold, apart from the braids already mentioned, was for gilding silver or copper alloy objects, which involved only a very sparing use of the metal.

It may be asked whether the gold foil used in the braids could have been the same as that used for our cell inlays. A conclusive answer to this must await chemical analyses of the two sorts of foil, but it is worth noting that the thicknesses of a few measurable examples are within one order of magnitude: three loose foils from Taplow have mean thicknesses of 0.031 mm. each (at points where the pattern no longer exists); thicknesses of some braids from Faversham are 0.065 and 0.053 mm. (no. ii), and 0.060 mm. (no. iv).[10] These thicknesses are far in excess of the thickness of modern gold *leaf* (0.0001 mm.) or even Roman gold leaf (0.0002 mm.),[11] but similar to that of, say, modern aluminium (cooking) foil (0.025 mm.).

We consider there to be three possible ways in which these foils could have been manufactured:

i) A sheet of hammered gold foil was placed on a supporting but slightly plastic surface and the evenly spaced grooves were ruled on to it with a suitable

[5] R. J. Forbes, *Studies in Ancient Technology*, III (Leiden, 1964), 154.

[6] E. Salin, 'Les tombes gallo-romaines et mérovingiennes de la basilique de Saint-Denis (fouilles de Janvier-Février 1957)', *Memoires de l'Académie des Inscriptions et Belles-Lettres*, XLIV (1958), 48, cited in S. C. Hawkes and E. Crowfoot, 'Early Anglo-Saxon gold braids', *Medieval Archaeol.*, XI (1967) 44.

[7] Hawkes, et al., op. cit. in note 1; Brown and Schweizer, op. cit. ibid.

[8] Brown and Schweizer, op. cit. in note 1; J. P. C. Kent, 'Gold standards of the Merovingian coinage, A.D. 580–700' in E. T. Hall and D. M. Metcalf (eds), *Methods of Chemical and Metallurgical Investigation of Ancient Coinage* (Royal Numismatic Society Special Publication, London, 1972), 69–74.

[9] R. Avent, *Anglo-Saxon Garnet Inlaid Disc and Composite Brooches* (*British Archaeological Reports*, XI, Oxford, 1975), i, 8.

[10] Those pieces of braid described and numbered as here in Hawkes and Crowfoot, op. cit. in note 6, 69.

[11] Forbes, op. cit. in note 5, 181, using Pliny the Elder, *Natural History*, XXXIII, xix, 61.

tracing tool. The foil was later cut up to fit the cells. There are a number of objections to this theory. Such a technique would place considerable strain on the foil at the point of contact with the tool and would almost certainly result in some pulling, crinkling or even tearing of the foil. Secondly, it is difficult to suggest a supporting medium which would have the necessary mechanical properties to permit the tracing of the sharp-contoured groove that we see without bending the foil downwards on either side of the groove or, at the other extreme of hardness, risking cutting the groove through to the far side of the foil — an accident never noticed in our observations of foils. Moreover, it seems unlikely that such a technique could result in so even-depthed a groove as seems generally to be the case. Finally, and convincingly, to the authors at least, the patterns do not *look* as if they were traced.

ii) Maryon suggested that the rows of squares forming the pattern were made by impressing a specially notched chisel-like tool and that the pattern was built up by repeated blows of this tool at a regular spacing all over the surface.[12] This would seem to us to be a most laborious and, at the required scale, almost impossible process, but in any case it is plain to see, under even low-power magnification (e.g. PL. I, B) that the ridges (or grooves) are smooth unbroken lines, that the pyramids are there by default, as it were, and that the lines are the dominant feature.

iii) The pattern could have been *stamped* on to foil laid on a firm but slightly plastic surface; sheets made in this way could have been cut up later to fit the cells. This is a technique which tallies with the visual appearance of the foils, and which we suggest was the method used.

Convincing evidence comes from the occasional foil where it has been possible to identify one stamped impression abutting the next, suggesting that a large sheet of foil had been stamped more than once. Examples of this can be found on a Class 3.2 keystone garnet disc brooch from Faversham (Catalogue no. 38) and on a square-headed brooch from Gilton (Catalogue no. 84). On another square-headed brooch from Bifrons (Catalogue no. 80) the grooves of the two separate impressions are not properly aligned and this seems to reflect a careless stamping of the original sheet of foil. On a Class 4 keystone garnet disc brooch from Sarre (Catalogue no. 44) the two impressions are set at completely different angles to one another and this provides further, and more or less conclusive, evidence that the pattern must have been stamped and not ruled on to the sheet of foil.

If this explanation is accepted, it remains to debate the material of which the stamp was made. The most likely candidates seem to be copper alloy, lead, wood or bone. Hardened iron tools would have been available for engraving the pattern in copper alloy, but there seems to be little other evidence at this time for metal engraving. Had this method been used, it seems probable that some metal burr would have remained on the stamp and that the impressions of this could have been, but were not, microscopically detectable on the surviving stamps. In addition, it would have been extremely difficult to cut fine lines, of the type found

[12] H. Maryon, *Metalwork and Enamelling* (5th edn. London, 1971), 79.

on these foils, with such smoothness and regularity into this type of material. There is, however, the possibility of a *cast* copper alloy having been used, the pattern or model for the casting having been made in some more plastic material such as wood or wax. We have evidence for the use of copper alloy matrices for the production of repoussé decoration.[13]

Lead might have provided a suitable medium in which to cut the pattern — certainly softer than copper alloy — but there might still have been some traces of metal burr and, if an engraving tool was used, it would remain difficult to cut a sufficiently even line. On the other hand, if the lines had been traced, the cutting tool would probably have blunted rather quickly, although this may not be a substantial objection. The chief objection must be to the very softness of lead which would make it deform and quickly lose its pattern after relatively few blows on to the foil.

Far more likely and more obvious materials must surely be wood and bone (or antler), which seem to us to possess the properties needed to allow fine, even-depthed lines to be cut into them with ease. We should not wish to choose between the two materials. Bone and antler are known to have been used for fine decorative work at this period (e.g. bone trial pieces and decorated bone combs). Wood, though rarely surviving, is likely to have been used for similar purposes. We know that fine-grained woods were available: such as yew, for making bucket staves and bows; and no doubt also box, used extensively by the Romans for fine woodwork such as combs, and likely to have been available in this country throughout our period.[14]

There is some evidence which inclines us to think that a fine-grained wood was used, at least for the manufacture of some foils. Close inspection of a number of foils shows there to be, superimposed on the intended pattern, a much finer and more faint pattern of roughly parallel, but not always straight lines which seem to correspond with the grain of a fine-grained wood (PL. II, D). In the course of making our survey we were not looking for this feature and it may be that it is more common than might be suggested by the four or five examples which we have noted, although it is by no means universal. One possible alternative explanation for the grain effect might be ivory, but, since it is much harder than wood, it is unlikely that its much finer grain could be transferred to the gold foil. Furthermore, the spacing of the grain lines on the foils of about fifty lines to the millimetre, corresponds most closely with the fine spacing of the grain on a fine textured wood (the lines within the growth rings, rather than the growth rings themselves). However, a third possibility is that the lines are striations associated with the finishing stage of foil manufacture.

In order to test this theory some experiments were performed; these are described in the Appendix and some of the results illustrated in PL. III, A, B. The experiments showed that it is possible to stamp metal foil with the desired pattern by using a stamp of fine-grained wood. We do not claim to prove that this was the

[13] T. Capelle, H. Vierck (1971), op. cit. in note 1, 66 ff.; idem (1975), op. cit. ibid., 123 f.
[14] H. Godwin, *History of the British Flora* (Cambridge, 1956), 181.

method used, but the possibility would seem to be strong. Other materials may equally well have been used: bone, as already mentioned, and copper alloy which could have been made from a wooden model. A metal stamp would have had a longer life than a wooden one. However, it is debatable whether a casting could reproduce such a fineness of detail as was necessary, and indeed our observations of foils have not revealed any minor blemishes such as one would have expected almost certainly to survive.

We have also shown that it is possible to rule by eye thin parallel lines with lines spaced evenly at about three per millimetre; that using this method stamped patterns were unlikely to be more than about 20 mm. across; and that boxed patterns could be created by cutting extra deep lines on to a standard pattern.

We have no way of knowing how large a foil was before it was cut up for mounting into cells. Commonsense and our observations, however, conspire to suggest that sheets of foil of some size, say 50 mm. square at least, were stamped all over by repeated blows of the stamp, and that the sheet was cut as required to the desired shape formed by the cell walls, generally discarding edges, junctions and other blemishes. To cut plain foil to such small sizes (rarely more than 10 mm. across, and usually less), and then to attempt to stamp it would have been a singularly tiresome process; the safe handling of tiny pieces of foil without loss or damage is clearly extremely difficult. What has become plain from our observations is that the cutting of the sheet foil into pieces was not always carefully performed. In instances too numerous to mention, we have seen the shapes of the pieces only roughly corresponding with the shapes of the garnets above.

FOIL SURVEYS

Our findings are based on two sets of measurements of the spacings of the ridges (or grooves) on the foils, expressed in lines per millimetre (l./mm.). The figures were derived by counting the number of lines viewed over a convenient number of millimetres, either directly through a microscope (Group 1) or indirectly, on photographs (Group 2). Group 1 (TABLE I) is the larger set of observations made on every visible piece of foil on each of 169 objects from six major collections.[15] The objects include round and square-headed brooches, pendants, buckles, spoons, etc. The smaller set of readings, Group 2 (TABLE III) is based on accurate and repeated measurements on every visible piece of foil on high-quality photographs of thirty-one square-headed brooches, including nineteen from the Group 1 survey. The two methods have produced slightly different, though still comparable, results for the same set of brooches, and they thus provide a valuable cross-check. Slight differences are to be expected when using different techniques of measurement and must be due to small systematic errors in one or both of the techniques which cannot readily be detected. As will be

[15] The six collections are in the Ashmolean Museum, Oxford; Merseyside County Museums, Liverpool; Maidstone Museums and Art Gallery; Royal Museum and Public Library, Canterbury; Department of Medieval and Later Antiquities, British Museum; and the Maison Dieu Collection which is temporarily housed in the Ancient Monuments Laboratory, Department of the Environment, Fortress House, London.

seen, however, they do not stand in the way of general observations on groupings and distributions.[16]

It may assist the reader to be informed of the terminology to be used in the following discussion. Where a piece of foil is so placed in its setting that its ridges appear to be upstanding we denote its position as being *positive* (P). Where it is placed so that it displays grooves, rather than ridges, we call its position *negative* (N). Where it is immaterial whether we speak of grooves or ridges we use the word *line* to stand for either.[17] When we write of *sheet foil* we refer to an (imagined) uncut sheet of cross-hatched foil, having an assumed constant pattern, and from which *cell foils* have been cut to fit the cells.

SURVEY GROUP I

TABLE I contains the results of the larger survey of foils using direct microscopic measurements. In FIGS. 3 to 7 these results are summarized in the form of histograms.

The method of measurement used was to view the foils through their garnet or glass inlays using a binocular microscope which had a graticule fitted into one eyepiece.[18] The graticule had at its centre two crossed hairlines, set at right angles, and graduated in millimetres (FIG. 2). Working at a magnification of × 20 with suitable illumination it was possible to count the number of lines to a given number of millimetres. The microscope was set so that one foil line coincided with a fixed point on a hairline and lines were counted (counting the first line as 1) up to the 2 mm. mark and then, if the foil was large enough, up to the 4 mm. mark and, where possible, up to the 6 mm. mark. Although it was sometimes possible to infer an exact half spacing, in which case 0.5 was added to the last whole number of lines, it was usual to count to the line nearest to the chosen graduation. The process was then repeated in the direction at right angles to the first. One set of such measurements was made on all visible foils on each object. Sometimes this might mean one foil; more often several foils. The spacing in each direction was simply calculated by dividing the line count by the relevant number of millimetres. The method provided measurements with an accuracy of between 2 and 12.5 per cent, depending on the size of the cell and hence the distance over which measurements could be made.[19]

[16] See below, p. 42.

[17] It appears to have been a purely arbitrary decision whether the foil was placed in its setting in a *negative* or *positive* position. The Group I Survey shows that slightly more foils were in a *positive* rather than a *negative* position. However, in general, all the foils on a particular object tend to be the same way up.

[18] A Myacope 1000 binocular microscope was used for this work. The accuracy of the method was checked by observing a separate microscope-stage graticule through the microscope. Furthermore, any possible errors caused by refraction of light by the garnets could be discounted by carrying out a few measurements on foils which, by accident or loss, were not overlain by garnets, and then comparing these with measurements on foils which were so overlain, on the same object.

[19] The major source of experimental error is the accuracy of line counts which was rarely closer than to the nearest line. Over a distance of 2 mm. this represents an error of ± 0.25 l./mm.; over 4 mm. an error of ± 0.13 l./mm.; and over 6 mm., an error of ± 0.08 l./mm. These equate errors ranging from, at worst, ± 12.5% (on the low spacing of 2 l./mm. read over a distance of 2 mm.) to, at best, ± 2% (on the high spacing of 4 l./mm. read over a distance of 6 mm.).

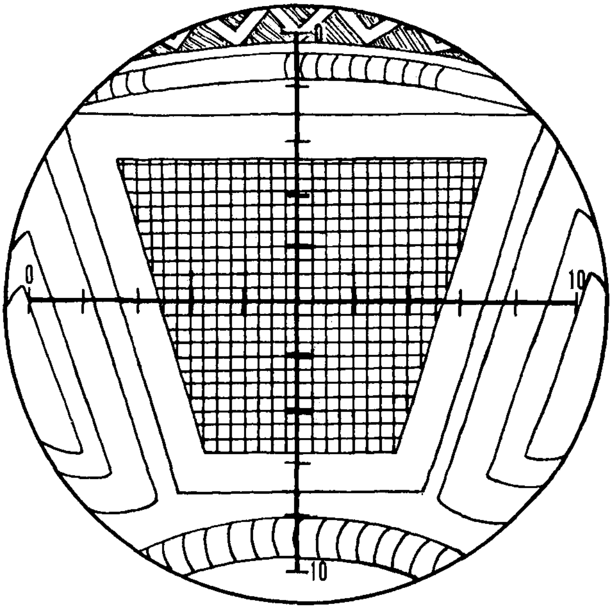

FIG. 2
VIEW THROUGH MICROSCOPE FOR READINGS OF SURVEY GROUP 1

In the TABLE 1 we have condensed the readings somewhat. For each foil only the most accurate reading is recorded (i.e. if there were readings at 2 *and* 4 mm., only the latter reading is used). The error stated is that associated with the most accurate reading. The readings in each direction on a foil were usually identical, and we have not therefore presented both sets, except where they differ (*italics*).

For the purposes of graphical representation, i.e. in the histograms, we have taken a number of liberties. Firstly, we represent each object by one reading only; where counts differed in each direction on a foil we have averaged them. The counts rarely differ by more than one line in 6 mm., so the loss in information is minimal, but, in any case, is retained in the Table. Where several foils on an object show similar, but not quite identical, sets of readings, and appear to have been produced by the same stamp, we have averaged them, for the purposes of the histogram, working on the assumption that, being on one object, they are *likely* to be the same foil. This happens only a few times, and the small risk of confusion is overriden by the increase in simplicity of presentation. The more accurate measurements from Survey Group 2 confirm that such an assumption is permissible.

