The crafts of Roman Britain

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THE CRAFTS

OF

ROMAN BRITAIN

A Thesis presented for the Degree of

Master of Arts

by

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April, 1965

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THE CRAFTS OF ROMAN BRITAIN

Introduction

It is known that several reasons existed for the invasion of A.D. 43. Apart from the idea of inaugurating his reign with a military success which would consolidate the northern frontier of the Empire, the consideration uppermost in his mind,(1) the Emperor Claudius must have decided that the possession of Britain would be advantageous to the economy.(2) His advisers would know something of the trade carried on between Britain and the continent, and of course, Caesar's record of the island and its inhabitants could be quoted to support the accounts of earlier writers. Diodorus Siculus, writing about 45 B.C., mentions the Cornish tin mines and the tin trade with Gaul.(3) The observations of the geographer Strabo, writing in the second or third decade of the first century, show that metalworking was of real importance in the chiefly agricultural economy.(4) "Exports comprised corn cattle, gold, silver, iron ... and also hides, slaves, and very good hounds." He also pointed out that the tribute that the Romans would gain from annexation would have to be set off against the cost of maintaining a garrison plus the loss of customs dues on trade between Britain and Gaul.

Nevertheless, the opportunity of exploiting the mineral deposits, possibly quite rich, must have appealed to Claudius, and Tacitus' description of Britain at the time of the conquest emphasises the value of the metals: "Britain produces gold and silver and other metals; conquest is worth while."(5) Once occupied, Britain would no doubt become wealthier as trade increased, and this, in fact, did happen. Strabo says that jewellery and glassware, among other manufactured articles, were imported, and we find that not only did these increase, but a demand grew for the pottery and metal goods of Gaul, works of art, wine and oil.

At the time of the conquest we are able to form a picture of an agricultural population occupying mainly the southern, or lowland, half of Britain and living away from the heavily

(1) C.A.H., X, 797, 676.
(2) C.A.H., XI, 516.
(3) H.C. Darby, "Historical Geography of England before 1800", page 27.
(4) Strabo IV, 199, from C.A.H., X, 406.
(5) Tacitus, Agricola, 191 (Loeb).

forested regions. The number of inhabitants has been estimated at between a million and a million and a half. They were not purely British; their civilisation was continental rather than insular in origin, and due to its descent from that of the Celtic races it has been called late Celtic. The primitive abundance of gold and tin in the island had fostered an exceptional excellence in metalwork, and the supreme achievement of the native craftsman was his beautifully enamelled metal ware, the objects ranging from jewellery to articles of everyday use. The conquest caused the decline of native art. Roman influence prevailed, and in surveying the crafts of Roman Britain we are in the main reviewing the crafts of the Roman Empire.

At first sight the task would seem to be a difficult one. In Britain we have no Herculaneum or Pompeii, nor- apart from a few which depict furniture - have we the sepulchral sculptures illustrating the daily life and crafts of the people which are found on the Continent. Nevertheless, below our soil there is a mass of evidence which the devoted work of archaeologists is steadily uncovering, and in the literature of Romano-British archaeology there is now a wealth of information which, if collated, would enable practically every section of this thesis to be expanded into a dissertation in its own right. All that we can attempt, within the limits of the present account, is a glance at each of the crafts of Roman Britain, trying as far as possible to achieve a balanced survey. We have also to bear in mind the fact that such a survey can illumine but one aspect of a continually changing picture. Only one Romano-British town, Silchester, has been at all completely excavated, and as this was done in the early part of the present century the finds were not as well identified as they would be today. Nineteenth century excavation has been described as a "trail of evidence destroyed and questions unanswered (and now often unanswerable)", but to some extent this is hindsight; the early excavators lacked the experience and the knowledge which has since been acquired. Fox and Hope, for example, excavating at Silchester came across what would now at once be recognised as a T-shaped corn dryer, but to them it was simply the site for "a long boiler or vat for dyeing stuffs".[1] The famous Chedworth fullery is now believed to be part of a bath suite; and, as we discuss

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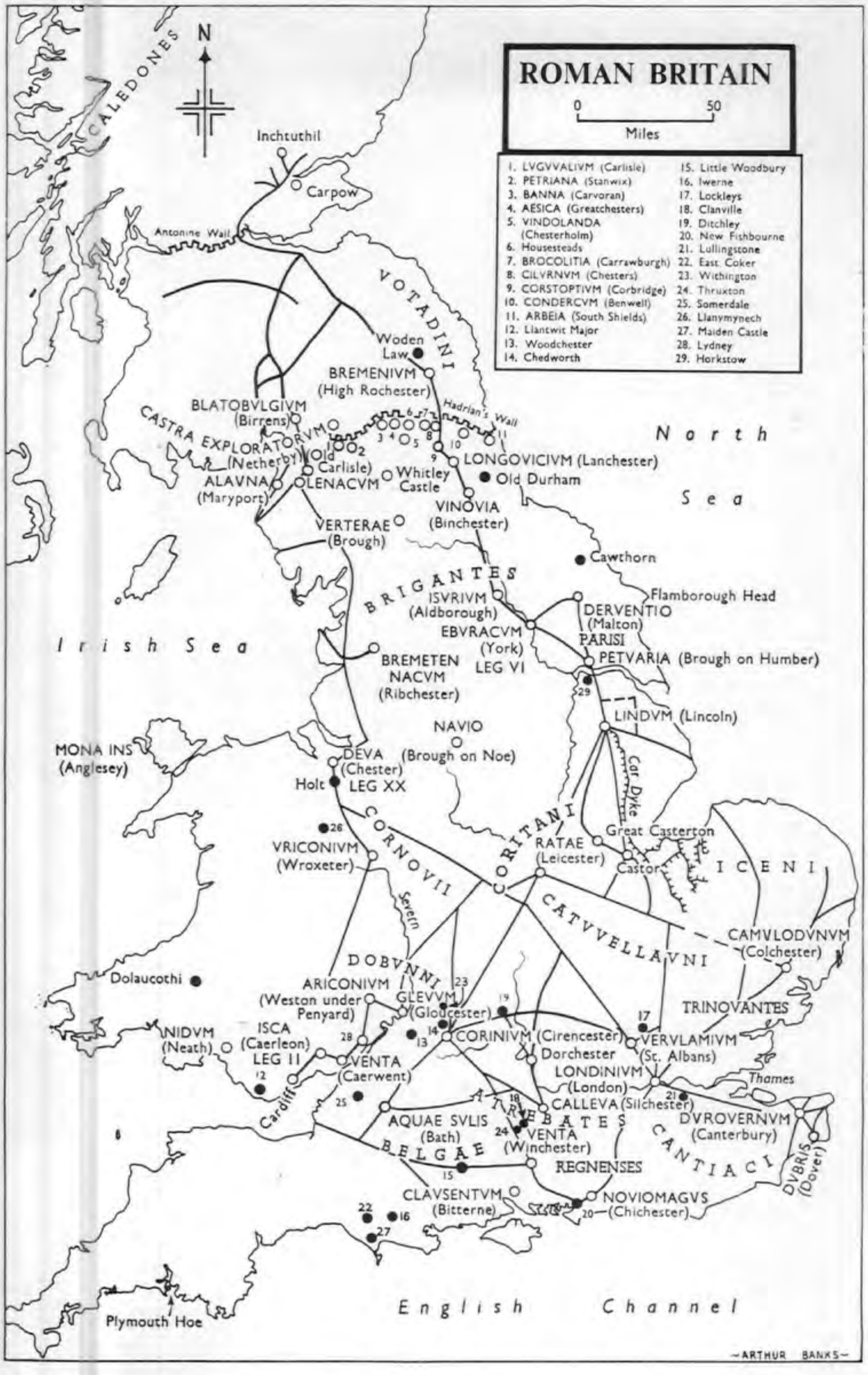
(1) Arch., 1905, LIX, 335.



ROMAN BRITAIN
0 50
Miles
1. LVGVVALIVM (Carlisle)
2. PETRIANA (Stanwix)
3. BANNA (Carvoran)
4. AESICA (Greatchesters)
5. VINDOLANDA (Chesterholm)
6. Housesteads
7. BROCOLITIA (Carrawburgh)
8. CILVRNVM (Chesters)
9. CORSTOPTIVM (Corbridge)
10. CONDERCVM (Benwell)
11. ARBEIA (South Shields)
12. Llantwit Major
13. Woodchester
14. Chedworth
15. Little Woodbury
16. Iwerne
17. Lockleys
18. Clanville
19. Ditchley
20. New Fishbourne
21. Lullingstone
22. East Coker
23. Withington
24. Thruxton
25. Somerdale
26. Llanymynech
27. Maiden Castle
28. Lydney
29. Horkstow
N
CALEDONES
Inchtuthil
Carpow
Antonine Wall
VOTADINI
Woden Law
BREMENIVM (High Rochester)
Hadrian's Wall
BLATOBVLGIVM (Birrens)
CASTRA EXPLORATORVM (Netherby)
Old Carlisle
ALAVNA (Maryport)
OLENACVM
Whitley Castle
LONGOVICIVM (Lanchester)
Old Durham
VINOVIA (Binchester)
VERTERAE (Brough)
North Sea
Cawthorn
BRIGANTES
ISVRIVM (Aldborough)
Flamborough Head
DERVENTIO (Malton)
PARISI
EBVRACVM (York) LEG VI
PETVARIA (Brough on Humber)
Irish Sea
BREMETENNACVM (Ribchester)
LINDVM (Lincoln)
NAVIO (Brough on Noe)
MONA INS (Anglesey)
DEVA (Chester) LEG XX
Holt
Car Dyke
CORNOVII
CORITANI
Great Casterton
RATAE (Leicester)
Castor
ICENI
VRICONIVM (Wroxeter)
Severn
CATVVELLAVNI
CAMVLODVNVM (Colchester)
DOBVNNI
Dolaucothi
ARICONIVM (Weston under Penyard)
GLEVVM (Gloucester)
TRINOVANTES
NIDVM (Neath)
ISCA (Caerleon) LEG II
CORINIVM (Cirencester)
VERVLAMIVM (St. Albans)
Dorchester
VENTA (Caerwent)
LONDINIVM (London)
Thames
Cardiff
CALLEVA (Silchester)
ATREBATES
DVROVERNVM (Canterbury)
AQVAE SVLIS (Bath)
VENTA (Winchester)
CANTIACI
BELGAE
REGNENSES
DVBRIS (Dover)
CLAVSENTVM (Bitterne)
NOVIOMAGVS (Chichester)
English Channel
Plymouth Hoe
ARTHUR BANKS

Fig. 1.

later in the present account, the verdict on the alleged Silchester dyeworks must be "Not proven". Even so eminent a metallurgist as Gowland fell into the trap of assuming what he might easily have enlightened by actual experiment, when he confidently asserted that the layered appearance of Roman pigs of lead "can only have been produced by pouring the lead into the mould in successive portions with a sufficient interval of time between each to allow of one solidifying before the next was added".(1) It was left to the brilliant Whittick-Smythe experiments, some forty years later, to prove that the Romans did not ladle the lead from their furnaces in this manner. We have therefore to beware even today of taking any statement or any evidence as being final. Verulamium and Wroxeter are still under investigation, and other sites await proper excavation. It may well be that, with the help of modern instrumental aids to discovery and more certain means of examination and preservation, our knowledge of Roman Britain will be greatly enriched and strengthened in the years to come.