As in all histograms the height of each bar indicates a frequency, in this case the number of objects bearing foils with particular spacings (lines per millimetre). In slight contrast to other histograms, however, the widths of the bars are used to indicate the degree of error associated with each reading. Thus the wider a bar the greater the error associated with its central value and the more uncertain we

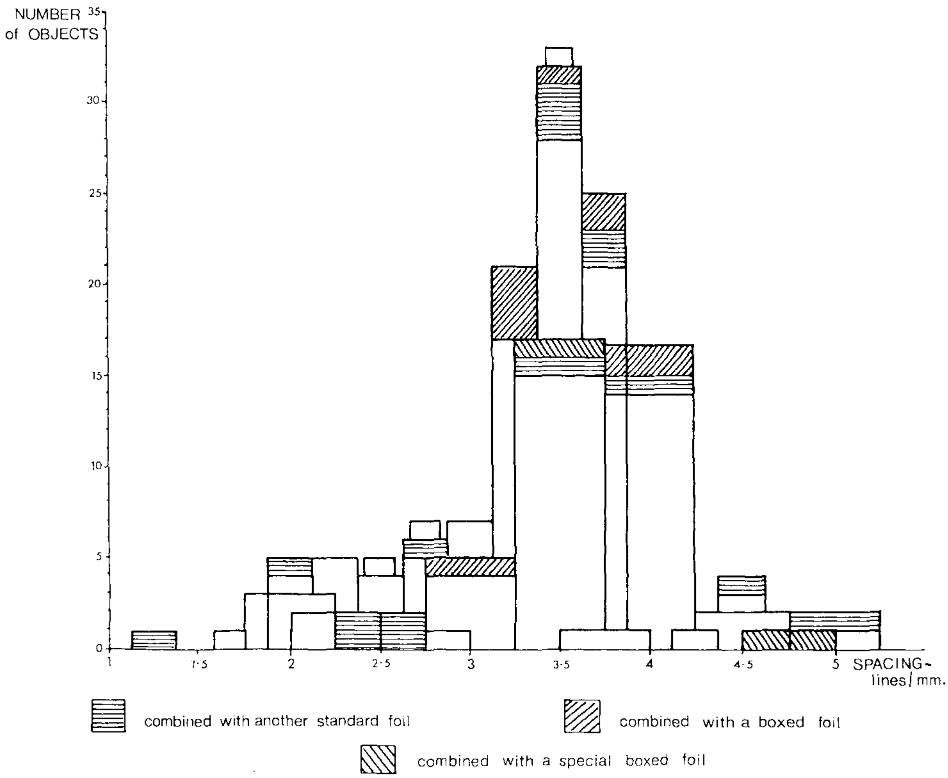

FIG. 3
FOIL SURVEY GROUP I
Histogram for objects bearing *standard* foils

are of the true spacing represented. The overlapping bars thus convey the imprecision of our measurements as well as the variation of line spacing across the cell foils in an object. Furthermore, we have distinguished on the histograms those objects on which more than one sheet foil has been used. Lastly, in assessing the histograms we must bear in mind the predominance of objects from Faversham in this survey group. They represent 36 per cent of all the provenanced objects studied.

From FIG. 3, showing the overall distribution of standard foils, we observe that within the spread of spacings from 1.25 to 5 l./mm. most foils fall in the range 3.25 to 4.0 l./mm., with a tendency towards the coarser end of that range (about 3.5 l./mm.). The evidence for boxed foils is summarized in FIG. 4 and, allowing for the smaller sample size, we see a much narrower spread of spacings (2.75 to 4 l./mm.) with a much more pronounced peak at 3.25 l./mm.

The information can be analysed in more detail by dividing the readings for standard foils according to the category of object on which they are found. In FIG. 5 keystone garnet disc brooches are presented by Class, while the other objects are grouped in a more general way. All the disc and composite brooch histograms are set out in an approximately chronological order, starting with the

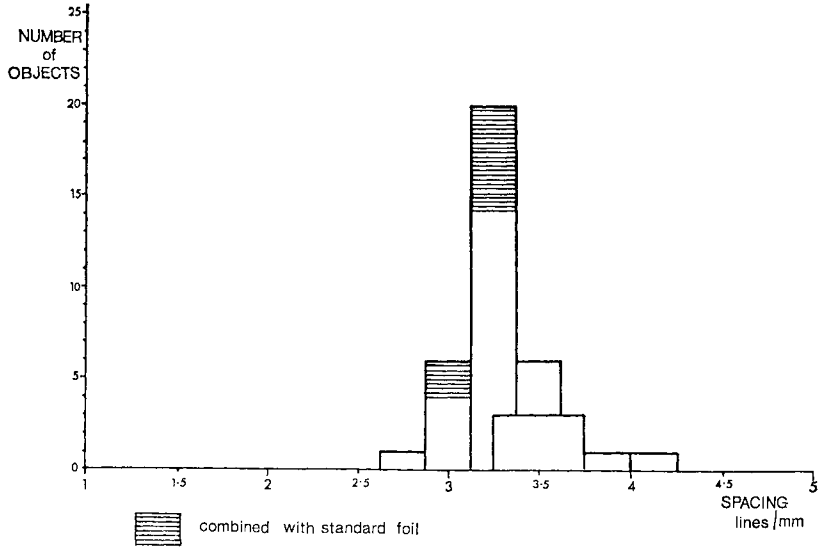

FIG. 4
FOIL SURVEY GROUP I
Histogram for objects bearing *boxed* foils

Class I keystone garnet disc brooches and ending with composite brooches, an order which obscures the overlapping periods of many of the brooches but which is fairly reliable.[20] In general terms all the objects represented in FIG. 5 fit into a date-range beginning early in the 6th century and ending around the middle of the 7th. By so dividing the evidence we are left with a relatively small sample for each group and consequently we can derive only somewhat tentative conclusions. Nevertheless, certain tendencies are observable from these histograms:

i) Earlier items employ more foils in the 4 l./mm. region, but as time goes on there is a movement towards coarser spacings of about 3.25 l./mm.
ii) For all objects other than buckles, there is a notable paucity of foils in the 2.75 l./mm. region.
iii) Among the earliest keystone garnet disc brooches there are no foils with spacings over 4 l./mm. ($\pm$ 0.25).
iv) Foils on composite brooches show little variation in their spacings, nearly all occurring at 3.25 l./mm.
v) The square-headed brooch foils are concentrated in the 3.75–4 l./mm. region, and have an overall distribution which places them in line with keystone garnet disc brooch Classes I and 2.
vi) Apart from the progression implied in (i) above, there is no significant change in the range of standard foil spacings throughout the period under discussion.

[20] Avent, op. cit. in note 9, Table 8.

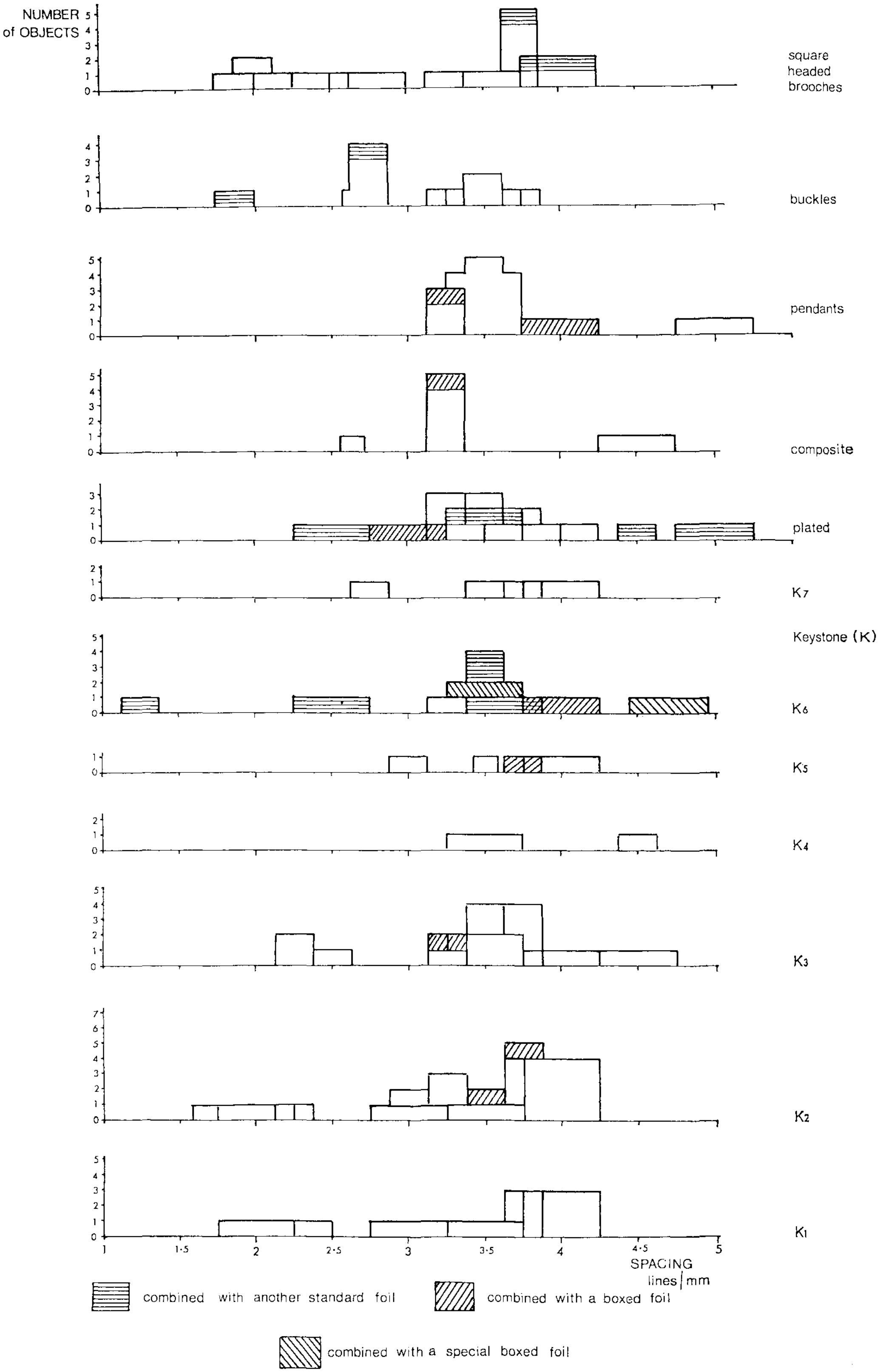

FIG. 5

FOIL SURVEY GROUP I

Histograms for objects bearing *standard* foils, according to category of object

In interpreting these observations it is tempting to equate peaks in the histograms with identifiable sheet foils; to say that if there is a large number of foils at, for instance, 3.25 l./mm., and a slight spread on either side of the peak, then we have identified a sheet foil with roughly this spacing. Unfortunately, it is impossible, using this set of readings, to determine whether each occurrence at a peak value represents a number of different stamps with closely similar spacing, or one stamp used repeatedly. It may well be that certain stamps continued in use through many decades, a view to which we subscribe, or, on the other hand, it may simply be that fashion, tradition or even the use of certain units of measurement (see below p. 29) ensured the repeated appearance of certain spacings or groups of spacings. The gap in the readings at about 2.75 l./mm. and the existence of definite peaks which appear to vary with time, however, imply not that we are dealing with a more-or-less even spread of spacings about some general mean (an implication we might have guessed at from the overall histogram, FIG. 3), but that a limited number of spacings was being aimed at. It is less easy to infer the precise measurements, but we might suggest one foil or group of foils produced at 3.75 to 4 l./mm., and others at about 3.5, 3.25 and 2.75 l./mm.

The fact that the distribution of foils on the square-headed brooches parallels so closely those on keystone garnet disc brooch Classes 1 and 2 is welcome confirmation of the potential usefulness of this line of enquiry, since it is readily accepted that there was a chronological overlap between these types of objects; and indeed the occurrence of Class 2.1 discs affixed to the bows of square-headed brooches from Howletts and Dover (TABLE 1, Catalogue nos. 77, 162) serves to confirm this.

When we turn to the boxed foils, with histograms similarly apportioned (FIG. 6) we find somewhat more precise evidence. As has already emerged, there is a marked preponderance of boxed foils in the region of 3.25 l./mm. We now see that they occur at this spacing throughout our chronological range, with little variation between one type of object and another. The contrast between this picture and that provided by the standard foils is so marked that we must consider the possibility that in many cases we are seeing repeated use of just one or two stamps which had spacings of 3.25 l./mm. $\pm$ 0.2 mm. If these had been the histograms of standard foils, we might be less confident, but the boxed foil, containing nine little pyramids, is so characteristic that it seems unlikely that very many stamps would have been created with this particular spacing. The uniqueness of this foil is further testified by evidence discussed below.

In FIG. 7 we have taken those cemeteries where the incidence of foiled objects is statistically sufficient and have plotted their histograms for standard and boxed foils site by site. The sites are: Howletts, with no object later than the 6th century; Kings Field, Faversham, which was in use from at least early in the 6th century until well into the 7th century, with its floruit in the late 6th and early 7th centuries; Sarre, with a long date-range from early 6th to mid 7th century; and Gilton, Ash, dating probably from the late 5th to the mid 7th century. The approximate correspondence of the histograms with these general date ranges is thus seen to provide confirmation of the chronology implied by our

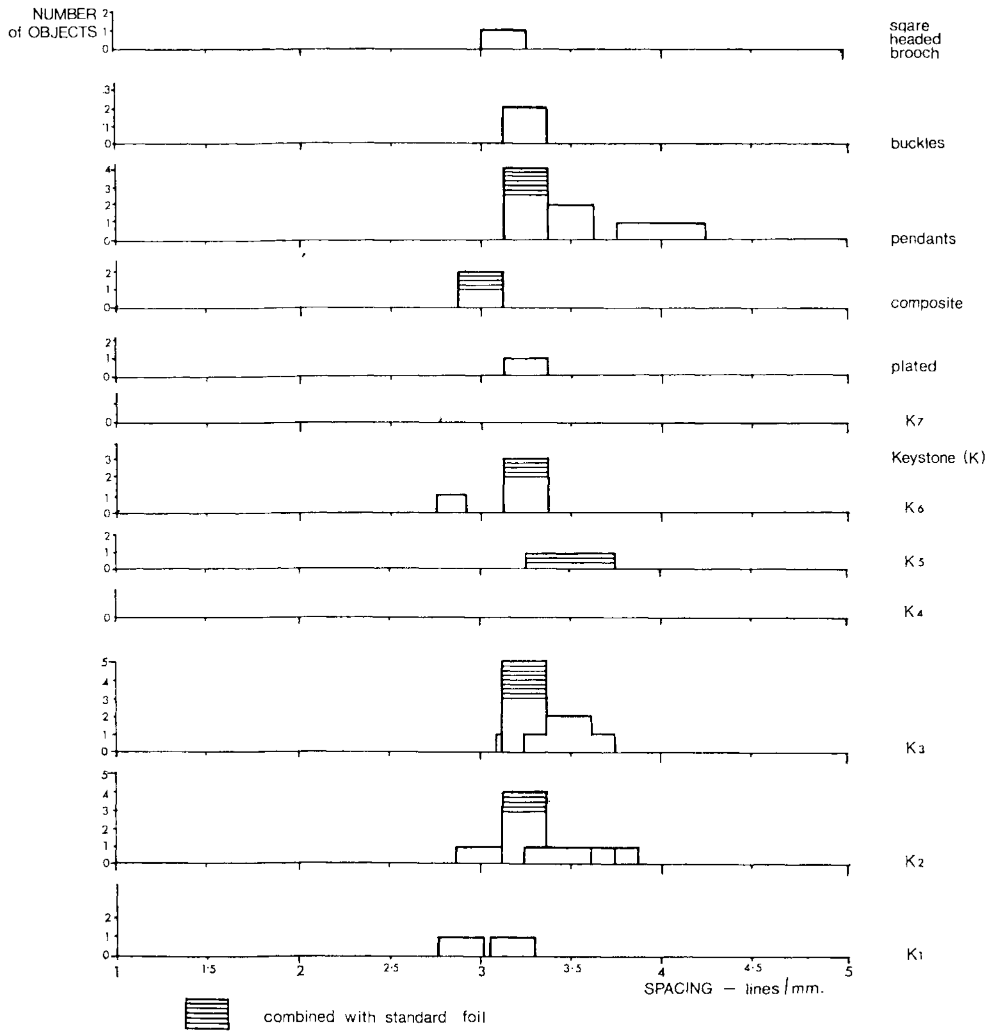

FIG. 6

FOIL SURVEY GROUP I

Histograms for objects bearing *boxed* foils, according to category of object

earlier histograms (FIG. 5) where we were able to show an apparent progression from finer to coarser spacings with time. Howletts, the one undoubtedly early cemetery, shows a preponderance of standard foils of the finer variety, 3·75–4 l./mm. Faversham, with the cemetery continuing rather later, shows a preponderance of foils with coarser spacings, especially around 3·5 l./mm., as well as a respectable proportion of finer foils. The histograms for Sarre and Gilton are not conclusive in this respect, but correspond roughly with the suggested development.