The evidence in the present survey is assembled under two main headings, "Industrial Crafts" and "Domestic Crafts"; the former is intended to deal with crafts which were carried out either on a large or on a widespread scale and served the needs of the community as a whole, whilst the latter is confined to more or less local activities, but it was realised that it would be impossible to draw a hard and fast distinction between the two, and in fact, some overlapping does occur. It was convenient, for instance, to describe metalworking under "Domestic Crafts", although the actual production of metals is treated under "Industrial Crafts". For ease of reference, the individual crafts are grouped in alphabetical order under the two principal headings; thus under "Industrial Crafts" Building Construction precedes Civil Engineering. Most of the places mentioned will be found on the map opposite.(2)

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(1) Arch., 1901, LVII, 398.
(2) Reproduced from A. Birley, "Life in Roman Britain", (London, 1964).

INDUSTRIAL CRAFTS

BUILDING CONSTRUCTION

Evolution of houses

A distinguishing feature of the Roman occupation was the introduction and growth of planned urban communities. Julius Caesar during his two invasions of Britain noticed the absence of towns, and remarked that the nearest approach to a town was "an area of woodland fortified by ramparts and ditches." Typical of these reservations were Maiden Castle, on a hill top, and Wheathampstead (Hertfordshire) which was a large area of flat ground protected by marshes and forest. These sites were simply places of refuge in times of trouble, rather than permanently-inhabited localities. When not threatened by an enemy the Celts appear to have lived in wooden shacks which were not grouped in any way resembling a planned town. "Even the new centres established between the invasions of Caesar and that of Claudius a century later, showed no notable advance. Cunobelinus' capital at Colchester (Camulodunum) was a vast collection of squalid huts and shacks" (1)

Excavation on Romano-British sites has revealed the foundations of houses of definite types. In many cases the stone foundations are of a light character, suggesting that they carried single-storey structures, and it is therefore probable that the majority of dwellings had no upper floors.(2) The type of town house most frequently encountered is a long, narrow building, some 50 to 100 feet long, with its length at right angles to the street, so that a street of such houses would appear as a row of gable-ends each with its own door.(3) In its simplest form this house is found merely as one long room; a natural development was partitions dividing the area into several rooms. The street end of the house could be 'open', the gable being set back relatively to the street. This in effect constitutes a shop: the stall being under the eaves, adjoining the street, and the owner living in the building behind, which serves both as home and warehouse.

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(1) Anthony Birley, "Life in Roman Britain", (London, 1964).

(2) Cellars, however, are known, e.g., at Chalk near Gravesend (J.R.S., 1962, LII, 189, Fig. 33).

(3) R.G. Collingwood, "Archaeology of Roman Britain," 107, (London, 1930).

Collingwood quotes Oelmann[1] for the suggestion that since houses of this type occur along the main streets of places like Caerwent and Silchester, such towns began their existence as markets, and it was only at a later stage in the developing town that wealthy merchants started to build themselves houses on its outskirts.

The house found in the countryside is the Roman "villa" which means "farm". The outstanding feature of the Roman villa in Britain is a corridor running along the front of the house, stopping short of its two ends which project as wings. Each wing is a room, and the remaining rooms open off at right angles to the length of the corridor. This simple plan was developed in various ways which, as we intend to deal with construction rather than lay-out, need not concern us here. A point of historical interest is that alongside some villas[2] is found a type of outbuilding which is a long barn-like structure with a broad central nave and a pair of side-aisles often bratticed off to form separate rooms which sometimes extend right across the central nave. This juxtaposition of 'barn-dwelling' and villa suggests that the barn-dwelling was for the farm-workers. In the south of England barn-dwellings have been fairly frequently discovered, some containing hypocausts and baths which have been inserted at a later date, obviously as an improvement. This evidence, coupled with the existence of sites where barn-dwellings and villa co-exist, has given rise to the idea that the barn-dwelling represents an early phase of Romano-Celtic culture, that is, the barn-dwelling was early or even pre-Roman, and in the course of the Romanisation of the province the more prosperous farmers built themselves villas and moved out of their former barn-dwellings which then served to accommodate the farm-workers[3]

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(1) Bonner Jahrbucher, 128; 77-97 (Collingwood, op.cit., 109-110).

(2) For example, at Mansfield Woodhouse, Notts. (See Arch., VIII, 363; Collingwood, op.cit., 116-117, 133-139).

(3) I.A. Richmond has drawn attention to Irish analogies for the Romano-British barn-dwelling (see J.R.S., 1932, XXII, 96). Similar farmhouses exist in Friesland today, the nave housing stores and livestock, while the workers occupy the aisles (cf. Ward, "Romano-British Buildings and Earthworks", 180-181).

As examples of the gradual Romanisation of the countryside, which in the south-east of Britain began even before the conquest, Rivet[1] has quoted a site at Lockleys, near Welwyn, and another at Park Street, near St. Albans, where it is possible to trace the evolution from a Belgic hut to a Romano-British farmhouse, the farmhouses having well-laid foundations of flint and chalk rubble, and appearing about A.D. 65.

During the first century A.D. stone buildings were rarities, apart from a few large structures intended for public use, such as the legionary amphitheatre at Caerleon (c. A.D. 80-90). Wheeler[2] suggests that there was probably little masonry until the reign of Hadrian, and even then timber was doubtless used to a greater extent than we can now ascertain as the principal material for the superstructures of non-military buildings. The simplest kind of wooden building was built around upright posts merely driven into the ground (and now represented only by the post-holes), but sometimes the uprights were mortised into sleeper-beams to provide a more secure foundation. J.P. Bushe-Fox has described[3] the construction of a timber building of this sort, with cement floors: "Roughly squared stones were first placed at intervals to support the sill-pieces of the outside walls and partitions, and into these were fitted uprights to carry the framework of the walls. The spaces between these beams would be filled with interlacing wattle, and the whole covered with a thick layer of clay. While still soft, the clay would be keyed to retain the plaster. This would be done either by slashing the surface with a sharp tool or stamping it with a mould formed of a wooden board carved with a herring-bone pattern or one of a diaper of lozenges. The plaster would then be applied, smoothed and finally painted. The floors were laid after the walls were finished, and last of all a quarter-round fillet was placed at the junction of the two."

Walls

Usually, all that now remains of the walls of such buildings is a channel between adjacent cement or tassellated floors. In a second-century house at Verulamium, however,

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(1) A.L.F. Rivet, "Town and Country in Roman Britain", 105-107, (London, 1958); the references cited are, for Lockleys, H.E. O'Neil in Arch.Jour., CII, and for Park Street, J.B. Ward Perkins in Antiqs. Jour., XVIII.
(2) R.E.M. Wheeler, J.R.S., 1932, XXII, 117.
(3) J.P. Bushe-Fox, First Wroxeter Report, Soc. Antiqs. London, 1913.

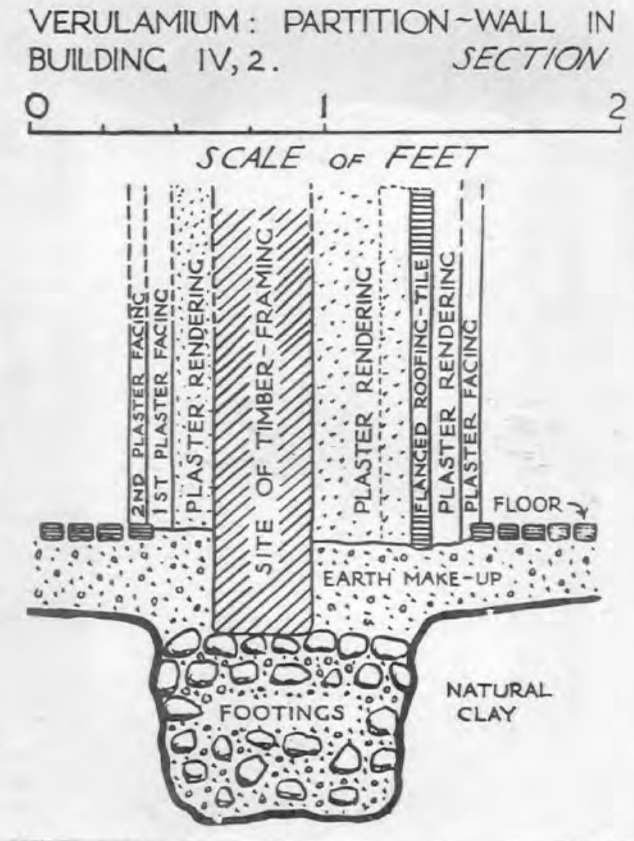

Fig.2

Fig.3

Fig.4

sufficient traces of a timber partition wall were found to enable the construction to be ascertained[1] The timber wall itself, four inches thick, had perished, but it was outlined by the plaster with which it had been faced on both sides. On one side the plaster had been reinforced by a layer of flanged roof-tiles placed vertically within it. The timber wall had been taken to a depth of 4 or 5 inches below the level of the adjacent floors, and was there bedded on pebble footings. Fig. 2 shows a section across the partition wall, which was 1 ft. 2¼ in. thick, and Fig. 3 shows the site as excavated. The outer walls of this building were of flint. In another second-century building at Verulamium timber wall-posts were used as a framework for the construction of its flint walls (Fig. 4 shows the matrix of one of these posts). The lower parts of the posts were circular in section, about 1 ft. in diameter, and they had been driven into the ground at intervals varying from 5 to 16 ft. The flint walls were built between them, the ends of each wall partly clasping the posts (the wall ends thus appearing concave, when viewed in plan).

A wall of unusual construction was found at Verulamium in 1956.[2] Low sleeper walls, some 2-3 ft. high, had been built of masonry. The smooth, flat tops of these were crossed by transverse slots at intervals of about 8 feet; the slots had held timber battens, probably used for fixing the wooden shuttering which would be employed for retaining the clean yellow clay of which the upper part of the wall was made. This had evidently been laid in a plastic condition, because it bore the imprint of a chevron-notched roller which had been used to provide 'keying' for the wall plaster. The upper part of the wall was thus pure clay about 2 ft. thick; it does not seem to have needed a timber frame, because no sockets for wall-posts were found in the masonry.

Excavation in Insula XIV at Verulamium in 1960 yielded evidence for the first time of oak plank flooring, laid on transverse joists.[3]

Tiles, Bricks, Water-pipes.

In the typical Romano-British villa full use was made of ceramics in the form of tiles and bricks, and it is possible that on occasion the kiln or kilns for making these were set

(1) R.E.M. Wheeler, loc.cit.,118.
(2) In Building XXI in Insula XXI. See Antiqs.Jour. 1957, XXXVII, 13, where also a footnote records that similar walls have been observed in villas at Farningham and Lullingstone.
(3) J.R.S., 1961, LI, 180.

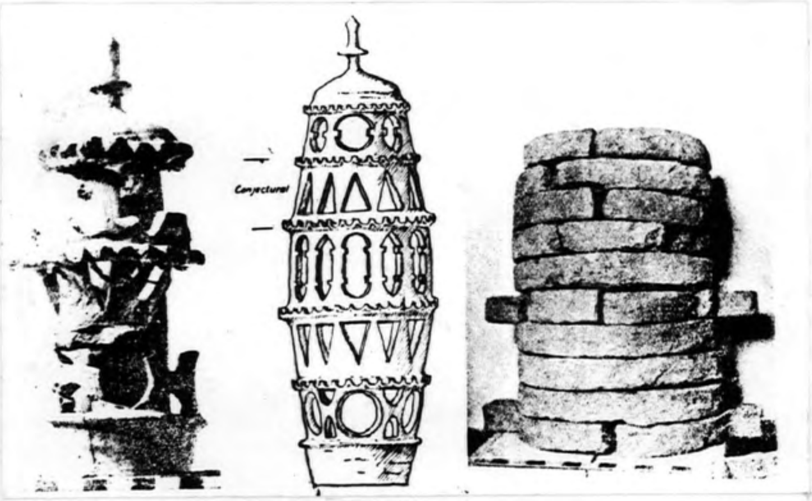

Fig.5

up on the building site. An instance of this may have occurred (1) at Ashtead in Surrey, where in the late first century a corridor house was built, with two heated rooms and a bath-annexe as well as a separate bath-building. The flue tiles seem to have been made on the spot, because traces of several kilns and layers of burnt and distorted tiles mixed with charcoal were found in the vicinity. Fig. 5 shows a column made of tiles, and what at the time of excavation was described as a chimney-pot, recovered from the site; the central sketch is a reconstruction of the alleged chimney-pot(2). Wheeler remarks that in regions devoid of freestone, shaped bricks were commonly used for the construction of columns and pilasters, sometimes even where freestone was available, e.g. Lincoln(3). The legionary works depot at Holt has given us a good idea of the ceramic building materials in use in the second century; W.F. Grimes(4) records the following among the standard sizes of bricks and tiles made at Holt:

Bricks

$4\frac{1}{2}$" x 3" (or $3\frac{1}{2}$") x $1\frac{1}{4}$", commonly used set on edge for 'herring-bone' pavements.

$8\frac{1}{4}$" x $8\frac{1}{4}$" x 2", used for pillars of hypocausts.

$10\frac{3}{4}$ to $11\frac{1}{2}$" square, x 2-3" thick, for paving and drain covers, also for kiln walls.

Tiles

2 ft.x 1 ft.x 1 in., and 2 ft.x 2 ft. x 2 in., used as facing and revetment tiles. The former were scored for keying to plaster, the latter are pierced with holes for fixing to a wall.

Tegulae, or flanged roofing tiles, length 1 ft. 8 ins., top width 16-17 ins., bottom width 15-$16\frac{1}{2}$ ins., height of flange 2 ins.

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(1) Surrey Arch. Collections, XXXVII & XXXVIII, also J.R.S. 1929, XIX, 208. It should, however, be noted that the excavator regarded the site as a kiln plant for tile making.
(2) Since identified as a lamp chimney to shelter a light in a courtyard or on an altar, or for burning incense. Ritual use confirmed by discovery of a similar example in a temple at Verulamium (see R.E.M. & T.V.Wheeler, "Verulamium: A Belgic and two Roman cities", 190, 191 (Fig.32), also Plate LVIII; Soc.Antiqs. Res. Report XI, Oxford 1936). Often mistaken for flue cowls or ventilators for bath buildings, but too scarce to have been so used. Also found in some graves, which again confirms ritual use.
(3) Arch., 1899, LVI, Plate XIX opposite page 371.
(4) Y Cymmrodor, 1930, XLI, 134-5.

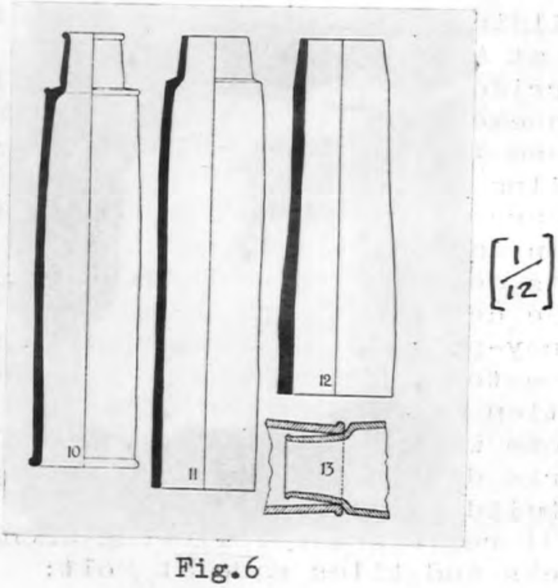

Fig.6

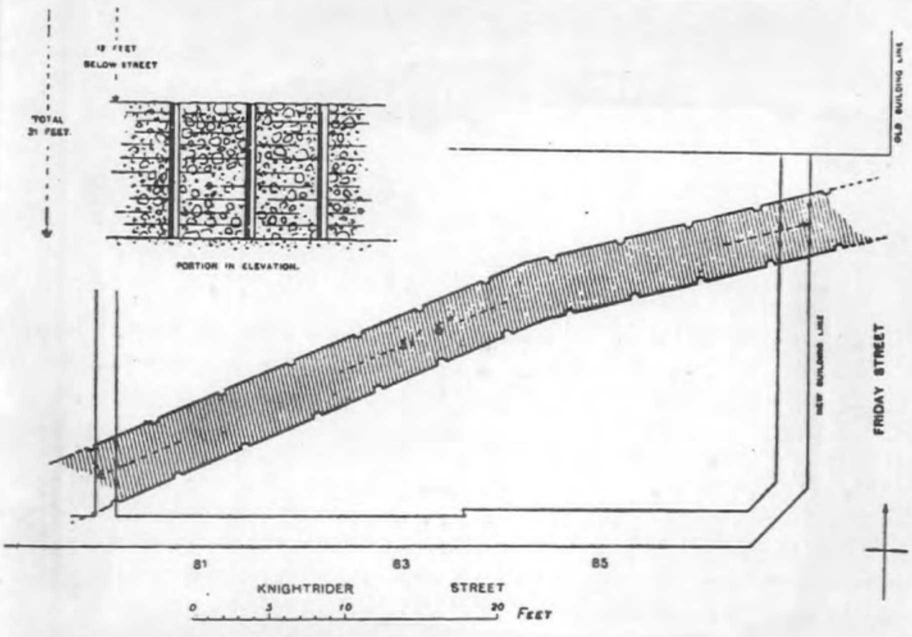

FIG. 7. ELEVATION AND PLAN OF ROMAN WALL FOUND IN FRIDAY AND KNIGHTRIDER STREETS, LONDON, IN 1905
(*Archaeologia* lx)

In addition, there was a variety of sizes of box tiles and other shapes for hypocausts and kilns, together with two main types of water-pipes. The first of these types was wheel-made; the second was much cruder, hand-made, and trimmed with a sharp tool before firing. Pipes of the first type are indicated by 10 and 11 in Fig. 6 ; 13 shows how the reduced end and its flange fitted the socket of the pipe in front. The hand-made form is shown by 12; in this type there was no flange, but the pipe had wide and narrow ends for jointing. These pipes illustrate the skill of the potters in the throwing and firing of large articles without deformation, especially when the relatively thin but uniform wall-thickness of the pipes is considered.

Use of concrete

For work on a large scale the Roman builders thought in terms of concrete, using for the 'aggregate' whatever coarse material was locally available, for example, flint and chalk-lumps were used at Verulamium, and nodules of argillaceous limestone, 'septaria', in the walls at Camulodunum. Unlike modern concrete work, where the mixture of aggregate and cement is prepared beforehand, the Roman practice was to lay the aggregate in horizontal courses, pouring on liquid mortar after each course was laid. In late Roman construction the mortar was generally sufficiently fluid to percolate through the aggregate, forming, when set, a solid mass like modern concrete. In some earlier work (e.g. the town walls of Caerwent) the mortar was thicker and so failed to seep completely into the aggregate. It functioned therefore more as a bond for individual courses, and air pockets were left in the heart of the wall. A characteristic feature of first and second-century work is that in laying the courses, the aggregate was pitched either in a constant slope or was sloped alternately to right and left in successive courses, giving a herring-bone effect. The concreted wall was often built between boards supported by upright posts which would normally be on the outside of the boards, but there are instances recorded(1) where the posts were placed inside the boarding. Such a case is the Roman wall discovered c.1905 in Friday and Knightrider Streets, London, where the matrices of these internal uprights together with the impression of the horizontal boarding, were clearly visible on the wall (Fig. 7)(2)

(1) R.E.M. Wheeler, J.R.S., 1932,XXII, 121-2.
(2) Archaeologia, LX.