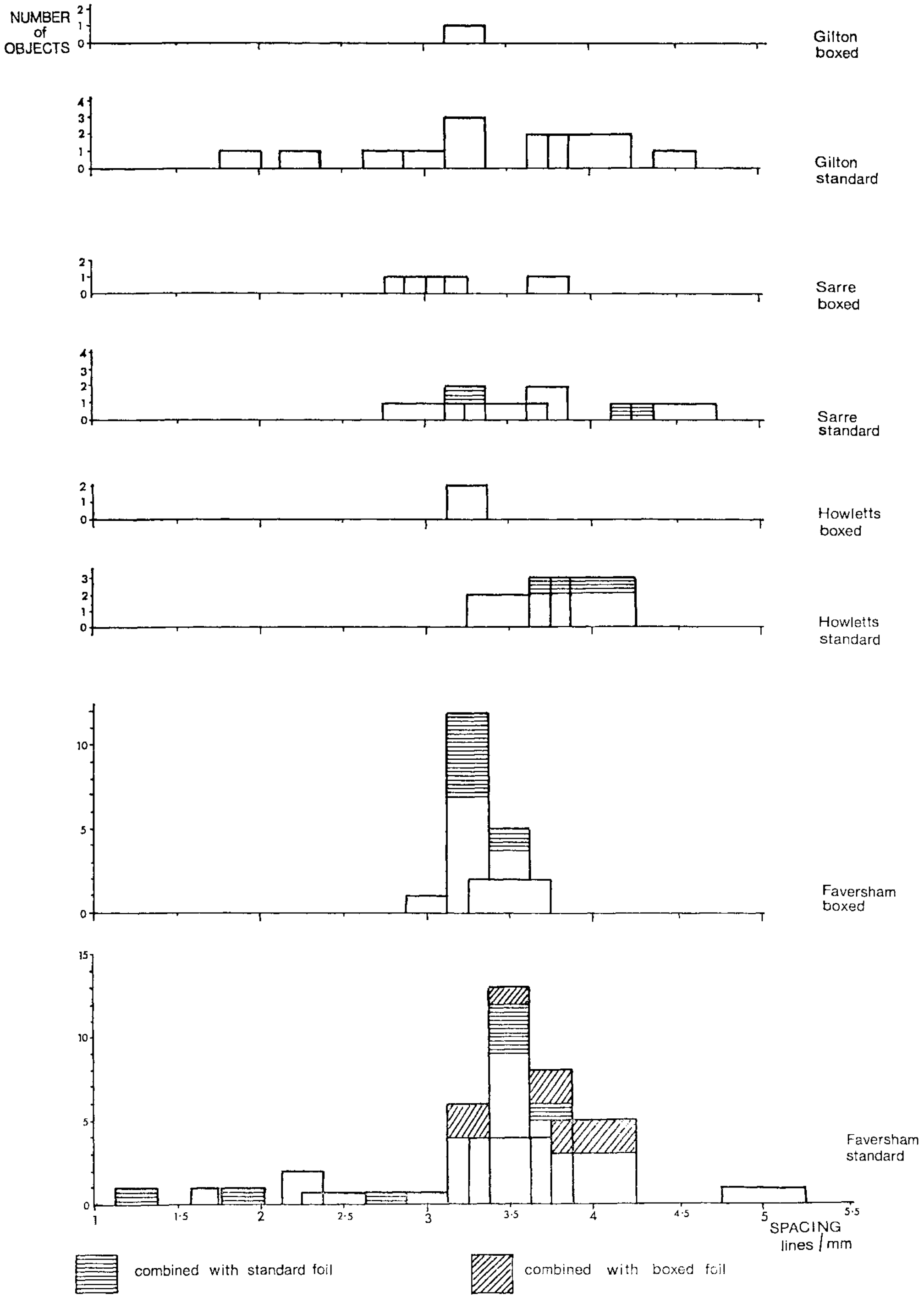

FIG. 7

FOIL SURVEY GROUP 1

Histograms for objects bearing *standard* foils and for objects bearing *boxed* foils, according to provenance: Faversham, Howletts, Sarre, Gilton

The site histograms for boxed foils (FIG. 7) need occasion little further comment, since they display the regular appearance of the 3.25 l./mm. foil to which we have already pointed. However, the high incidence of boxed foils at Faversham is worth noting. They occur there eighteen times out of a total of thirty provenanced occurrences, i.e., 60 per cent, which should be compared with the overall incidence of Faversham objects in relation to all provenanced objects in this survey, namely, 36 per cent. This clearly signifies a close relationship between this foil and the Faversham cemetery.

One of the most distinctive types of foil is the special boxed foil (PL. I, D; FIG. 1, c, d) on which the pattern consists of sixteen or twenty small squares within each box. Examples of this foil are found on seven objects[21] and were evidently produced by a stamp (or stamps) having a rather irregular pattern of 16-unit boxes (4 × 4) interspersed with occasional 20-unit boxes (5 × 4). Where we can see the transition (PL. I, D) it becomes apparent that the craftsman's original intention was to produce a 16-unit box, but that in some places his box-forming lines diverged from their correct paths, thus producing 20-unit boxes. This highly characteristic pattern has a line spacing centred in the region of 3.5 to 3.6 l./mm., and variations in the readings may be attributed to the irregularity of the pattern. We may have here identified a unique foil.

It seems likely to us that individual stamps would have been used repeatedly over a fairly long period of time, and this view appears to be confirmed by the date-range of those objects bearing the special boxed foil. The silver spoon from Bifrons (Catalogue no. 163) and the square-headed brooch from Sarre (Catalogue no. 164) should be dated to around the middle of the 6th century, while the Class 6.1 keystone-garnet brooches (Catalogue nos. 158, 159) and the silver pendant from Dover (Catalogue no. 161) should be dated to the latter part of the 6th and the early 7th centuries.[22]

Of the six provenanced occurrences of this foil, we note that four are on objects from Dover. It has been possible for us to examine the foils on a total of ten objects from Dover, all of which, with one exception (Catalogue no. 154), came from the same site in the town.[23] Three of these have standard boxed foils: one, a mixture of standard and ordinary boxed foils; four, the special boxed foil; and the remaining two have unusual and distinctive foils which have been entered in the *miscellaneous* section of TABLE I. Amongst these the four keystone garnet and the two plated disc brooches are characterized by a particularly fine standard of workmanship, in comparison with other brooches in their respective classes, and it may be that there is some connexion between this and the use of unusual foils at Dover. Lastly, one point should be made about the square-headed brooch from Dover (Catalogue no. 162). The fact that the special boxed foil is found on both the main part of the brooch and on the disc attached to its bow

[21] Catalogue nos. 158–64.

[22] Avent, op. cit. in note 9, 36, 59, 62.

[23] The exception, a composite brooch, is thought to have come from the Priory Hill cemetery: S. E. Rigold and L. E. Webster, 'Three Anglo-Saxon disc brooches', *Archaeologia Cantiana,* LXXXV (1970), 13–17. The other objects come from the Old Park cemetery.

TABLE I

FOIL SURVEY GROUP 1

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings		Foil position	Number of lines per mm.		Error
					Position/ Shape	Number readable	Positive (P) Negative (N)	Standard foils	Boxed or special boxed foils	± lines per mm.
	STANDARD FOILS									
	Keystone Garnet Disc Brooches									
1	Beakesbourne, Grave 22	1.1	1	Canterbury 7517	Keystone	1	P	4		.25
2	Faversham	1.1	7	BM 1050 '70	Keystone	3	P	3.75		.13
3	Stowting	1.1	13	Maidstone AS 301	Keystone	1	P	4		.25
					Central		N	3.75		.13
4	Gilton, Grave 41	1.2	15	Merseyside M 6058	Keystone	1	P	4		.25
5	Howletts, Grave 10	1.2	16	BM 1936 5–11 40	Keystone	1	P	4		.25
					Central		P	4		.25
6	Mersham, Grave	1.2	17	Canterbury 2632	Keystone	1	P	2		.25
					Central		P	2		.25
7	Sarre, Grave CLVIII	1.2	19	Maidstone 404	Keystone	1	P	3.75		.13
8	Sarre	1.2	18	BM 93 6–1 233	Keystone	2	P	3.5		.25
9	Unprovenanced	1.2	20	BM OA 2985	Keystone	1	P	3		.25
10	Unprovenanced	1.2	21	Canterbury 2164	Keystone	1	P	2.25		.25
11	Bifrons, Grave 29	2.1	23	Maidstone B29 592	Keystone	1	P	2		.25
					Central		N	2		.25
12	Dover, Grave 14	2.1	25	BM 1963 11–8 78	Keystone	2	P	3.25		.13
13	Lyminge, Grave 44	2.1	31	Maidstone KAS 1954	Keystone	3	P	4		.25
	Pair to 14				Central		P	3.75		.13
14	Lyminge, Grave 44	2.1	32	Maidstone KAS 1954	Keystone	3	P	4		.25
	Pair to 13				Central		P	4		.25
15	Postling	2.1	33	Merseyside M 7351	Keystone	2	P	3.75		.13
	Pair to 16									
16	Postling	2.1	34	Merseyside M 7375	Keystone	3	P	3.75		.13
	Pair to 15									
17	Sarre, Grave 4	2.2	42	Maidstone 402	Keystone	2	P	3		.25
18	Faversham	2.3	44	BM 1045 '70	Keystone	2	P	2		.25
					Central		P	1.67		.08
19	Gilton, Grave 62	2.3	45	Merseyside M 6062	Keystone	2	N	2.25		.13
20	Bifrons	2.4	47	Maidstone AS 820 195ac	Keystone	1	N	3.25		.13
					Keystone	2	P	3.25		.13

21	Faversham	2.4	49	BM 1043 '70	Keystone	3	N	3·75		·13
22	Faversham	2.4	51	Ashmolean 1909.203	Keystone	1	P	3·5		·25
23	Faversham	2.4	52	Ashmolean 1909.193	Central		N	3·75		·13
24	Unprovenanced	2.4	55	D.o.E. 682429	Keystone	2	N	4		·25
25	Dover, Grave 38	2.5	56	BM 1963 11–8 192	Keystone	3	N	3·75		·13
26	Howletts, Grave 18	2.5	57	BM 1936 5–11 62	Keystone	3	P	4		·25
27	Westbere	2.6	60	Canterbury 6423	Keystone	1	P	4		·25
28	Faversham?	2.6	59	BM OA 389	Keystone	1	N	3·25		·13
29	Gilton	2.9	69	Ashmolean 1782 Douglas Collection No. 11	Keystone	3	N	3		·13
30	Chatham Lines, 'Tumulus XII'	3.1	72	Ashmolean 1779.12	Keystone	1	P	3·75		·13
					Intermediate	1	P	4		·25
					Intermediate	1	N	4		·25
31	Faversham	3.1	77	BM 1041 '70	Keystone	3	N	3·5		·13
					Intermediate	1	N	3·75		·25
					Central		N	3·5		·13
32	Faversham	3.1	79	Ashmolean 1942.238	Keystone	1	N	2.25		·13
33	Gilton, Grave 19	3.1	80	Merseyside M 6009	Keystone	1	P	4·5		·25
					Intermediate	1	P	4·5		·25
34	Kingston, Grave 161	3.1	81	Merseyside M 6347	Keystone	2	N	4		·25
					Intermediate	1	N	4		·25
35	Unprovenanced	3.1	86	D.o.E. 682012	Keystone	1	N	3·75		·13
					Intermediate	2	N	4		·25
					Central		N	4		·25
36	Faversham	3.2	87	BM 1039 '70	Keystone	3	N	3·5		·13
					Rim	1	N	4		·25
37	Faversham	3.2	88	BM 1040 '70	Keystone	3	N	2.25		·13
38	Faversham	3.2	91	Ashmolean 1909.209	Keystone	1	P	3.67		.08
39	Kingston, Grave 299	3.2	93	Merseyside M 6243	Keystone	2	N	3·25		·13
40	Gilton	3.3	98	Ashmolean 1782 Douglas Collection No. 10	Keystone	3	N	3·75		·13
41	Howletts, Grave 5	3.5	101	BM 1936 5–11 29	Keystone	1	N	3·5		·25
42	Unprovenanced	3.5	102	BM OA 2984	Keystone	4	P	2.5		·13
43	Unprovenanced	3.5	103	D.o.E. 682409	Keystone	1	N	3·5		·25
44	Sarre	4	106	Maidstone 407	Keystone	1	P	4·5		·25
45	Unprovenanced	4	108	D.o.E. 682404	Keystone	2	N	3·5		·13
46	Faversham	5	109	BM 1042 '70	Keystone	3	N	4		·25
47	Faversham	5	111	Ashmolean 1909.205	Keystone	4	P	3·5		.08
					Rim	3	P	3·5		·25
48	Faversham	5	112	Ashmolean 1909.197	Keystone	2	N	3		·13
49	Faversham	6.1	115	BM 1031 '70	Keystone	2	N	3·75		·13
					Rim	1	N	3·5		·13
					Rim	1	P	3·5		·13
50	Faversham	6.1	116	Ashmolean 1942.239	Keystone	1	N	1.25		·13
					Central		N	3·5		·13
51	Faversham	6.1	118	Ashmolean 1909.202	Keystone	4	N	3·5		·13
					Intermediate	1	P	3·5		·25
					Intermediate	1	P	2.5		·25

TABLE I (continued)

FOIL SURVEY GROUP 1

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings		Foil position	Number of lines per mm.		Error
					Position/ Shape	Number readable	Positive (P) Negative (N)	Standard foils	Boxed or special boxed foils	± lines per mm.
52	Gilton	6.1	119	Ashmolean 1782 Douglas Collection	Keystone	2	P	3.25		.13
53	Faversham	7.1	128	Ashmolean 1909.183	Keystone	1	P	3.75		.13
54	Unprovenanced	7.1	130	D.o.E. 682431	Keystone	1	N	3.5		.13
55	Faversham	7.2	131	Ashmolean 1942.237	Keystone	1	N	4		.25
56	Wrotham	7.3	132	BM 1927 5.12 2	Keystone	2	P	2.75		.13
57	Ozingell	U	141	Merseyside M 7276	Keystone	1	P	3.5		.25
58	Sarre, Grave CXV	U	142	Maidstone 399	Keystone	1	N	3.25		.13
					Keystone	1	P	3.5		.25
					Rim	1	P	4.25		.13
59	Unprovenanced	U	144	D.o.E. 682430	Keystone	1	N	3.5		.25
	Plated Disc Brooches									
60	Faversham	1	147	BM 35 3.20 4	A Few Foils		N	3.5		.25
61	Faversham	1	148	Ashmolean 1909.184	One Foil		P	4		.25
62	Unprovenanced	1	151	Canterbury 2614	All Foils		N	3.25		.13
63	Faversham	2	155	Ashmolean 1909.199	Central		N	2.5		.25
					One Other Foil		N	5		.25
64	Gilton, 'Tumulus XV'	2	153	Ashmolean 1836, p. 129, 216	All Readable Foils		P	3.25		.13
65	Wingham, Grave	2	157	BM 79 5–24 34	A Few Foils		N & P	3.5		.13
66	Faversham	3	158	BM 84 12–21 4	All Foils		N	3.25		.13
67	Faversham	3	159	BM 1916 2–11 1	All Readable Foils		N	3.75		.13
68	Unprovenanced	4	161	D.o.E. 682410	Two Foils		N	3.75		.25
69	Dover, Grave F	7	164	BM 1963 11–8 758	Central		N	3.5		.25
					Main	1	N	4.25		.13
					Main			4.75		.13
					Main	1	N	4.5		.25
					Main	1	N	4.75		.25

	Composite Brooches									
70	Faversham	1.1	170	Ashmolean 1909.204	All Readable Foils		N & P	3.25		.13
71	Monkton, Grave 3	1.2	172	Ashmolean 1973.1401	All Readable Foils		N & P	3.25		.13
72	Gilton, Grave 42	2	175	Merseyside M 6006	Central		P	3.25		.13
					Other Readable Foils		N	3.5		.25
73	Sarre, Grave	2	177	BM 60 10–24 1	All Foils		N	3.25		.13
74	Kingston, Grave 205	3.2	179	Merseyside M 6226	All Foils		P	2.67		.08
75	Milton North Field, Abingdon, Oxfordshire	4.2	182	Ashmolean 336 p. 123.59	All Foils		N & P	4.5		.25
	Square-Headed Brooches									
76	Chessel Down, Isle of Wight			BM 67 7.29 8	All Foils		N & P	2.5		.13
77	Howletts (Keystone Disc Brooch on bow)	2.1	29	BM 1918 7–11 1	Head-All Foils		P	4		.25
					Foot-One Foil		P	3.75		.13
					Keystone	1	P	4		.25
78	Lyminge, Grave 44 Pair to 79			Maidstone KAS 1954	All Foils		P	3.25		.13
79	Lyminge, Grave 44 Pair to 78			Maidstone KAS 1954	All Foils		N & P	3.75		.13
80	Bifrons, Grave 42 Pair to 81			Maidstone 587 B42	Head	1	P	2.5		.25
					Head			2.25		.25
					Head	1	P	2.25		.25
					Foot	2	P	2.25		.25
					Foot	1	P	2.5		.25
81	Bifrons, Grave 42 Pair to 80			Maidstone 574 B42	Head	1	P	2		.25
					Head	2	P	2.25		.25
					Foot	1	P	2.5		.25
					Foot	2	P	2.25		.25
82	Bifrons Pair to 83			Maidstone KAS 620 1954 C	Head	1	N	4		.25
83	Bifrons Pair to 82			Maidstone KAS 620 1954 C	Foot	1	N	4		.25
84	Gilton			BM 62 7–1 13	All Foils		N	1.88		.13
85	Howletts, Grave 7			BM 1936 5–11 28	All Foils		P	3.75		.13
86	Howletts, Grave 7			BM 1936 5–11 27	Head	1	P	4		.25
					Foot	1	P	4		.25
87	Howletts			BM 96 11–26 2	Head	1	P	3.5		.25
88	Howletts			BM 96 11–26 1	Head	2	N & P	3.83		.08
					Foot	2	N & P	4		.13
89	Mersham			Canterbury 2636	Head	1	N	3		.25
					Foot	1	N	2.5		.25
90	Stowting, Grave 9			Canterbury 2677	All Foils		N & P	3.75		.13
91	Stowting			BM OA 275	Foot	1	P	2		.25

TABLE I (continued)

FOIL SURVEY GROUP I

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings		Foil position	Number of lines per mm.		Error
					Position/ Shape	Number readable	Positive (P) Negative (N)	Standard foils	Boxed or special boxed foils	± lines per mm.
	Triangular Buckles with Interlaced Animal Ornament									
92	Faversham			BM 1098–70	Buckle Plate		N	3.5		.13
					Tongue Plate	1	P	3		.25
					Tongue Plate	5	P & N	2.5		.13
93	Gilton, Grave 23			Merseyside M 6018	Tongue Plate		N	3.75		.13
94	Taplow, Bucks., Grave			BM 83 12–14 1	All Readable Foils		P	2.67		.08
95	Wickhambreux			BM 1905 4–18 14	Tongue Plate		P	3.5		.13
	Miscellaneous Buckles									
96	Barrington, Cambridgeshire			Ashmolean 1909.273	Central		P	3.5		.25
97	Broomfield, Essex			BM 94 12–16 1	All Foils		P	3.25		.13
98	Crundale			BM 93 6–1 204	All Foils		P	2.75		.13
99	Gilton			Merseyside M 6652	All Foils		P	2.75		.13
	Gold Cloisonné and Filigree Pendants									
100	Faversham			BM 1137 '70	One Foil		N	5		.25
101	Faversham			BM 1145 '70	One Foil		N	3.5		.25
102	Faversham			BM 84 12–21 5	All Foils		N	3.5		.13
103	Faversham			BM 84 12–21 6	One Foil		P	3.5		.25
	Other Pendants									
104	Kempston, Bedfordshire			BM 91 5–24 3	Square		N	3.5		.25
105	Kingston, Grave 142			Merseyside M 6273	Foil		P	3.17		.08
106	Standlake, Oxfordshire			Ashmolean 1971.448	Foil		P	3.25		.13
107	Unprovenanced			BM 35 8–3 1	All Foils		P	3.5		.25

	Other Objects									
108	Bifrons, Grave 71 Pair to 109 Small saucer-shaped brooch			Maidstone 615 B71	Central		P	2.5		.08
109	Bifrons, Grave 71 Pair to 108 Small saucer-shaped brooch			Maidstone 615 B71	Central		P	3		.25
110	Sarre, Grave 94 Button-type brooch			Maidstone 400	Central		P	3.75		.13
111	Gilton Gilded silver pin fragment			BM 62 7–1 15	Pin-head		N	4		.25
112	Wigber Low, Derbyshire. Pair to 113 Cross-shaped pin-head			BM 73 6–2 96	All Foils		N	4		.25
113	Wigber Low, Derbyshire. Pair to 112 Cross-shaped pin-head			BM 73 6–2 97	One Foil		N	4		.25
114	Ixworth, Suffolk Christian Cross			Ashmolean 1909.453	One Foil		N	3		.25
115	Wilton, Norfolk Christian Cross			BM 59 5–12 1	All Foils		P	3.5		.25
116	Bifrons, Grave 42 Gilded silver ring			Maidstone 566 B42	Foil		P	3.67		0.8
117	Faversham Gold hingeing Object			BM 1144 '70	Square Boss		N N	3.5 3.5		.13 .25
118	Stodmarsh Silver spoon			BM 54 12.2 6	Foil		N	2.75		.08
119	Wickhambreux Inlaid gold stud			BM 1905 4–18 16	Two Foils		P	3		.25
	BOXED FOILS									
	Keystone Garnet Disc *Brooches*									
120	Howletts	1.1	9	BM 1918 7–8 41	Keystone	1	P		3.25	.13
					Keystone	2	P		3.25	.13
					Keystone				3	.13
121	Sarre	1.1	12	BM 93 6–1 232	Keystone	1	P		2.75	.13
					Keystone				3.5	.25
					Keystone	1	P		3	.13
					Keystone				3.5	.25
					Keystone	1	N		2.88	.13
					Keystone				3.5	.25

TABLE I (continued)

FOIL SURVEY GROUP I

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings: Position/Shape	Settings: Number readable	Foil position: Positive (P) Negative (N)	Number of lines per mm.: Standard foils	Number of lines per mm.: Boxed or special boxed foils	Error: ± lines per mm.
122	Howletts, Grave 9	2.1	30	BM 1936 5–11 39	Keystone	2	P		3·25	·13
					Keystone				3·25	·25
123	Faversham	2.2	40	BM 1048 '70	Keystone	2	P		3	·13
124	Sarre, Grave 4	2.2	43	Maidstone 401	Keystone	3	P		3·75	·13
					Central		P		3·75	·13
125	Faversham	2.8	63	BM 1033 '70	Keystone	2	P		3·25	·13
126	Faversham	2.8	66	BM 70 4–2 799	Keystone	1	P		3·5	·25
127	Unprovenanced	2.8	68	D.o.E. 682408	Keystone	4	P		3·25	·13
128	Faversham	3.1	75	Canterbury 2659	Keystone	2	P		3·5	·13
129	Faversham	3.1	76	BM 1035 '70	Keystone	2	P		3·5	·25
130	Faversham	3.1	78	Ashmolean 1909.200	Keystone	3	N		3·25	·13
					Intermediate	2	N		3·25	·13
131	Stowting	3.1	83	Maidstone AS 189	Keystone	1	P		3·25	·13
132	Unprovenanced	3.2	94	D.o.E. 682406	Keystone	3	P		3·17	·08
133	Maidstone	6.1	121	Maidstone AS 283	Keystone	2	P		2·75	·13
					Keystone	1	P		2·83	·08
					Keystone				2·75	·13
134	Unprovenanced	6.1	122	D.o.E. 682407	Keystone	4	P		3·25	·13
					Rim	2	P		3·5	·25
135	Unprovenanced	6.1	124	D.o.E. 682403	Keystone	2	P		3·25	·13
	Plated Disc Brooches									
136	Faversham	1	145	BM 1030 '70	All Readable Foils		P		3·25	·13
	Composite Brooches									
137	Sarre	3.1	178	Ashmolean 1934, 202	All Foils		N		3	·13
	Square-headed Brooches									
138	Sarre, Grave 159			Maidstone 409	All Foils		P		3·25	·13
					All Foils				3	·13

	Triangular Buckles with Interlaced Animal Ornament									
139	Gilton			BM 62 7.1 10	Tongue Plate	5	N		3.25	.13
	Miscellaneous Buckles									
140	Faversham			Merseyside 2.4.85.4	Foil		P		3.25	.13
	Gold Cloisonné and Filigree Pendants									
141	Faversham			Ashmolean 1909.188	Triangular	2	N & P		3.25	.13
	Pair to 155				Circular	3	N & P		3.5	.25
142	Unprovenanced			D.o.E. 682411	All Readable Foils		P		3.25	.13
	Other Pendants									
143	Faversham			Ashmolean 1909.195	Foil		N		3.25	.13
144	Faversham			BM 1139 '70	All Foils		P		3.5	.13
	Pair to 145									
145	Faversham			BM 1139A '70	All Foils		P		3.5	.13
	Pair to 144									
146	Unprovenanced			Canterbury RM 2161	All Foils		P		4	.25
	STANDARD AND BOXED FOILS (on the same object)									
	Keystone Garnet Disc Brooches									
147	Faversham	2.8	64	BM 1034 '70	Central		P	3.75		.13
					Keystone	2	P		3.25	.13
148	Faversham	2.8	65	Ashmolean 1909.187	Keystone	2	N	3.5		.13
					Keystone	1	N		—	—
149	Faversham	3.2	89	Ashmolean 1909.206	Central		N	3.25		.13
					Rim	6	N	3.5		.25
					Keystone	3	N		3.25	.13
150	Faversham	3.2	90	Ashmolean 1909.201	Rim	3	N	—		—
					Keystone	2	N		3.25	.13
151	Faversham	5	113	Ashmolean 1909.186	Rim	2	P	3.75		.13
					Keystone	4	P	3.75		.13
					Central		P		3.5	.25
152	Faversham	6.1	117	Ashmolean 1909.196	Rim	4	N	4		.25
					Keystone	3	N		3.25	.13

TABLE I (continued)

FOIL SURVEY GROUP 1

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings: Position/Shape	Settings: Number readable	Foil position: Positive (P) Negative (N)	Number of lines per mm.: Standard foils	Number of lines per mm.: Boxed or special boxed foils	Error: ± lines per mm.
	Plated Disc Brooches									
153	Sibertswold-Barfreston,	1	149	Merseyside M 6491	One Foil		P	3		.25
	Grave 101				One Foil		P		—	—
	Composite Brooches									
154	Dover, ?Priory Hill,	2	174	BM 79 10.13 1	Some Ring 3		N		3	.13
	Grave				Other Foils		N	3.25		.13
	Gold Cloisonné and Filigree Pendants									
155	Faversham			Ashmolean 1909.189	Circular	2	N & P		3.5	.25
	Pair to 141				Circular	1	N & P	4		.25
					Triangular	3	N & P		3.25	.13
	Other Pendants									
156	Faversham			BM 1140 '70	Central		P		3.25	.13
					Other Foils		P	3.25		.13
	Other Objects									
157	Broomfield, Essex			BM 94 12–16 2	Foil on Top		P	3.25		1.3
	Gold garnet-inlaid				Foils on Side		P		3.0	.08
	pyramid stud				*Foils on Side*				3.17	.08
	STANDARD AND SPECIAL BOXED FOILS (16 SQUARES) (on the same object)									
	Keystone Garnet Disc Brooches									
158	Dover, Grave 29	6.1	114	BM 1963 11–8 141	Central		N	3.5		.25
					Rim	2	N		4	.25
					Keystone	4	N		3.63	.13