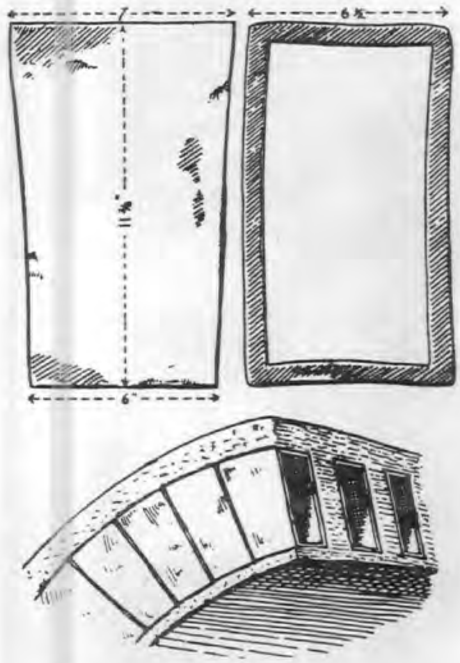

FIG. 8. BOX-VOUSSOIRS FROM LONDON (London and Guildhall Museums).

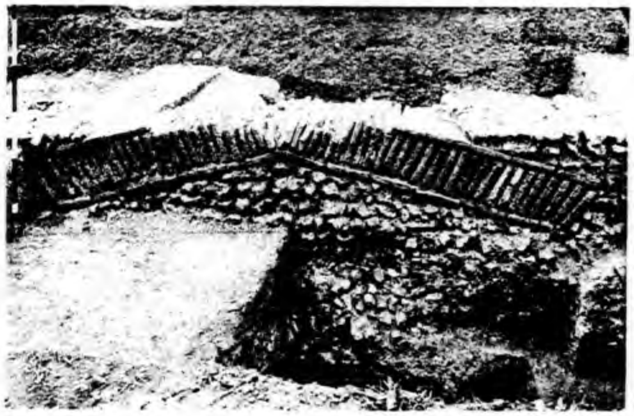

Fig. 10

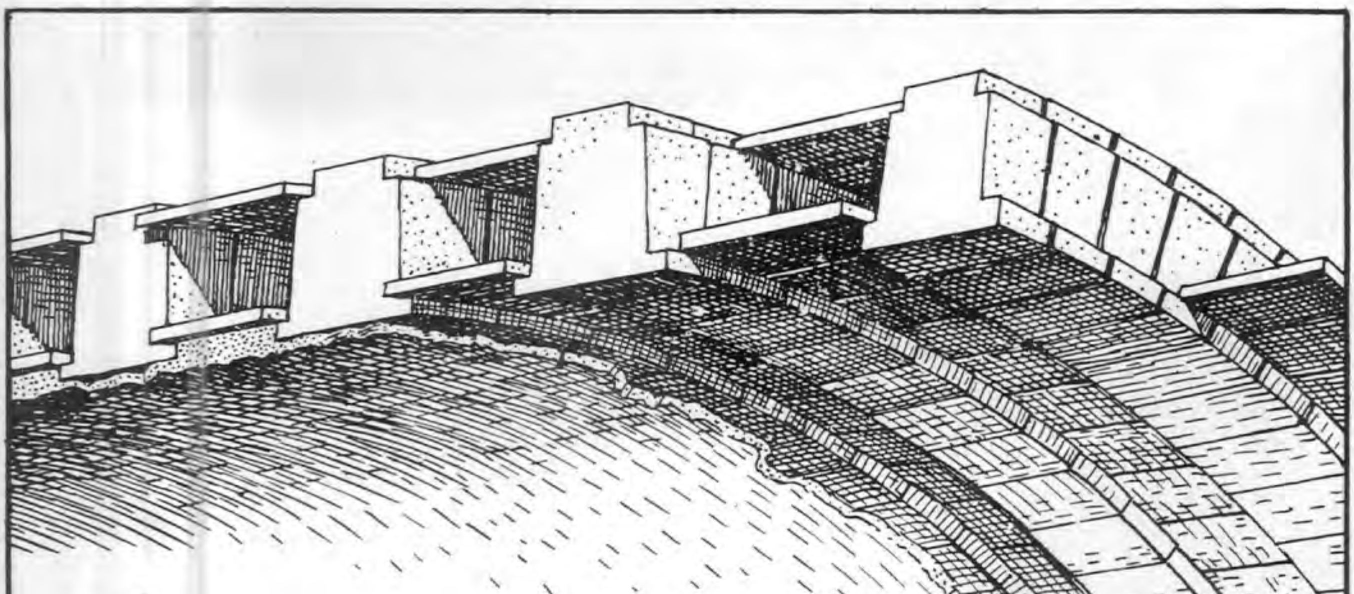

FIG. 9. RECONSTRUCTION OF VAULT IN THE BATH-BUILDING AT CHESTERS. (From *Archaeologia Aeliana*, 4th series, viii, p. 281, fig. 8)

Vaults and Arches

Roman domes and vaults were normally solid masses of concrete, but where the span of the vault was large the structure was lightened by embedding box-tiles, wedge or 'voussoir' shaped, in the concrete. This method of construction seems to have been employed for the 40 ft. span of the great bath at Bath, and similar box-tile voussoirs have been found in London (Fig. 8)[1]. It is possible that an even lighter form of vaulting was achieved by the use of calcareous tufa, a calcified mass which is formed when limestone, dissolved by the natural action of rain water, is precipitated when the water evaporates. When freshly dug, tufa is easily cut and shaped, but on exposure it hardens to form a mass which is light because of its 'sealed-pore' structure. On the site of the caldarium in the bath-building at Chesters, on Hadrian's Wall, many voussoirs of tufa were found, and P. Brewis has suggested[2] that these were used to form arched ribs for the vaulted ceiling. The ribs could have been spaced a foot or so apart, the intervals between the ribs being closed by a double set of tiles forming 'arched hollows' in which the air would be stagnant. The whole assembly (Fig. 9) would thus provide a light, heat-insulating roof.

A purely structural engineering use of an arch is where the arch is used solely to redistribute a weight or thrust, and the arch is not part of the architectural features of the building. An arch used in this manner is termed a 'relieving arch'. Wheeler[3] illustrates (Fig. 10) a straight-sided brick arch which was used at Verulamium "to carry a late third-century wall across a second-century rubbish-pit to which the builder did not trust his foundations without this aid".

External decoration.

Discussing the external appearance of Roman buildings in Britain, Wheeler points out [4] that much of the masonry which we have come to regard as typically and even attractively Roman in appearance looked very different in its own day.

(1) London and Guildhall Museums.
(2) Arch. Ael., 1931, VIII, 278.
(3) R.E.M. Wheeler, J.R.S., 1932, XXII, 131.
(4) R.E.M. Wheeler, loc.cit. 126.

For example, the town walls at Caerwent were smoothed by a coat of white mortar in which false joints were struck. The rough walls of the late first-century amphitheatre at Caerleon were smoothed by flush pointing, and false joints were then painted on, in crimson paint[1]. Cement or plaster renderings were thus frequently used by the Roman builder in an attempt to give a neat and regular exterior aspect to his buildings. Occasionally materials were brought from long distances to enhance the character of a building in Roman eyes: At Verulamium and at Colchester, Purbeck marble from Dorset was found[2]; green marble from the Peloponnese was discovered in a small Romano-British house at Ely near Cardiff[3]; white Italian marble was used about A.D.85 for a monument at Richborough in Kent, and Egyptian granite was employed for a column base in the Guildhall, London[4]. At Silchester there were fragments of Egyptian porphyry in a workshop[5]

Internal decoration.

Internally, Romano-British buildings seem to have been as gaily painted as any of the buildings which have survived in Italy; archaeological literature contains many references to painted plaster found in various parts of Britain, generally in a fragmentary state, unfortunately, but sometimes with enough evidence to enable the original effect to be surmised. One of the earliest records is of the remains of a painted wall in a villa at Comb End, Gloucestershire. Lysons reproduces this[6]; his sketch shows the feet of four people and the hem of their red garments, with the bases of three pillars. These pillars could be part of the scene which the artist had depicted. Artis, on the other hand, shows us[7] a fresco, from the wall of a Roman bath in Northamptonshire,

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(1) Archaeologia, LXXVIII, 118.
(2) Essex Arch. Soc. Trans., XVI, 360.
(3) Cardiff Naturalists' Soc. Trans., LV, 45.
(4) R.C.H.M., "Roman London," 42.
(5) Report on Excavations at Silchester, 1905, 7.
(6) Samuel Lysons, Plate 1 in Vol. II of "Reliquiae Britannico-Romanae" (3 vols., London, 1813-17).
(7) E.T. Artis, Plates 26 & 32 in "The Durobrivae of Antoninus", (London, 1828).