159	Unprovenanced	6.1	123	D.o.E. 682405	Rim	2	N	4·5		.25
					Rim	2	P	5		.25
					Keystone	2	P		3·5	.13
					Keystone	1	P		3·5	.13
					Keystone				3·25	.13
					Keystone	1	P		3·75	.13
	SPECIAL BOXED FOILS (16 SQUARES)									
	Keystone Garnet Disc Brooches									
160	Dover, Grave 1	3.1	73	BM 1963 11–8 2	Keystone	3	N		3·63	.13
	Other Pendants									
161	Dover, Grave 29			BM 1963 11–8 144	Foil		N		3·5	.08
	SPECIAL BOXED FOILS (20 AND 16 SQUARES)									
	Square-headed Brooches									
162	Dover (Keystone Disc Brooch on bow)	2.1	27	BM 1963 11–8 776	Head-All Foils		P		3·25	.13
					Foot-One Foil		P		3·33	.08
					Foot-Other Foils		P		3·25	.13
					Keystone	1	P		3·5	.25
	Other Objects									
163	Bifrons, Grave 42 Silver Spoon			Maidstone KAS 313	One Foil		P		3·5	.25
	SPECIAL BOXED FOILS (20 SQUARES)									
	Square-Headed Brooches									
164	Sarre, Grave 4			Maidstone 408	Head-One Foil		P		4	.25
					Head-One Foil				3·5	.25
					Foot-One Foil		P		4	.25
					Foot-One Foil				3·5	.25
	MISCELLANEOUS FOILS									
	Keystone Garnet Disc Brooches									
*165	Faversham	1.1	6	BM 1049 '70	Keystone	1	P	3·5		.25
					Keystone	1	P	3·5		.13
					Keystone	1	P	3·25		.13
					Central		P	3·25		.13

TABLE I (continued)

FOIL SURVEY GROUP I

Catalogue number	Site	Class	Corpus number	Museum/Collection accession number	Settings		Foil position	Number of lines per mm.		Error
					Position/ Shape	Number readable	Positive (P) Negative (N)	Standard foils	Boxed or special boxed foils	± lines per mm.
*166	Faversham	2.4	48	BM 1044 '70	Keystone	1	P	2.5		.25
*167	Dover, Grave 35	3.1	74	BM 1963 11–8 181	Keystone	3	P	1		.13
	Plated Disc Brooches									
*168	Dover, Grave 126	6	163	BM 1963 11–8 583	One Foil		N	3.5		.25
	Miscellaneous Buckles									
*169	Faversham			Ashmolean 1909.134	Foil		N		1.25	.13
					Foil				3.5	.25

* NOTES ON TABLE I

165 Very irregular standard foils with the lines varying considerably in thickness.

166 Very irregular standard foils with wide grooves in one direction and narrow grooves with wide grooves next to them in the other. (FIG. 1, e)

167 Very unusual foils consisting of large squares with a circular punch-mark inside each one (FIG. 1, g).

168 Most of the foils appear to be of the boxed type, although they are not clear enough to be read, but one is of the standard type with grooves set set at 40°/135°, thus producing a lozenge-shaped pattern with the reading given in the table (PL. II, C; FIG. 1, h).

169 The only readable foil on this triangular buckle consists of large boxed squares, each of which is divided, on one alignment, into rectangles (FIG. 1, f).

Italics in the Position/Shape column refer to a separate reading on the same foil at right angles to the one above.

should serve to dispel any possible doubts about the contemporaneity of the two parts of such a combination.

We must now turn to a review of the various associations of foil-types on individual objects (TABLE II). The association of standard and boxed foils on keystone garnet disc brooches occurs only on examples from the Faversham cemetery, with the exception of one from Dover (Catalogue no. 158) and one unprovenanced (Catalogue no. 159), both of Class 6.1 and both bearing the special boxed foil. The Faversham series comprises six associations between boxed and standard foils, and three between standard and standard foils. The latter all involve foils of 3.5 l./mm. spacings, but otherwise there appears to be no regularity about the choice of standard foils in these associations.

Faversham material is also predominant amongst the other objects showing associations of foil types but there are also examples from Dover, Howletts, Sarre and on a gold pyramid stud from Broomfield, Essex. This last item has a combination of boxed and standard foils, the boxed foil showing different readings in each direction, and an average spacing of 3.08 l./mm., indicating that it may in fact be an unusual boxed foil. Amongst these other objects four have boxed-standard and four standard-standard combinations. Again, no one particular type of standard foil seems to predominate in these combinations.

It is noticeable that there are no apparent combinations of boxed foils with different measurements, which helps to confirm our suspicion that there may have been only a very few stamps producing this type of foil.

The use of different foils on single objects was not random. On objects with more than one standard foil, with the exception of one — a Class 6.1 keystone garnet disc brooch from Faversham (Catalogue no. 51) — the difference is related directly to the different types of setting on those objects. For instance, the foil in the keystone settings may be different from that in the rim settings (e.g. Catalogue nos. 49, 58), or a central foil may differ from that used in all the other settings (e.g. Catalogue nos. 50, 63). There is the same careful selection for effect on all but two of the thirteen objects sharing both standard and boxed (or special boxed) foils.

Orientation of cell foils

In some cases the patterns on the foils are aligned with the settings into which they were fitted; on a rectangular setting, for instance, the lines may be parallel with the sides of the rectangle (e.g. square-headed brooches of Survey Group 2, TABLE III, C, I, Ki). More often the orientation bears a close relationship to the position of the setting on the object: on a keystone setting, for instance, the lines may be parallel with the radius of the disc (e.g. Catalogue nos. 16, 20) or they may be at approximately 45° to the radius (e.g. Catalogue nos. 130, 158); on composite brooches, with their all-over cellwork, the orientations may bear only a rough relationship to the position of the setting, but the orientations are *different* and so help distinguish one cell from the next.

The jewellers, as one might expect from the overall design of their products, had a very strong feeling for symmetry and carried this into the minutest details of their work, including it would seem, the need for care in the placing of their foil. This is nowhere better seen than on some of the square-headed brooches, such as that from Howletts (TABLE I, Catalogue no. 77) or the closely similar brooch from Dover (TABLE I, Catalogue no. 162). On the head-plate of the Howletts brooch the two top corner foil-patterns point towards the bow while the patterns on the two triangular settings are angled at about 45° to the axis of the brooch. These directions may be compared with those on the Dover headplate where all the foil pieces are placed so that they are parallel (and at right angles) to the axis of the brooch. On both brooches, the symmetry is less successful on the footplates (perhaps due to difficulties imposed by the large sizes of foil needed) but the intention is still clear.

In contrast to these examples, there are some objects, though these are in the minority, where there is no obvious intention in the placing of the foil pieces; their orientations bear no evident relationship to setting shapes or positions. This may reflect either slipshod workmanship or perhaps the using up of foil offcuts.

Unusual foils

Among the objects studied in Survey Group 1, there are five with miscellaneous and very distinctive foils, which cannot be compared with any of the regular foils. Two keystone garnet disc brooches from Faversham (Catalogue nos. 165, 166) have foils which are irregular variations of the standard type (FIG. 1, e) while the only readable piece of foil on a triangular buckle from Faversham (Catalogue no. 169) consists of a series of large boxed squares, each of which is divided, on one alignment, into a rectangle (FIG. 1, f). The plated disc brooch from Dover (Catalogue no. 168) has a unique foil pattern in which the normal squares are transformed into lozenge shapes (PL. II, C; FIG. 1, h).[24] A most remarkable foil, found on a Class 3.1 keystone garnet disc brooch from Dover (Catalogue no. 167), has a pattern consisting of a series of large squares (at about 1 l./mm.) each of which has within it a ring-and-dot punch-mark (PL. II, B; FIG. 1, g). These circular punch-marks are not always evenly placed with respect to the chequered pattern, and it appears that two separate processes were involved in making the stamp. First, the ring-and-dot design was rather irregularly punched into the face of the stamp, and then the cross-hatched pattern was built up around these punch-marks. This theory is supported by a close examination of PL. II, B where, in places, the straight lines can be seen to override the edges of the circular punch-marks, even though some effort has clearly been made to fit those lines around the punch-marks. We know of three other occurrences of this foil

[24] A boxed foil of similar pattern has been observed on an unprovenanced Class 2.7 keystone garnet disc brooch in the University Museum of Archaeology and Ethnology in Cambridge. Avent, op. cit. in note 9, 18, plate 11, no. 62.

pattern in this country,[25] and Arrhenius refers to various ring patterned foils from mainly Vandal and Gothic sources, with a few Frankish appearances.[26] We cannot determine without close comparison whether these are similar foils.

While we have not made any systematic study of the foils on Continental material, we have noticed, from cursory inspection of some of the few sufficiently detailed photographs published, that there is considerable use of boxed foils, and more often than not of a special, sixteen-squared variety. Whether these occurrences are all of the same special boxed type as our Kentish examples we cannot of course know without more detailed work on the other side of the Channel.

Units of measurement

Over the range of foil spacings measured by us there is a marked clustering of 3.25 to 4 l./mm., with a tailing off on either side (FIG. 3). The question which must be asked is why there is not a more even spread of line spacings over a somewhat wider range.

Clearly there were some parameters: given the techniques and skill available it was impossible to go beyond a certain degree of fineness; on the other hand, if a pattern was too coarse, insufficient of it would be seen within the boundaries of a small setting for the cross-hatched effect to be apparent. Within these limits, however (say 1.5 to 5 l./mm.), why is there still such a concentration around a central value? One answer *may* be that some unit of linear measure was being employed and, if we accept that, then we may be further enticed into trying to relate our measurements to some known units of the period. Here there is a difficulty for, as Grierson has pointed out,[27] although we have some documentary information on the inter-relationships of different early measures, we have virtually no way of knowing the accurate absolute values of these units until the 15th century, from which time some linear standards survive. This need not matter, however, since it is doubtful if fixed accurate standards existed at this time. It is likely that more variable units were employed which were related to 'natural' measures, such as palms, hands, thumbs, etc. It seems possible that one of the current units employed was the thumb of about 1.1 (modern) inches, or about 28 mm.[28] If so, then it is a simple matter to calculate the number of lines per 'Saxon' inch on the foils. For instance, our 3.5 l./mm. works out at 98 lines to the 'Saxon' inch; our 3.75 at 105 lines to the 'Saxon' inch. If our value for this inch could be relied upon (which it cannot) then our craftsmen might just have been aiming for about 3.57 l./mm., or 100 lines to the inch. This may be too fanciful for some tastes, but it is a beguiling proposition, and if we could find some way of verifying it, we might, in turn, have the first evidence for the true values of the 'Saxon' inch during this period.

[25] A. Warhurst, 'The Jutish cemetery at Lyminge', *Archaeologia Cantiana*, LXIX (1955), 16, 25, 34 f., pl. X, nos. 1, 2; E. T. Leeds and D. B. Harden, *The Anglo-Saxon Cemetery at Abingdon* (Oxford), 55, fig. 8.
[26] Arrhenius, op. cit. in note 1, 117–118.
[27] P. Grierson, *English Linear Measures* (*the Stenton Lecture, University of Reading*) (Reading, 1971), 3 f.
[28] F. G. Skinner, *Weights and Measures* (London, 1967), 91.

TABLE II

SURVEY GROUP 1: OCCURRENCES OF TWO FOILS ON ONE OBJECT

Catalogue No.	Class	Site	STANDARD FOIL		STANDARD FOIL		BOXED FOIL	
			Settings	Spacing (l./mm.) Error	Settings	Spacing (l./mm.) Error	Settings	Spacing (l./mm.) Error
		Keystone Garnet Disc Brooches						
147	2.8	Faversham	Central	3·75 ± 0.13			2 Keystone	3·25 ± 0.13
148	2.8	Faversham	2 Keystone	3·5 ± 0.13			1 Keystone	—
149	3.2	Faversham	Central, 6 Rim	3·25 ± 0.13			3 Keystone	3·25 ± 0.13
150	3.2	Faversham	3 Rim	—			2 Keystone	3·25 ± 0.13
151	5	Faversham	2 Rim	3·75 ± 0.13			Central	3·5 ± 0.25
49	6.1	Faversham*	4 Keystone 2 Keystone	3·75 ± 0.13	2 Rim	3·5 ± 0.13		
50	6.1	Faversham	1 Keystone	1.25 ± 0.13	Central	3·5 ± 0.13		
51	6.1	Faversham	1 Intermediate	2.5 ± 0.25	4 Keystone, 1 Intermediate	3·5 ± 0.13		
152	6.1	Faversham	4 Rim	4.0 ± 0.25			3 Keystone Special Boxed	3·25 ± 0.13
158	6.1	Dover, Grave 29	Central	3·5 ± 0.25			2 Rim	3·63 ± 0.13
159	6.1	Unprovenanced	4 Rim	4·71 ± 0.25			4 Keystone 2 Keystone	3·5 ± 0.13
58	U	Sarre, Grave cxv	2 Keystone	3·5 ± 0.25	1 Rim	4·25 ± 0.13		
		Plated Disc Brooches						
153	1	Sibertswold/Barfreston, Grave 101	One foil	3.0 ± 0.25			One foil	—
63	2	Faversham	Central	2.5 ± 0.25	One other	5.0 ± 0.25		
69	7	Dover, Grave F	Central	3·5 ± 0.25	Other main foils	4·5 ± 0.13		
		Composite Brooches						
154	2	Dover, ?Priory Hill Grave	All but some ring 3	3·25 ± 0.13			Some ring 3 foils	3.0 ± 0.13
		Square-headed Brooches						
77		Howletts*	Main brooch settings	3·75 ± 0.13	1 Keystone on disc	4.0 ± 0.25		
		Buckles						
92		Faversham*	Buckle plate	2.5 ± 0.13	Tongue plate	2.75 ± 0.13		

		Gold Cloisonné and Filigree Pendants					
155		Faversham (Pair to 141)	1 Circular	4.0 ± 0.25		2 Circular 3 Triangular	3.25 ± 0.13
		Other Pendants					
156		Faversham	Other foils	3.25 ± 0.13		Central	3.25 ± 0.13
		Other Objects					
157		Broomfield (Gold pyramid stud)	Top foil	3.25 ± 0.13		Side foils	3.08 ± 0.08

NOTE ON TABLE II

* On these objects the spacings are sufficiently close and the errors sufficiently large to make it possible for there to be only one standard foil, rather than two. This is particularly so in the case of No. 77, with its large error for the readings on the disc of the square-headed brooch.

SURVEY GROUP 2

The square-headed brooches of Kent form a small group of objects, nearly all of which probably were produced in the first three-quarters of the 6th century. A number of them carry garnet-on-foil decoration, and twenty of these have been included in the general Survey Group 1 presented above. We have carried out a more detailed and intensive study of thirty-one of these inlaid brooches by the use of high-quality photographs on which the foils are more visible than they tend to be on most published photographs.

Photographs of the brooches at ×2 magnification were viewed through a stereomicroscope[29] while an accurately made transparent ruler, graduated in millimetres, was placed on the surface of the photograph so that the images of the foils could be seen beneath the graduations. The zero of the ruler was made coincident with a foil line and a count of lines taken to the maximum convenient number of millimetres, an estimate of 'tenths of a line' being made by eye up to the final millimetre mark (the first line being counted as 1). Sometimes it proved more convenient to take a whole number of lines and to measure the distance between them to (estimated) tenths of a millimetre.

Having made a count along one line, another line a few spaces away from it was chosen and a count made along that, and then another line, and so on taking as many readings in one direction on a piece of foil as seemed to be representative of the overall spacing; on smaller pieces of foil fewer readings could be taken. The photograph was then turned through a right angle and the process repeated in the other direction. The same sequence was then followed for each piece of foil clearly visible.

To calculate the spacings from these figures was simply a matter of dividing the number of lines by the number of millimetres and multiplying by 2 to allow for the magnification of the photographs.[30] Using all the readings for a single brooch, a mean spacing ($\bar{x}$) could be calculated, together with its standard deviation(s) and, for use on the graphs, a variance (s^2).[31] Thus all the readings on each cell foil on a brooch could be combined to give a single figure representing the line spacing of the sheet foil used on that brooch. (For the moment no account is taken of the directions of readings.) For this purpose it was necessary to assume, as we did in Survey Group 1, that all similar cell foils on an individual brooch derived from the same sheet of foil. This seems a reasonable assumption and is borne out by the readings themselves, which show much smaller variations between cell foils than those found between foils on one brooch and another. In preparing the graphs (FIGS. 8–10) the same assumptions were made for the cell foils on a pair of objects, unless there was a marked difference between all the readings on one item of the pair and the other.

[29] A Wild M7A Stereomicroscope was used merely as a convenient magnifier, and its exact magnification was immaterial to the ensuing calculations.

[30] In order to allow for slight imprecision in printing of the photographs a correction was applied: the length of the image of a brooch was compared with its true length, as measured (usually with calipers) in the museum. The mean spacing ($\bar{x}$) could then be multiplied by the appropriate correction factor.

[31] s^2, the variance, is the mean-squared deviation from the mean; s, the standard deviation, is the square root of the variance.

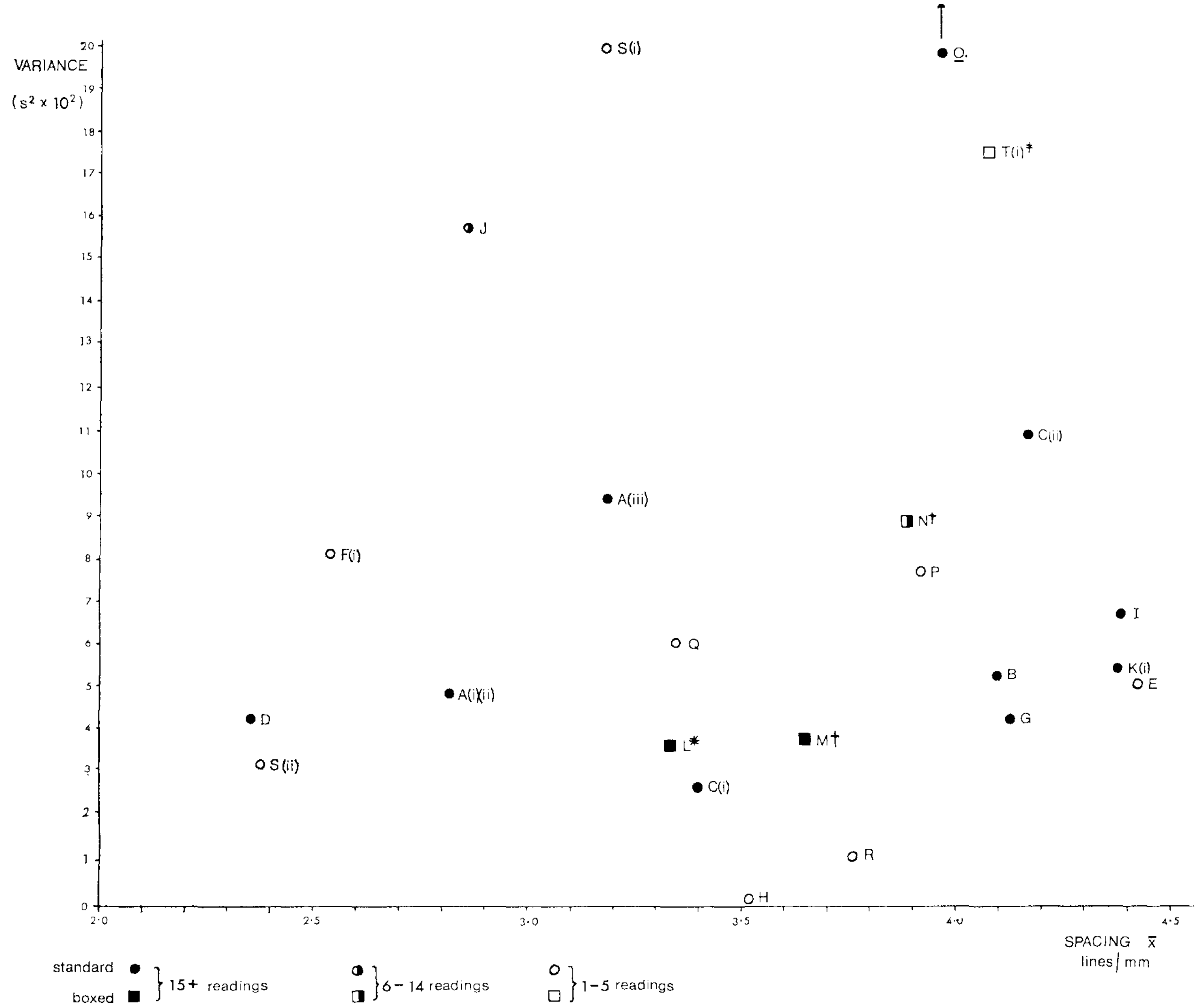

FIG. 8

FOIL SURVEY GROUP 2: SQUARE-HEADED BROOCHES

Mean line spacing ($\bar{x}$) plotted against variance ($s^2 \times 10^2$), s being the standard deviation for all readings on a brooch (or pair), irrespective of direction of reading. Pairs of brooches are plotted once, using averaged figures

TABLE III
SURVEY GROUP 2 — SQUARE-HEADED BROOCHES

Brooch[a]	Group I number	Site	Museum Accession number	Mean Spacing ($\bar{x}$) (l./mm.)	Number of Readings	Standard Deviation[f] (s) (to 1 d.p.)	Difference Between High and Low Means ($\bar{x}_h - \bar{x}_l$)	References to Illustrations[b]
A i	76	Chessel Down, I.O.W.	BM 67 7–29 8	2.83	25	0.17	0.15	Åberg, fig. 126; de Baye, pl. vii, no. 6; Kendrick, pl. xxx; Hillier, No. 33 and p. 29. *V.C.H.*, 388; *Med. Arch.*, I, 19, fig. 3 (b).
A ii		Chessel Down, I.O.W.	BM 67 7–29 9	2.81	15	0.27	0.28	
A iii		Chessel Down, I.O.W.	BM 67 7 29 7	3.19	25	0.31	0.16	
Ai and ii				2.82	40	0.21	0.19	
B	77	Howletts	BM 1918 7–11 1	4.10[c]	17	0.23	0.14	Jessup, pl. xii, fig. 1; BM Guide, fig. 57; *P.S.A.*, xxx, pl. 2, fig. 9; Åberg, fig. 145; *Med. Arch.*, I, pl. i, D; Avent, No. 29.
C i	78	Lyminge, Grave 44	Maidstone KAS 1954	3.40	35	0.16	0.16	*Arch. Cant.*, LXIX, pl. xii, 1A; *Med. Arch.*, I, pl. iv, A.
C ii	79	Lyminge, Grave 44	Maidstone KAS 1954	4.17	32	0.33	0.22	*Arch. Cant.*, LXIX, pl. xii, 1B.
D i	80	Bifrons, Grave 42	Maidstone 587 B42	2.43	11	0.23	0.43	Åberg, fig. 135; Brown, III, pl. xxxiv, 2.
D ii	81	Bifrons, Grave 42	Maidstone 574 B42	2.26	9	0.09	0.05	
D				2.36	20	0.21	0.36	
E i	82	Bifrons	Maidstone KAS 620 1954 C	4.52	2	(0.39)	0.57	Åberg, fig. 134.
E ii	83	Bifrons	Maidstone KAS 620 1954 C	4.31	3	(0.08)	0.07	
E				4.39	5	0.23	0.31	
F i	84	Gilton	BM 62 7–1 13	2.54	6	0.29	—	Åberg, fig. 136; Boys, 868–9, pl., fig. 9.
F ii		Gilton	BM 62 7–1 12	—[c]	0	—	—	
G i	85	Howletts, Grave 7	BM 1936 5–11 28	4.14	16	0.23	0.25	*B.M.Q.*, XI, pl. xv, 12.

4

G ii	86	Howletts, Grave 7	BM 1936 5–11 27	4.07	4	0.02	0.04	
G				4.13	20	0.21	0.20	
H	87	Howletts	BM 96 11–26 2	3.52	4	0.04	0.05	
I	88	Howletts	BM 96 11–26 1	4.39	22	0.26	0.09	
J	89	Mersham	Canterbury 2636	2.86	12	0.40	0.31	Åberg, fig. 137; Salin, fig. 140; *Coll. Ant.*, VI, pl. xxxvii, No. 5; Bakka, fig. 52(a).
K i[d]	90	Stowting, Grave 9	Canterbury 2677	4.38	27	0.23	0.21	*Archaeologia*, XLI (1867), pl. xix, 1.
K ii[d]	91	Stowting	BM OA 275	—[c]	0	—	—	Åberg, fig. 144; *Archaeologia*, XLI, pl. xix, No. 1; *Med. Arch.*, I, 19, fig. 3 (a).
L*	138	Sarre, Grave 159	Maidstone 409	3.34	52	0.19	0.25	Leeds (1949), B4, 84; Åberg, fig. 120; *Arch. Cant.*, VI, pl. 6:1; Brown, IV, pl. 155.5.
M†	162	Dover	BM 1963 11–8 776	3.65	38	0.20	0.18	Avent, No. 27.
N†	164	Sarre, Grave 4	Maidstone 408	3.89	10	0.30	0.40	Bakka, fig. 54; (Åberg, fig. 184; Leeds (1913), fig. 21).
O		Chessel Down, I.O.W.	BM 67 7–29 10	3.96	15	0.70	—	Åberg, fig. 143.
P		Chessel Down, I.O.W.	BM 67 7–29 11	3.92	4	0.28	0.34	Åberg, fig. 129; *Med. Arch.*, I, 19, fig. 4 (a).
Q i		Chessel Down, I.O.W.	BM 67 7–29 13	3.18	3	(0.14)	0.26	
Q ii		Chessel Down, I.O.W.	BM 67 7–29 23	3.60	2	(0.06)	—	
Q				3.35	5	0.25	—	
R		Finglesham, Grave E 2	Private Collection	3.76	5	0.10	0.10	Leeds (1949), S.2; *Med. Arch.*, II, 19, fig. 11 (a), pl. iv, A.
S i		Finglesham, Grave E 2	Private Collection	3.18	4	0.47	0.74	Leeds (1936), pl. xvi (1); *Med. Arch.*, I, 19, fig. 4 (c); *Med. Arch.*, II, 19, fig. 11 (b).
S ii		Finglesham, Grave E 2	Private Collection	2.38	2	0.18	—	
T i‡		Faversham	BM 1054 '70	4.08	4	0.42	—	Åberg, fig. 97; *Med. Arch.*, I, 19, fig. 3 (c).
T ii		Faversham	BM 1054 '70	—[c]	0	—	—	

NOTES ON TABLE III

a Pairs are denoted by a single letter and differentiated by small Roman numerals.
b Where a drawing is cited for a pair of brooches it is often not clear from the drawing or its caption which one of the pair is represented. Sometimes the drawing contains elements of both brooches.
c The absence of a reading indicates that no foil could be read.
d There is no evidence that these two brooches were found together, but they quite evidently form a pair.
e Measurements were not made on the foils on the discs of these brooches.
f The standard deviation (s) used in this table is that associated with readings in all directions on a brooch, taking no account of division into high and low readings (cit. notes 31, 32).
* Boxed foils. † Special boxed foils. ‡ Irregularly boxed foil.

ABBREVIATED REFERENCES USED IN TABLE III

Åberg	N. Åberg, *The Anglo-Saxons in England* (Uppsala, 1926).
Arch. Cant.	*Archaeologia Cantiana.*
Avent	R. Avent, op. cit. in note 9.
Bakka	E. Bakka, 'On the beginnings of Salin's Style I in England', *Universitetet i Bergen Årbok 1958, Historisk-antikvarisk rekke Nr. 3* (1958).
Brown	G. B. Brown, *The Arts in Early England,* III and IV, *Saxon Art and Industry in the Pagan Period* (London, 1915).
BM Guide	(R. A. Smith) *A Guide to the Anglo-Saxon Antiquities in the Department of British and Medieval Antiquities* (British Museum, 1923).
B.M.Q.	*British Museum Quarterly.*
Boys	W. Boys, *Collections for a History of Sandwich,* Pt. II (Canterbury, 1792).
de Baye	J. de Baye, *The Industrial Arts of the Anglo-Saxons* (London, 1893).
Hillier	G. Hillier, *History and Antiquities of the Isle of Wight* (London, 1855).
Med. Arch.	*Medieval Archaeology.*
Jessup	R. F. Jessup, *The Archaeology of Kent* (London, 1930).
Kendrick	T. D. Kendrick, *Anglo-Saxon Art* (London, 1938).
Leeds (1913)	E. T. Leeds, *The Archaeology of the Anglo-Saxon Settlements* (Oxford, 1913, reprint 1970).
Leeds (1936)	E. T. Leeds, *Early Anglo-Saxon Art and Archaeology* (Oxford, 1936, reprint 1968).
Leeds (1949)	E. T. Leeds, *A Corpus of Early Anglo-Saxon Great Square-Headed Brooches* (Oxford, 1949).
P.S.A.	*Proceedings of the Society of Antiquaries of London.*
Salin	B. Salin, *Die altgermanische Thierornamentik* (1904, 2nd impression, Stockholm, 1935).
V.C.H.	*Victoria County History,* Vol. I of the relevant county (Kent or Hampshire).

Because of the technique used and because of the far more numerous measurements taken on each piece of foil, and on each brooch, the major source of variation in measurements is likely to be in the variations on the foils themselves, and ought to be considerably greater than that due to experimental error. Thus, in contrast to the possibilities provided by Group I, we are able to use the statistical concept of variance to help us judge the degree of irregularity of spacings on any one foil. The measurements are presented in TABLE III and plotted in FIG. 8. On the latter the overall mean spacing for all the foils on a brooch (or pair) is plotted against the variance, or irregularity, of that foil pattern. *The greater the variance, the more irregular is the pattern, and vice versa.* By plotting the information in this way we have a means of distinguishing and perhaps grouping foils both by their spacings, in lines per millimetre, *and* by their degree of regularity. Thus two foils with a closely similar spacing may be distinguished by very different variances (i.e. one is very regular, the other very irregular). Clearly this can be very helpful. If, however, both the spacings and the variances are close, although there is then a strong case for calling them the same foil, we may now invoke the evidence provided by visual inspection of a photograph, or better still, the brooch itself. The eye can often see features which characterize foils but which are not readily amenable to measurement. We have been able to take not only good photographs at ×2 magnification, but also a series of macrophotographs, taken at higher magnification of details of the foils.