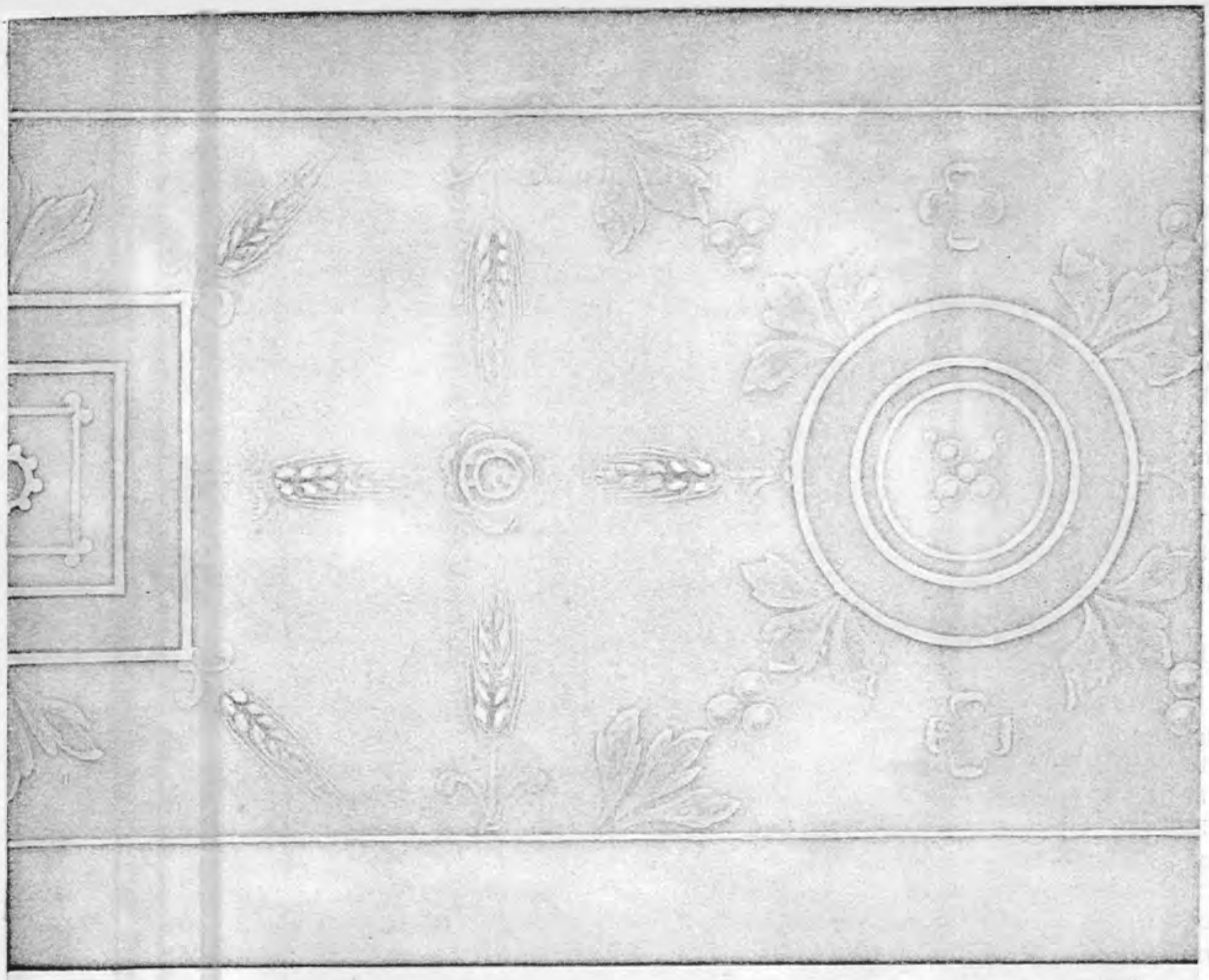

Fig. 11. Diagram showing restoration of pattern of a painted dado in House No. 1, *Insula* XIV. ¼ linear.

Fig. 12

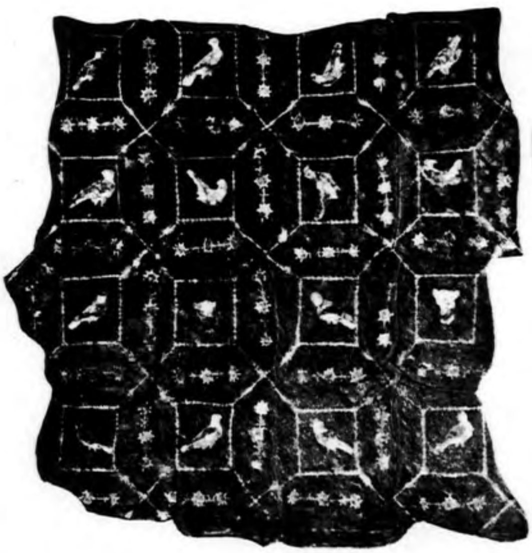

Fig. 13

where three painted (i.e., imitation) pillars divide the wall into two sections each containing a red panel surrounded by a blue border and having a yellow dado below. Painted columns, about $3\frac{1}{2}$ ft. high, with diaper ornament and lotus-leaf capitals were found(1) in a house at Verulamium; between the capitals were painted panels of reddish-brown marbling.

At Pompeii it appears to have been customary to mark the outline of the design on painted plaster with a stylus before commencing the painting. At Silchester in 1895 pieces of plaster from a house in Insula XIV were found to have traces of similarly incised setting-out or guide lines(2). This plaster was evidently part of a painted dado, shown reconstructed in Fig. 11 . The rings and hollow squares are grey, linked with yellow ears of barley; the background is maroon with blue rosettes, and there are diagonal lines of berries and green leaves.

In 1956, at Verulamium part of the painted plaster of a second-century house in Insula XXI was found intact (but face downwards) beneath later floors(3). One side of a corridor had a red-panelled wall with yellow and blue decoration; the opposite wall, in purple, had panels of yellow bearded wheat stalks enclosing doves. Most remarkable of all was a 12 ft. length of a painted frieze; this had a bright yellow background with a green acanthus scroll and large red flowers alternately top and bottom. In the central portion there was a feline (leopard?) shown full face, and two pheasants seen in profile. One of these pheasants is illustrated in Fig. 12 . Two years later part of a painted ceiling associated with the red-panelled wall was discovered(4); this is shown in Fig. 13 .

A word must be said about mosaics, which are a characteristic Roman decorative flooring. The method of construction was straightforward: small cubes (tesserae) were made out of local stone or clay and were laid with a very durable cement of lime on a concrete bed. Much ingenuity, however, was used to obtain effects of colour: Haverfield writes(5) "Experiments made on a Cirencester mosaic showed

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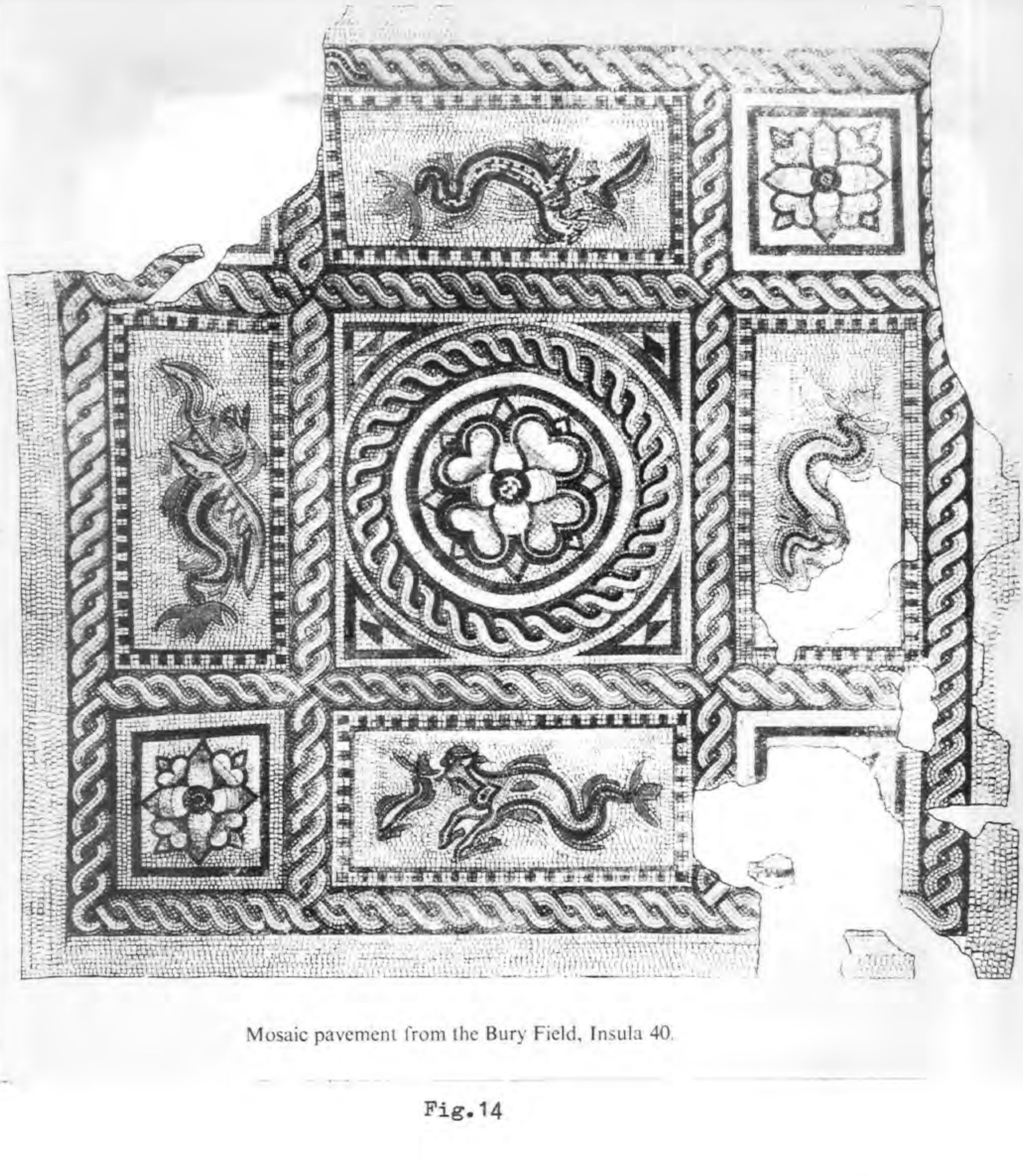
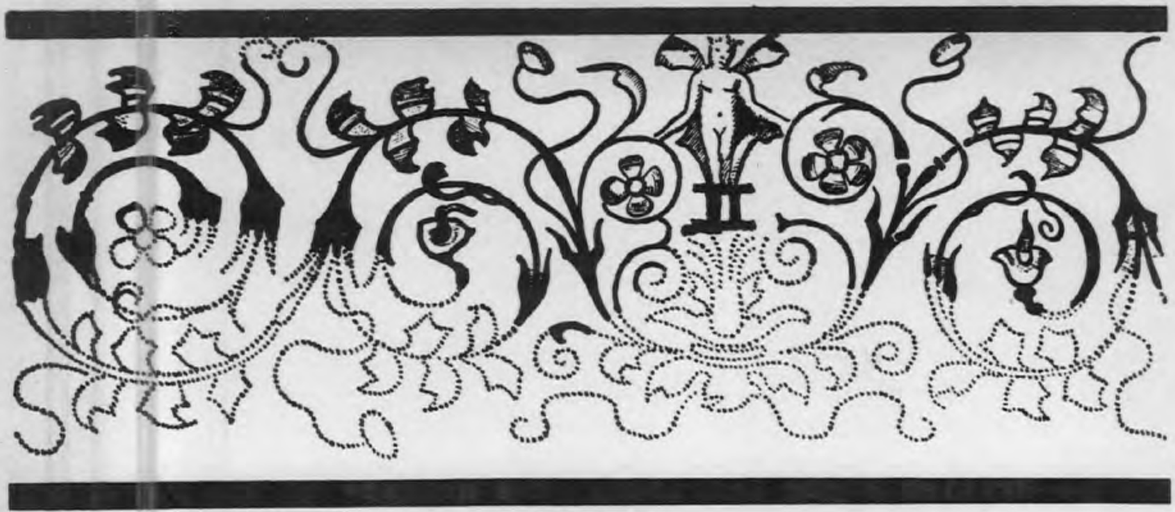
(1) J.R.S., 1959, XLIX, 123.
(2) Archaeologia, 1896, LV, 249-250.
(3) Antiqs. Jour., 1957, 37, 14; J.R.S., 1957, XLVII, 217. The restored plaster 12 ft. long, 5 ft. high, is now in the British Museum.
(4) J.R.S., 1959, XLIX, Plate XIII.
(5) F.Haverfield, "The Art and Architecture of Roman Britain", in H.D. Traill & J.S. Mann's "Social England".