However, other information can be obtained from the figures to refine the investigation further. It seems likely that when a stamp was cut the spacing in one direction did not always exactly match that in the direction at right angles to it; the pattern formed was of rectangles rather than true squares. Fresh calculations were therefore made, based on the readings for each cell foil, in order to derive a mean spacing in each direction on that piece of foil. It was then possible to label the 'high-reading' direction and the 'low reading' direction. Where the means were identical they were arbitrarily labelled. All the original figures were then combined for a single brooch (or pair) to give mean high ($\bar{x}_h$) and mean low ($\bar{x}_l$) readings, again with standard deviations and variances (S^2).[32] To some extent this is an arbitrary operation and, where the spacings are very similar in both directions (i.e. we have nearly true squares), there may be little or no significance in the measured differences. Where the differences between the readings are more pronounced, however, they may be quite significant and so may help to characterize different sheet foils. We may thus do further graphical plots of mean overall spacings against mean high and mean low readings ($\bar{x}_h$ and $\bar{x}_l$) and this we have done, though not published here since they add little to FIG. 8. However, they have been consulted in arriving at a final grouping. It is more useful to plot the spacings against the *difference* between the high and low readings ($\bar{x}_h$–$\bar{x}_l$) (FIG. 9), since this gives us another method of expressing the irregularity of a foil Where this factor is low, there is little difference between the spacings in each direction and we have an even foil composed of more or less true squares. Where this factor is high, then the spacing in one direction is much higher than that in another, and the foil will look uneven, the spaces between the lines being nearer rectangles rather than true squares. A further graph can be drawn, which does not materially add to the information already plotted, but which gives us a useful visual indication of the overall regularity of the foil (FIG. 10). This graph is a plot of variance (S^2) against ($\bar{x}_h$–$\bar{x}_l$). The nearer a point lies to the origin of this graph, the better the foil it represents.

In plotting the graphs, different symbols have been used to indicate the degree of reliability to be placed on the relevant measurement. A spacing based on more than fifteen readings on a single object is clearly much more reliable than one based on two or three readings, such as we were forced to depend on when some of the foils were missing or obscured, and this has to be taken into account when drawing conclusions from the graphs.

In deciding whether apparently individual foils with fairly similar spacings from two different items may in fact derive from a single large sheet foil, we may use a statistical test which says that we may so consider them provided their variances do not differ by a factor of more than about 3.[33] Another more refined statistical test, of the difference between two means,[34] proved impossible to use

[32] S^2. This variance differs from that already used (s^2), being the combined standard deviation for high and low readings, weighted to allow for the relevant number of readings in each direction, n_h and n_l:

$$\frac{n_h}{n_h + n_l} . S_h^2 + \frac{n_l}{n_h + n_l} . S_l^2$$

About 450 pairs of readings were made (lines and millimetres) and the considerable body of calculations, including photographic correction factors, standard deviations and variances, demanded the help of a programmable calculator (Hewlett-Packard 125).

[33] The Variance Ratio test (F-test), e.g. M. J. Moroney, *Facts from Figures* (London, 1951), 234 ff.; J. E. Doran and F. R. Hodson, *Mathematics and Computers in Archaeology* (Edinburgh, 1975), 66. The variance ratio of 3 is an acceptable approximation for our usual sample sizes, though it might rise to 5 where the sample becomes very small.

[34] The *t*-test for the difference between two means, e.g. Moroney, ibid., 231 ff.; Doran and Hodson, ibid., 54.

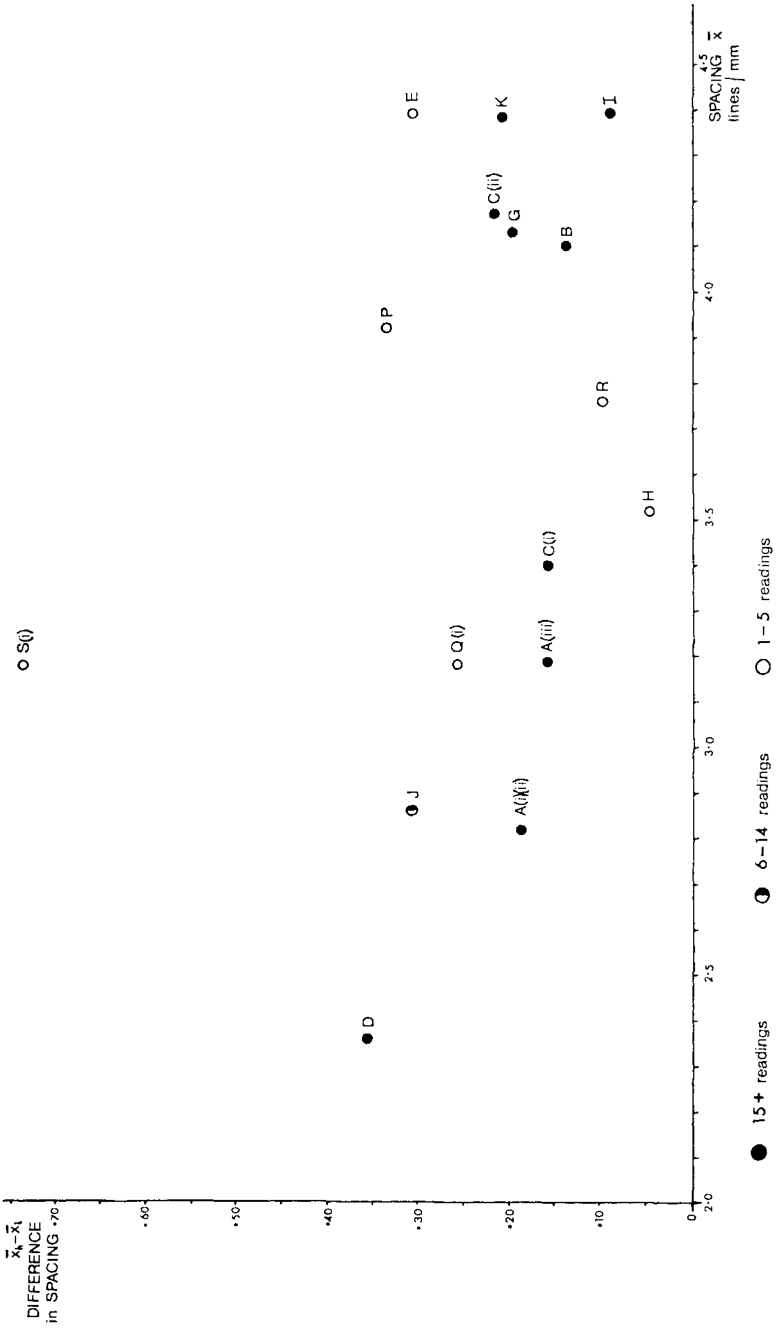

FIG. 9

FOIL SURVEY GROUP 2: SQUARE-HEADED BROOCHES

Mean line spacing ($\bar{x}$) plotted against differences between mean high and mean low spacings ($\bar{x}_h - \bar{x}_l$). Pairs of brooches are plotted once, using averaged figures

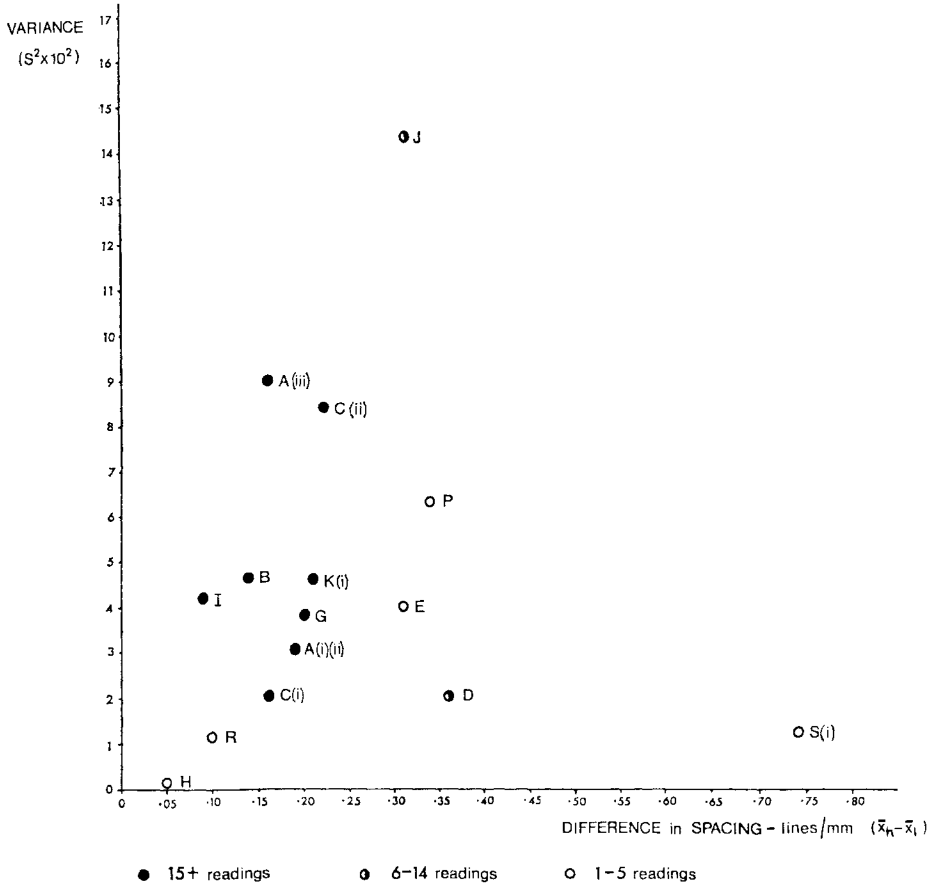

FIG. 10

FOIL SURVEY GROUP 2: SQUARE-HEADED BROOCHES

Difference between mean high and mean low spacings ($\bar{x}_h - \bar{x}_l$) plotted against variance ($S^2 \times 10^2$), S being the combined standard deviation for high and low readings. Pairs of brooches are plotted once, using averaged figures

due to the small size of most of the samples, i.e. the limited number of readings which could be made on each brooch.

Using these graphs, the photographs and photomacrographs, and the above criteria, we are able to arrive at a total of at most fourteen different foils used on twenty-eight brooches which have visible foils. The groupings are presented in TABLE IV. This is not to say that we may not have even fewer stamps represented, but our evidence and methods of detection cannot securely group the foils any more tightly. Certain imponderables also limit our conclusions: without knowing for certain the size of stamp used, we cannot know the amount of variation to be expected over any one foil; furthermore, it may be that on occasions two foils

TABLE IV

SURVEY GROUP 2 — RE-GROUPING OF DATA

Brooch or Pair	Group 1 number	Site	Mean spacing ($\bar{x}$) (l./mm.)	Group mean (l./mm.)	Standard deviation (s)	Difference between high and low means ($\bar{x}_h - \bar{x}_l$)
Di, ii S ii	80, 81	Bifrons 42 Finglesham E2	2.36 2.38	2.37	0.20 0.18	0.36 —
Ai, ii	76, —	Chessel Down	2.82		0.21	0.19
J	89	Mersham	2.86		0.40	0.31
Fi Qi, ii	84	Gilton Chessel Down	2.54 3.35	2.95	0.29 0.25	— —
Si		Finglesham E2	3.18		0.47	0.74
Aiii		Chessel Down	3.19		0.31	0.16
Ci H R	78	Lyminge 44 Howletts Finglesham E2	3.40 3.52 3.76	3.56	0.16 0.04 0.10	0.16 0.05 0.10
P		Chessel Down	3.92		0.28	0.34
O		Chessel Down	3.96		0.70	—
Ti‡		Faversham	4.08		0.42	—
Cii K i Ei, ii	79 90 82, 83	Lyminge 44 Stowting 9 Bifrons	4.17 4.38 4.39	4.31	0.33 0.23 0.23	0.22 0.21 0.31
I B Gi, ii	 77 85, 86	Howletts Howletts 7 Howletts 7	4.39 4.10 4.13	4.21	0.26 0.23 0.21	0.09 0.14 0.20
L*	138	Sarre 159	3.34		0.19	0.25
M† N†	162 164	Dover Sarre 4	3.65 3.89	3.77	0.20 0.30	0.18 0.40

NOTES on Table IV:

* Boxed foils
† Special Boxed foils
‡ Irregularly Boxed foils

with very similar spacings were used on one brooch, and, using our method for averaging calculations for a whole brooch, it would then be difficult for us to detect this.

In addition to these groupings there are a number of observations on the results which are worthy of note. The trio of brooches from Chessel Down (A i–A iii, PL. III, c) share two foils. One of these, used on two of the brooches (A i and A ii), has a spacing of 2.82 l./mm., with a standard deviation of 0.21; the other, used on the third (A iii), has a spacing of 3.19 l./mm., with a standard deviation of 0.31. This confirms other findings about these brooches which suggest the separate manufacture of a pair and a single brooch. Diagnostic of this are:

i) the differing use of punched decoration round the outer edge of the headplates;

ii) the use of two garnets on the foot-plate terminal of A iii instead of a larger one;

iii) the differing use of niello decoration. Compare for example the presence of niello on the bar of the foot terminal of A iii and its absence on the 'pair'; the double zigzag on the side-terminals of A iii compared with single zig-zag on the other two; the poorer execution of niello decoration round the corners of the headplates of A iii compared with the other two;

iv) numerous minor differences in the chip-carved animal decoration; compare for example the work on the shoulders of the foot-plates.

These differences all point to the manufacture of a pair of brooches, as was normal in the Kentish and Isle of Wight repertoire, followed by the manufacture of a third which was intended to match the pair and was probably made by the same craftsman or craftsmen, though perhaps on a separate occasion. This trio, then, provides us with valuable corroboration of the foil evidence and of the methods used to identify foils. The archaeological implications of this discovery are not relevant to the present study, but it can be said, in passing, that the two other ocurrences of trios in the Kentish square-headed series — one set from Chessel Down and one set from Milton-next-Sittingbourne[35] — do not appear to show these differences of manufacture.[36]

Items F, G and I (two pairs and one single) are all very similar brooches having, for instance, the same arrangement of garnets on the head-plate (one rectangular and two lentoid) and, so similar in most other respects that one would readily attribute them to a single workshop. G and I have, almost certainly, the same foil, one with close spacing and low irregularity, while item F (judging by the one of the pair that has readable foils, F i) has a markedly different foil, with a coarse spacing and a more uneven quality.

Items G and I are both from Howletts, as is item B, a square-headed brooch bearing a Class 2.1 keystone disc brooch on its bow. All three items share the same foil which may possibly suggest that the high quality B and the poorer quality G and I were made in the same workshop, although we cannot be sure without more evidence: it is possible that the same foil was available in more than one workshop.

[35] Chessel Down trio, British Museum Accession Numbers 67, 7–29, 14, 15, 16; Milton-next-Sittingbourne, British Museum Accession Numbers 1905, 4–18, 19, 20, 21; E. T. Leeds, 'Notes on Jutish art in Kent between 450 and 575', *Medieval Archaeol.*, I (1957), pl. iv, B; E. T. Leeds, *A Corpus of Early Anglo-Saxon Great Square-Headed Brooches* (Oxford, 1949), S.3; *A Guide to the Anglo-Saxon Antiquities in the Department of British and Medieval Antiquities* (British Museum, 1923), fig. 56; N. Åberg, *The Anglo-Saxons in England* (Uppsala, 1926), fig. 127.