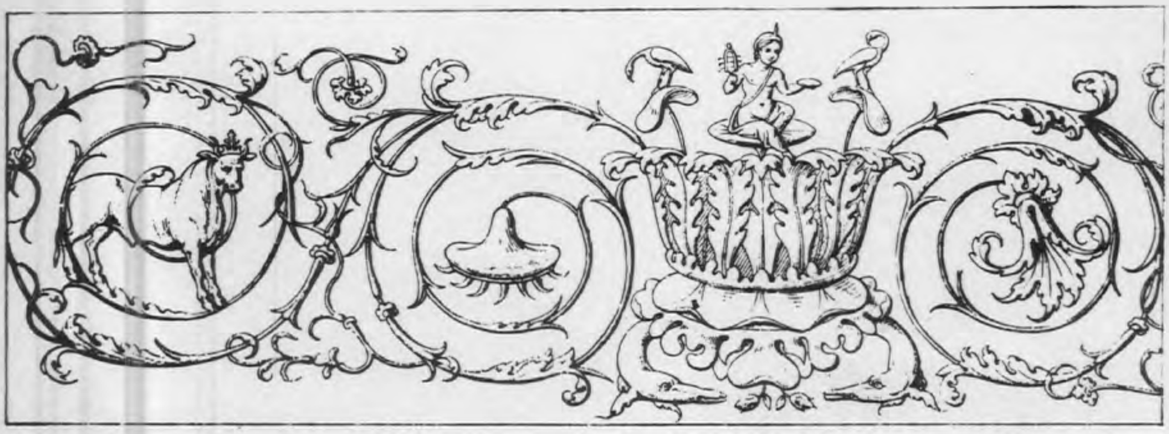


Mosaic pavement from the Bury Field, Insula 40.

Fig.14



SILCHESTER.



POMPEII (No. 1.)

Fig. 15

that the cream-coloured cubes were obtained from a local limestone, grey from the same slightly roasted, white from chalk, yellow from local gravel drifts, slate-coloured from a Gloucestershire lias, and chocolate from a Herefordshire old red sandstone, while red and black were baked clays with added pigment, and a small piece of bright red was proved to be ruby glass." Wheeler[1] thinks that "it seems probable that mosaic pavements were for the most part made by itinerant craftsmen working from hard-worn pattern books." When they are not conventional and more or less geometric designs the subjects of mosaics are typically Roman: the Seasons, Muses, Cupids, Actaeon devoured by his dogs, hunting scenes, sea monsters, and so on. "No late Celtic traits, no specially Romano-British style intrudes; the artists of the mosaics rarely, if ever, ventured even to introduce objects which might be supposed to be drawn from their British surroundings. Here, as in the other fittings and decorations of the Romano-British residence, Roman fashions ruled alone.[2] A typical specimen, from Colchester[3] is shown in Fig. 14 ; this pavement was 19 ft. square, including the red surround. It is generally considered that many of these mosaic pavements do not equal the best Italian work, but on occasion a favourable comparison can be made, as at Silchester where the choice of design and the delicacy of the workmanship in the margin or frieze of a first-century mosaic has prompted comparison with a painted frieze originally existing in the portico of the Temple of Isis at Pompeii[4]. The similarity in style is apparent in Fig. 15 . (Incidentally, the acanthus scroll-work on the 12 ft. length of painted frieze at Verulamium, mentioned on page 12 , has also been compared[5] with the Temple of Isis frieze).

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(1) R.E.M. Wheeler, loc.cit., 127.
(2) F. Haverfield, loc.cit.
(3) M.R. Hull, "Roman Colchester", Plate XXXIV, (Soc.Antiqs. Res. Report XX, 1958). This mosaic, now in the Colchester & Essex Museum, was found in Insula 40 in the grounds of what was known as Bury or Berry Field.
(4) W.H. St. John Hope & G.E. Fox, Archaeologia, 1899, LVI, 245-250.
(5) See J.R.S., 1957, XLVII, 217, footnote 72. Other interesting parallels are drawn, and it is suggested that "The scroll with masks, animals, and birds used by wall-painters of the later first century could easily still exist in the pattern-books fifty or so years later in the provinces."

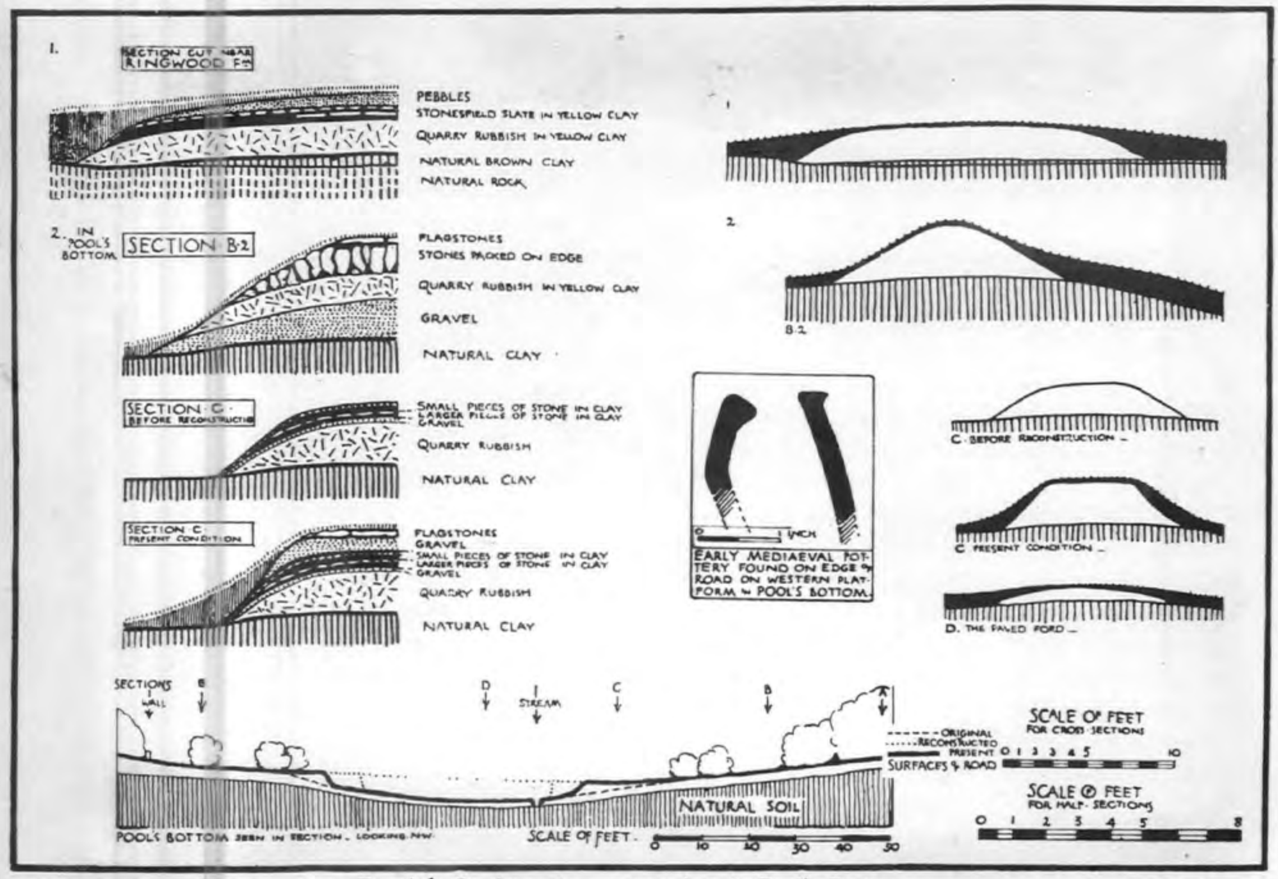

FIG. 16. Sections, &c.: excavations in Pool's Bottom.

CIVIL ENGINEERING

Roads

The basis of the civilization of Rome was her road system, providing the means for rapid movement of troops in emergency, and for trade in time of peace. The needs of the army meant that the construction of many roads was a military undertaking, and a highway linking places of strategic importance by a direct route would be often the first permanent constructional enterprise in newly conquered territory. It has been pointed out[1] that since the resources of a country were initially exploited under military direction, roads connecting centres of purely commercial importance were similarly built by the army, even if later it relinquished the chief responsibility for maintenance. Thus, in Britain, most of the main roads were first constructed as part of military strategy, but after the conquest they became chiefly means of peaceful communication. The earliest roads were built in the south-east of Britain, thrusting north, north-east and west as the Conquest gathered momentum.