[36] There is one recently noted parallel for the enlargement of a set, in this case from one brooch to a pair, and that is from Donzdorf, W. Germany; E. M. Neuffer, 'Der Reihengräberfriedhof von Donzdorf (Kreis Göppingen)', *Forschungen und Berichte zur Vor- und Frühgeschichte in Baden-Württemberg*, II (1972), 15 ff., Abb. 5a; for illustration also see G. Haseloff, 'Salin's Style I', *Medieval Archaeol.*, XVIII (1974), pl. vi, c. Bakka cites another possible example, the pair from Basel-Kleinenhüngen, Grave 74: E. Bakka, 'Goldbrakteaten in norwegischen Grabfünden: Datierungsfragen', *Frühmittelalterliche Studien*, VII (1973), 78.

Item C, consisting of a pair of brooches, C i and C ii, from Grave 44, Lyminge, quite clearly has two different foils, one of moderately fine spacing and of very high quality, the other of much finer spacing, but less even in its execution. In this case, there is no reason to believe that two brooches were made on different occasions, for they are very similar in all other respects. They are, however, some of the largest in the Kentish cabinet, and employ an exceptionally large area of foil. One can perhaps assume that the craftsman who made the pair did not have enough foil of one sort to cover both brooches. If so, then we may infer that he had supplies of stamped foil, but not the means to stamp his own. Alternatively, he may simply have wanted to achieve a contrast between the two brooches.

Each of the remaining pairs of brooches with readable foils (items G, D, S, Q and E) shares the same foil with the exception of the pair from Finglesham (S), which has widely differing spacings and regularities. The reasons for this are not obvious, although the Finglesham pair is a somewhat unusual example of its type.[37]

Other unusual foils came from Chessel Down, Mersham and Faversham (O, J and T). The foils on brooch O (PL. II, A) are quite evidently bungled: one of the authors was able to make better examples than these at his first attempt. Other decoration on the same brooch, from Chessel Down, also appears to be rather sub-standard. Item T, a most unusual pair from Faversham, also has visually poor foils, and displays a clear attempt at boxing (5×5). They were probably imported from Scandinavia. Item J from Mersham, one of the earliest square-headed brooches, has a coarse and moderately irregular foil spacing, and may perhaps be of Scandinavian manufacture.

If we discount these last unusual and highly irregular foils, we are left with a maximum of nine standard foils in regular use on the Kentish square-headed brooches at this time, plus a boxed and a special boxed foil.

RECONCILIATION OF TWO SETS OF DATA FOR SQUARE-HEADED BROOCHES

FIGURE 11 is a simple graphical representation of the similarities or otherwise between the two sets of measurements for square-headed brooches. If both sets of measurements agreed exactly they would be joined by vertical lines. As it is, there is a more-or-less even slope, which accords with one set of measurements being about 0.2 l./mm. higher than the other. There are clearly a few points of discrepancy, e.g. item F i, but in such instances the poor quality and lack of readable foils make accurate measurements almost impossible.[38]

[37] S. E. Chadwick (Hawkes), 'The Anglo-Saxon cemetery at Fingelsham, Kent: a Reconsideration', *Medieval Archaeol.*, II (1958), 57–8.

[38] In the course of carrying out our survey we encountered numerous difficulties in observing the foils on objects or their photographs sufficiently clearly to provide reliable figures. These may be listed for the benefit of other workers: *i*) the foils were lacking because either there was no foil placed under the garnet originally, or the foil and garnet had both been lost, or the garnet had been reset, without its foil; *ii*) the garnet (or glass) was so blemished or opaque that the foil could not be clearly seen beneath it; *iii*) the pattern on the foil, though visible, was squashed or otherwise damaged; *iv*) in the case of a photograph, the foil may not have been sufficiently well lit, or else light may have been reflecting off the surface of the garnet. To these difficulties should be added the problem of attempting to compare foils, by eye and memory, on brooches from different collections.

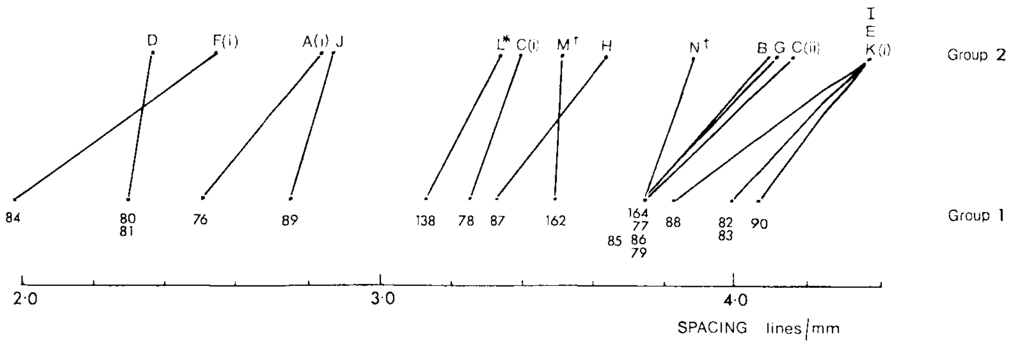

FIG. 11
FOIL SURVEY GROUPS 1 and 2
Comparison between the two sets of data for the same (square-headed) brooches

Minor discrepancies aside, and ignoring for the moment the systematic error, the two sets of readings provide good confirmation of each other, the general order and groupings of the brooches being followed more-or-less exactly. This welcome observation serves to bolster our trust in the larger set of measurements from which we may with confidence draw conclusions about relative order and distributions, even if we cannot employ them as accurate, absolute measurements.

CONCLUSIONS

At the beginning of this paper, we posed two questions. How were the cross-hatched gold foils, which were used as backings to inlays on Anglo-Saxon jewellery, produced and is it possible to identify specific foils or groups of foils by the methods we proposed to employ in this analysis? As to the first, our experimental work leads us to believe that the cross-hatched patterns were stamped on to sheets of gold foil with stamps which were probably made from fine-grained wood or bone and that these stamps could have been used over a considerable period of time. To enable us to tackle the second question, we devised two new and complementary methods of analysis and have thus been able to produce a considerable body of general information about the types and uses of these gold foils. In addition to distinguishing the main groups of standard and boxed foils, we have discovered certain unusual foils and in particular one distinctive group which we have called special boxed foils. We have shown that it is possible to trace an apparent chronological progression from finer to coarser line spacings amongst standard foils and an unusually high incidence of boxed foils amongst the Faversham material. A detailed, statistical, study, using photographs and photomacrographs, of square-headed brooches has shown that, at the very most, fourteen different foils were used on twenty-eight of those brooches which have visible foils. Using these methods, it has also been possible to undertake a reassessment of a trio of square-headed brooches from Chessel Down. Further, the results of these analyses have suggested that a fixed unit of measurement may have been in use at this time in this context. Throughout this study it has become increasingly clear to us that the Anglo-Saxon craftsmen used these gold foils with considerable skill and sensitivity, deliberately selecting different foils for different parts of the same object to emphasize certain features in its overall design and often taking considerable care to ensure that individual cell foils were aligned in such a way as to maximize their effect.

In this paper we have only been able to concentrate on one, very specific, area of technical expertise employed in the production of jewellery during this period. We are certain that with more work along these lines, perhaps improving on our techniques, it will be possible to identify individual foils with certainty and hence relate objects more closely both to each other and to the workshops which produced them. When this evidence is combined with other complementary technological, artistic and archaeological evidence, we shall be closer to an understanding of the Anglo-Saxon jeweller's craft and eventually, perhaps, his place in Anglo-Saxon society.

APPENDIX

EXPERIMENTAL WORK

In order to test a theory for the production of foils we carried out some experiments using fine-grained wood to produce stamps with which to impress a cross-hatched pattern of lines on metal foil. Tests were made on an ordinary softwood, pine, and on two hard soft-woods, yew and box. Two sorts of knife-blades were tested: a no. 15 scalpel blade and the slightly blunted blade of a Stanley Slim-knife. Gold foil proved to be too costly for the tests; gold leaf is not of the required thickness and aluminium foil is too hard. Eventually, high-purity tin foil was chosen, since it could be obtained in the correct thickness (0.025 mm.), and it has similar working properties to gold. Further, in order to conserve the tin, some of the preliminary testing was done by making impressions in plasticine. Observations during the experiments may be summarized as follows:

Choice of wood. Pine, a particularly soft wood, had too coarse a texture and although the first set of cuts was satisfactory, the second set, at right-angles, resulted in the loss of little chips of wood between the lines. It was also difficult to maintain an even depth of cut, and the knife tended to wander about and was difficult to control. Box proved to be much more satisfactory. It was possible to cut lines to an even depth and the hard wood gripped the knife so that one could maintain even spacing and draw straight lines by eye. There was no loss of wood when cutting the second set of lines. Although hard, it is sufficiently elastic, on the macroscopic scale, to pull when the second set of lines is cut, so that there was a tendency for the second set of cuts to draw or comb the first set, rather like a combed effect on cake icing. With care in the choice of knife and the angle at which it was held this effect could be reduced, but not eliminated. It is not an effect we have ever observed on foils. Yew produced the best results. It was possible to draw thin, parallel lines of even width and to do this without loss of wood or any combing effect.

Choice of knife. Attempts to use the scalpel blade, originally chosen on the erroneous assumption that it would enable the necessary fineness to be achieved, were quickly abandoned since the very fine blade tended to be too tightly held by the wood, and the channel cut by the thin blade was so narrow that some displacement of wood took place on either side of the groove. This resulted in the appearance of two grooves on either side of the ridge in the plasticine impression. The slightly blunted Stanley-knife blade proved much more satisfactory and, provided it was held at the correct angle, the displacement effect would be avoided.

Angles of cut. An important lesson was that the angle of cut must be diagonal to the grain direction of the wood. If either direction of cut was allowed to follow the grain then the grain took hold of the knife and determined its direction, rather as tram-lines used to trap bicycle wheels. In the few examples of foil where we have been able to observe grain, the angles of the grooves are not parallel to the grain, though not necessarily at 45°, as they ideally ought to be. In the vertical plane, it was found preferable to hold the blade at a low angle to the wood, so that a length of blade was in contact with the wood, rather than using it nearly vertically with only the point in contact. Using this low angle of cut on yew the combing effect could be entirely eliminated.

Line-spacing. 10 mm. squares were first marked out in 1 mm. units and an attempt was made to cut three to four lines to the millimetre, trying to keep the lines parallel and of even depth. To the experimenter's surprise he was able to carry out this task with reasonable success after only one or two attempts, finding it quite possible to cut lines as close as this, if not as evenly as might be wished, nor always parallel. The experimenter is somewhat myopic and normally wears spectacles. However, he found it slightly easier to do the work without spectacles, perhaps implying that such work was best done originally by short-sighted individuals. The work soon caused eye-strain, however, and later parts of the experiment were conducted using a low-power stereo-microscope (× 6). As skill developed it was found that the spacing of the lines could be made more even if they were cut entirely freehand without regard to 1 mm. marks. No straight-edge was needed as a guide since it was very easy to cut straight lines in the wood for distances up to about 20 mm., beyond which movement of the hand would have caused a jerking effect. This may be an important observation since if the lines on our foils were indeed created by freehand methods, we have some indication of the maximum size of any one stamp.

Line depth. By measuring with a microscope it was possible to monitor the line depths produced and, by varying the pressure on the knife blade, achieve a depth of about 0.03 mm., corresponding with measured depths on some original foils.[39]

Boxing. We wished to know whether boxed (strong) lines were created first and the finer lines drawn between them, or *vice versa*; or whether the strong lines were drawn on top of existing fine lines on a standard pattern. The experiments showed that by far the easiest method is to draw the fine, standard pattern first, and then to draw the knife over selected fine lines afterwards in order to strengthen them. This bears out our observations on certain of the boxed foils, where divergences in direction of the strong lines enable the original fine lines to be seen in place (PL. I, D). Using this argument, we can see that it should have been possible, in theory at least, to convert a stamp of standard pattern to a stamp of boxed pattern simply by re-cutting some of the lines.

Production of stamped foil. Although the test patterns were cut on a larger piece of wood, it was found easier to apply the necessary hammer blow if the surface area of the wooden stamp was reduced to a minimum, so that the stamp formed, in effect, the tip of a hand tool. In this way all the pressure could be concentrated on the patterned area. This is another observation to support the idea that not very large areas of foil were stamped at one time. The tin foil was placed on various supports: lead sheet, leather and beeswax.

[39] This figure is based on nine readings made on two loose foils from Taplow in the British Museum. The measurement of depths of grooves or heights of ridges on loose pieces of foil was accomplished with the help of a Wild M20 research microscope. The focusing knob on this is calibrated in microns (μm) so that by focusing first on the top of a ridge and then at its base one is able to calculate the depth by simple subtraction.

Tolerable impressions could be obtained on all three, although lead seemed to be preferable. The best results were obtained by hitting the stamp on to the foil with a sharp blow of the hammer.

RESULTS

The stamped tin foil that we produced (PL. III, B) presents a tolerable imitation of the gold foils which we have observed. There is no mistaking the difference, however, and we may ascribe this to a number of factors: gold foil would probably behave slightly differently from tin foil; a better support medium could well have been used (pitch?); (NB.: It was noticeable that better results were produced by impressing into plasticine (PL. III, A) rather than into foil on lead, though foil on plasticine did not work at all); there may well have been a better blade to use for cutting the stamp; the skill of the experimenter left much to be desired and would probably have improved with more practice and a greater aquaintance with fine metalworking techniques; no doubt there are other 'tricks of the trade'.

ACKNOWLEDGEMENTS

The general survey of foils was prepared with the help of an award from the Society for Medieval Archaeology's Colt Fund and we are grateful to the Society for this assistance. We are also grateful to the following for allowing us ready access to objects in their collections and for their help at various times during our research: Mrs Leslie Webster, Department of Medieval and Later Antiquities, British Museum; Miss Louise Millard, Royal Museum and Public Library, Canterbury; John Musty, Ancient Monuments Branch of the Department of the Environment; Mrs Margaret Warhurst, Merseyside County Museums, Liverpool; David Kelly, Museum and Art Gallery, Maidstone; David Brown, Ashmolean Museum, Oxford, and Lord Northbourne.

We also wish to thank Drs J. Haworth, A. B. Nix, and B. A. Rogers of the Department of Mathematics, University College, Cardiff, for helpful discussions on the statistical problems and for suggesting the method of plotting variances; the Forest Products Research Laboratory for supplying samples of yew and box woods; Andrew Oddy of the British Museum Research Laboratory for providing microscope facilities; the Departments of Archaeology at Southampton University and University College, Cardiff, for microscope and photographic facilities; Mrs Jean Barber and Miss Sabina Thompson for assistance with the typing, and Howard Mason and Keith Bellamy for preparing the drawings and photographs respectively. Our special thanks go to Dr Tania Dickinson for reading the manuscript and making many helpful suggestions.

NOTE

The Society is much indebted to the Council for British Archaeology for a grant towards the cost of publishing this paper.