The design of roads, and the materials used in construction varied considerably, and a modern writer[2] makes it clear that Roman technique changed as they learnt from experience; nevertheless certain outstanding features characterise the Roman road throughout the Empire: the foundations were thoroughly sound, although the terrain might be dry or damp; a base of broken stones, tiles or gravel was always made, the smaller stones being included in the top of the layer; clay or lime mortar made the fragments into a watertight mass; a paved surface was provided for principal roads. In Britain there are foundations of timber corduroy, or piles, or gravel. The road over Blackstone Edge was built on peat. The same road had a paved surface, although in many cases the top is of rammed gravel. Widths of road vary from eight to twenty-five feet, and the ditches can be up to fifty or sixty feet apart. Several of these features are illustrated in Fig. 16 which depicts sections cut across Akeman Street[4] in Pool's Bottom, east of Asthally, showing the construction of the Street and the way in which its width decreased from 36 ft. to 18 ft. and then to 10 ft. while its line diverged, to descend the slope to a high-pitched causeway 10 ft. wide; it ultimately

(1) I.D. Margary, "Roman Ways in the Weald," (Phoenix Press, 1948).
(2) H. Schreiber, "History of Roads", (Barrie & Rockliff, 1961).
(3) R.G. Collingwood, "Archaeology of Roman Britain," 3, (London, 1930).
(4) C.G. Stevens and J.N.L. Myres, "Excavations on the Akeman Street, near Asthally, Oxon." Antiqs.Jour., 1926, VI, 43-53.

crossed the stream by a paved ford. The roadway was found to be most perfectly preserved at Section B.2 (Fig. 16) where it had the following construction:

(i) The surface was paved with large flat Stonesfield flags up to 1 ft. by 1 ft. 6 in. in size, and 2 to 3 in. thick; several of these were found in situ.

(ii) Beneath the paving is a layer, about 1 ft. thick, of stones packed on edge in a bed of small stones and sloping at an angle in the direction of the road.

(iii) Beneath this is a layer of quarry rubbish in yellow clay 8 in. thick.

(iv) Beneath this is a foundation layer of pure river gravel, varying from 6 in. thick at the edge to 1 ft. 3 in. in the centre of the road, and lying directly on the natural clay and sand of the valley floor.

In general, the roads were well-metalled with the best materials available locally, as for example flints, broken stone, stone slabs or squared blocks, or even waste products from local industry, such as the iron slag or cinder found in the Weald. The thickness of the metalling varied; six to twelve inches in the middle is usual, but as much as two or even three feet has been found, although where such exceptional thicknesses are revealed they are probably the result of repeated re-surfacing. The roads were cambered to a degree which to the modern eye would seem uncomfortably steep: thus where a road is well preserved it can sometimes be proved to have had a fall of as much as eight inches from the crown to the sides, on a half-width of only nine feet[1].

British roads were similar to Gaulish in that the army engineers drove them along ridges of high ground, with the object not only of commanding valleys but also of avoiding rivers. Thus Watling Street crosses small streams and the Fosse Way crosses only one river of reasonable size, the Avon, at Bath. There is a striking similarity, as Haverfield said[2], between the layout of the British railway system and the arterial routes of Roman Britain. Watling Street ran from Canterbury to London, and then to Wroxeter via St. Albans, Towcester and High Cross. A branch to Chester gave access to

(1) I.D. Margary, op.cit..

(2) Quoted in H.C. Darby's "Historical Geography of England before 1800", (Cambridge, 1936), Chapter 2, E.W. Gilbert.

northern Wales and Britain. The route as a whole is like the former London, Midland and Scottish main line. On the other hand the old London and North Eastern system was almost identical to Ermine Street; from London to York via Braughing, Castor, Lincoln and Doncaster. In avoiding Thorne and Hatfield marshes this road was built to pass through the sites of Littleborough, Doncaster, Castleford and Tadcaster. "It is clear that...vegetation did not create any difficulty for the Roman road builder...the course of the road is a striking example of the fact that marshes provided a much greater physical obstacle to movement than woodland(1). The road north-east from the capital to Chelmsford, Colchester and Caister-by-Norwich is again similar to a former L.N.E.R. main line. Stane Street's course to the Hampshire coast is like that of the Southern railway system.

In the north, the Tyne Gap has been penetrated by Roman and railway engineer alike in linking Newcastle and Carlisle. Of the various cross-country main routes, the greatest was the Fosse Way, over 220 miles long, from Exeter to Lincoln via Bath, Cirencester and Leicester.

Bridges

It is accepted that the Romans did not build many bridges in Britain, and quite often they relied on fords, constructed as submerged roads, for the passage of streams. In Italy and the Empire, engineers laid concrete foundations for the largest bridges by means of cofferdams and made free use of circular masonry arches. However, some of their biggest bridges were timber built, on concrete or rock foundations; those in Britain could hardly have approached Apollodonis' structure spanning the Danube in size, but they certainly made much use of wood. Collingwood(2) remarks that "All the Roman bridges of which we have certain knowledge in this country were wooden structures on stone piers".

The North Tyne provides us with the remains of what must have been a fine bridge some 200 ft. long over the river at Chesters. Research(3) has disclosed the remains of an earlier and narrower Hadrianic bridge on the same site, apparently to

(1) Haverfield, quoted in (2), page 15.
(2) R.G. Collingwood, "Archaeology of Roman Britain," 5, (London, 1930).
(3) Summarised by J. Collingwood Bruce, "Handbook to the Roman Wall," (Eleventh edn. 1957, edited by I.A. Richmond).

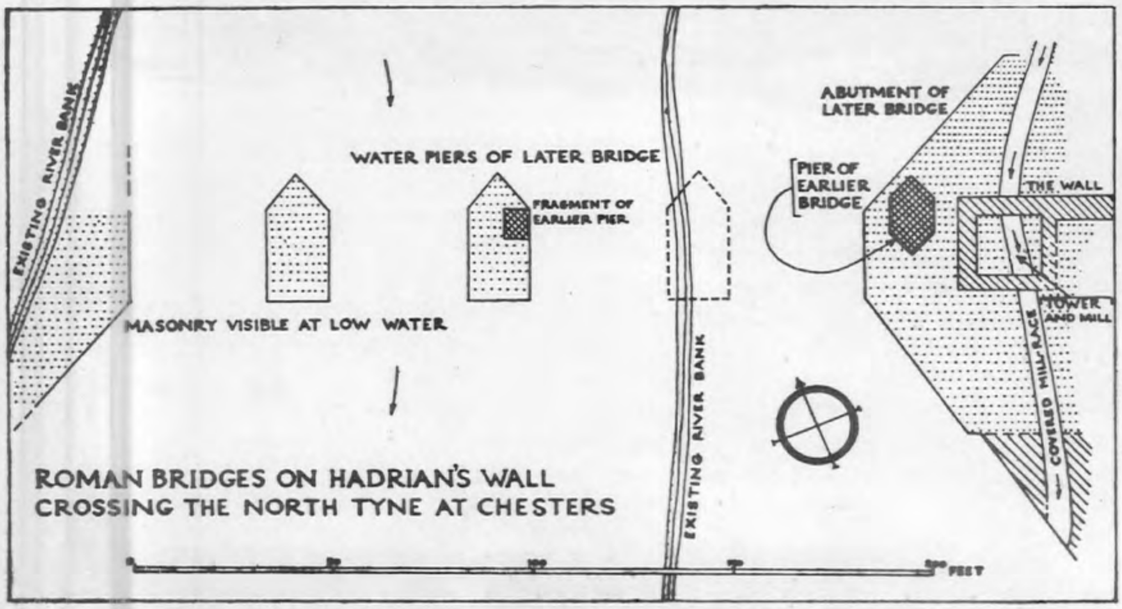

DIAGRAM OF ROMAN BRIDGES AT CHESTERS.

Fig. 17

carry the Wall only. A pier of the first bridge, discovered in the eastern abutment of the later bridge (Fig. 17) shows that the original piers had cutwaters both up and downstream; the cutwaters of the second bridge face upstream only. The main face of the eastern abutment of the second bridge is 22 ft. long and the piers are built in proportion, suggesting that this later bridge carried a road some 20 ft. wide. The facing stones of the abutment were bound together by iron tie-bars run in with lead. The road was undoubtedly carried on a timber superstructure because grooves corresponding to the beams are visible in some of the scattered masonry on the site, and no arch stone of this period has been found, whereas voussoirs built into one of the later piers show that the first bridge was arched in stone. This of course is understandable if it carried the Wall. The stones of the earlier piers were held together by single dovetail cramps between each stone.

On the site of the present Swing Bridge at Newcastle upon Tyne there was the Pons Aelius, built by Hadrian. Work in connection with the building of the Swing Bridge in 1866 showed that the stone piers of Hadrian's bridge had each been built on a raft of iron-shod oaken piles. The piers had cutwaters both upstream and down, and they were wide enough to accommodate an 18 ft. road.

R.G. Collingwood states(1) that the Romans deliberately avoided the building of bridges in this country, and whilst this may in the main be true, it is clear from the present brief account that when the necessity arose they could call upon civil engineering resources of a high order.

Water Supply

The primary sources of water in Roman Britain were rivers, springs and wells; the latter are numerous; they were skilfully constructed and are invariably lined with stone or timber. On occasion barrels with the ends knocked out were used, and at Silchester tubs made of fir, with staves 6 ft. 5½ ins. long, were recovered from wells(2). Nine Roman wells examined within the City of London were of two types: either square, lined with wood, or circular in plan, lined with wooden barrels from which the ends had been removed(3).

It is, however, in the conveyance of water from a distant source that Roman civil engineering ability is seen at its

(1) C.A.H., XI, 250.
(2) Arch., 1898, LVI, 121.
(3) J.R.S., 1955, XLV, 138-9.

best. At Dorchester water was led from the Frome, at a point about nine miles outside of the town, in an open leat over a carefully contoured course to its destination. A channel of similar length was constructed in Carmarthenshire to serve the Dolaucothy gold mine (see page 77). At Wroxeter, the Bell Brook was tapped in the same way, to provide running water for part of the town. Undertakings of this nature demand thorough planning and accurate surveying[1].

Lindum provides an excellent example of this proficiency in civil and hydraulic engineering: The city of Lincoln stands on a hill nowhere less than 40 ft. above the water-table. This makes a normal gravitational supply of water impossible, but the Romans provided[2] a supply under pressure from a spring some three miles outside Lindum Colonia by transferring water at the spring site into a high-level cistern or water tower, from which it was conveyed to the city by a pipe-line consisting of socketed ceramic pipes heavily encased in concrete. Associated with the city boundary of this pipe-line is the remains of an aqueduct which in 1951 was traced[3] downhill to its starting point, a stream called Roaring Meg, where the water tower might have stood. In 1952 the foundations of three more piers of the aqueduct, near the stream, were uncovered[4]. One of these piers, larger than the others, had a hollow which could conceivably have been the site of a force pump. The ground in this region was probably covered by a pool, and this would be necessary for a force pump, which can only work "drowned". Possibly, therefore, water was pumped directly into the aqueduct. Large nails found nearby suggested that the piers of the aqueduct were not arched but were spanned by timber.

Lindum is also unique as having the only known Roman planned underground sewerage system in Britain. This was traced in 1838[5] for 100 yards; it was 4½ ft. high and

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(1) "Long division or multiplication had to be done by cumulative subtractions or additions; and in sum, the wonders of Roman architecture and engineering seem even more enhanced when viewed against their primitive mathematical background" (G.C.Boon, "Roman Silchester," 116; London,1957); "..that miscalculations could be made is shown by the case of Leicester, where the aqueduct, now represented by the Raw Dykes, seems never to have been finished, and was never used. Here, as in many other towns, water was obtained from the river and from wells." (A.L.F.Rivet," Town and Country in Roman Britain", 88; London, 1958).

(2) Arch.Jour.,1946,CIII,36-37.

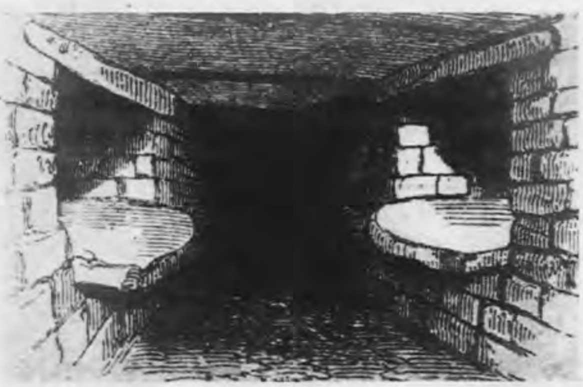
(3) J.R.S.,1952, XLII, 94.

(4) J.R.S., 1953, XLII, 114.

(5) Arch.Jour., XL, 319 and XLI,320, quoted by I.A. Richmond.

Part of the sewers at Lincoln

Fig. 18



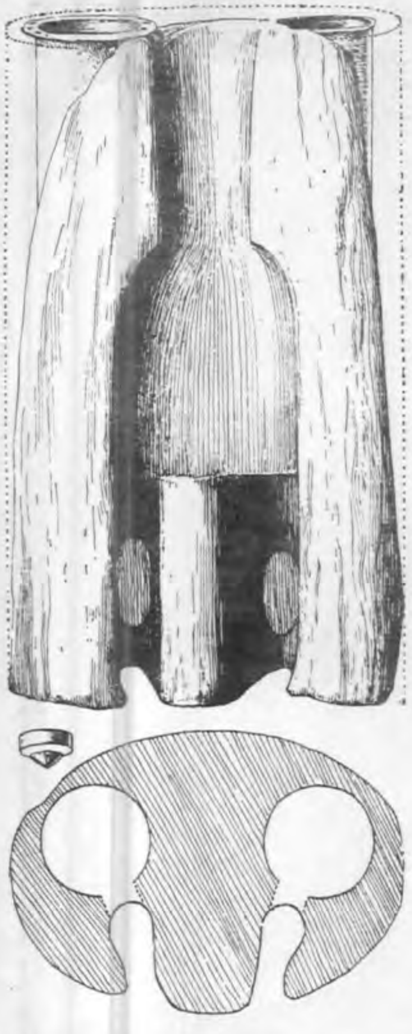


Fig 19. Elevation and section of a block of wood and lead cylinders found in a well or pit in *Insula* XIV. ($\frac{1}{6}$ linear.)

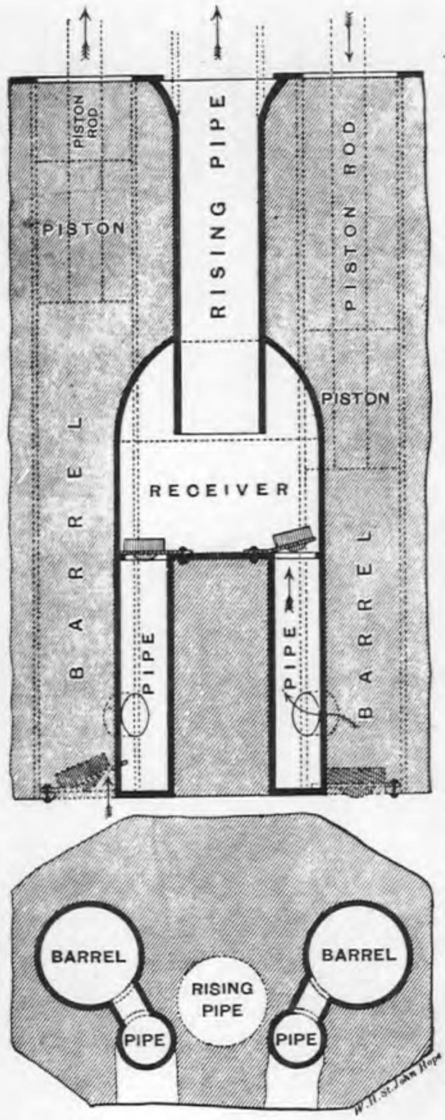


Fig. 20. Conjectural restoration of a Force Pump found at Silchester in *Insula* XIV. $\frac{1}{6}$ linear.

2 ft. 4 in. wide. Lateral sewers joined it, and house drains 14 in. square ran into all (see Fig. 18, from a nineteenth century engraving[1]). At intervals there were shafts or man-holes to facilitate cleaning and inspection. In contrast, Silchester for example, seems to have had no proper drainage system nor do the houses appear to have had drained latrines[2]. At Wroxeter the leat was tapped at some points by sluices for flushing private latrines[3]. The same source of water was also connected to lead and wooden pipe-lines for drinking purposes. Wooden pipe-lines, joined by iron collars, are known at Corinium (Cirencester), Calleva (Silchester), Venta Silurnum (Caerwent), Venta Icenorum (Caister-by-Norwich)[4] and Verulamium (St. Albans).[5]

Silchester provided a very remarkable find in connection with hydraulics: In 1895 Hope and Fox recovered from a rubbish pit in Insula XIV a block of oak, some 22½ inches long, containing two lead pipes[6] (see Fig. 19). There were also hollows or passages in the block indicating that other pipes had originally existed therein, and in one of these branch passages was found a small leaden weight "such as might have been fixed on the upper surface of a leather valve by means of a rivet passing through to the underside." J.T. Micklethwaite pointed out that the whole contrivance was similar to the force pump described by Vitruvius[7] as the "Ctesibica Machina," and this enabled the Silchester find to be restored as in Fig. 20, from which its identity with a force pump is clear.

Water-wheels of the undershot type were known to the Romans, and in Britain they were employed for working flour mills at three points on the Wall: at Chesters, using the water of the North Tyne; at Haltwhistle burn; and at Willowford, using the river Irthing. At Chesters the stone hub of the undershot waterwheel, with eight holes for the wheel spokes, can still be seen. Part of the wooden wheel of the Haltwhistle burn mill were found in 1908, and its large mill stones are in the Chesters museum. At Willowford the bed of the stream was paved where the water-wheel operated, and a stone spindle-bearing for either the wheel or the mill stones was found[8]. Hub cores similar to the Chesters specimen have recently been found at Lincoln[9].

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(1) Reproduced by A. Birley, "Life in Roman Britain" (London, 1964)
(2) G.C. Boon, "Roman Silchester," 161, (London, 1957).
(3) A. Birley, "Life in Roman Britain," 70, (London, 1964).
(4) I.A. Richmond, "Roman Britain," 106, (Pelican History of England, 1963).
(5) J.R.S., 1959, XLIX, 123.
(6) W.H.St.John Hope & George E. Fox, Arch., 1896, LV, 232.
(7) Vitruvius, De Architectura, X, xii.
(8) J. Collingwood Bruce, op.cit., 85, 152, 172.
(9) I.A. Richmond, op.cit.

Fig.21

CERAMICS:
KILNS

The potter's art is one of the oldest crafts in the history of mankind. Excavations in Europe show that ceramics go back at least to the Neolithic age. Fig. 21 shows a group of European Neolithic pottery, c.2000-1500 B.C., in the British Museum. Reading from left to right the pieces are: Western Neolithic bowl from Jersey, diameter 6¼ in., Corded Beaker from near Merseberg, Germany, height 5½ in., and a bowl from near Mainz, height 3½ in.. Prehistoric ceramic pieces have been found in most continents, notably in North and South America, which suggests that the craft must have started spontaneously in various parts of the world, probably wherever rudimentary civilisations had become established. In the Old World, the most ancient pottery so far discovered has come from the Nile Valley. The potter's wheel was used in the earliest times by the Egyptians, the Babylonians and Persians, and with outstanding skill by the Greeks. From a comparison of Greek and Roman pottery it is clear that the Romans based much of their work on Greek originals; where the Romans excelled was in the more utilitarian and practical arts of making bricks and tiles, and the construction of brick buildings. The Roman armies took the craft of brick and tile making into all the colonies of the Empire, and in Britain, as on the Continent, some of the more important 'factories' for these building materials are therefore found in association with military sites.

The large number of kilns discovered all over Britain shows, however, that pottery was made wherever there was a need for it. There would be no restriction as to location, because the two essential materials, clay and fuel, were available anywhere: clay was to hand simply for surface digging, and in a densely-forested country the fuel - wood - presented no problem. In the New Forest there are many kiln sites, probably because the New Forest potters moved frequently, following the fuel; as one area became denuded of brushwood they would move on to a new site, perhaps taking the more important parts of their kilns with them.

This they could do because the kilns were of the simplest construction. A typical kiln[1] consisted of a circular or oval combustion chamber formed by digging a hole in the ground, a clay hearth at ground level, covering the

(1) See Heywood Sumner, "Excavations in New Forest Roman Pottery Sites", London, 1927.

combustion chamber (except for a firing hole through which fuel would be fed), and a dome of wattle-work covered with earth. The hearth was pierced with holes to allow the hot gases from the combustion chamber to enter the dome and circulate around the ware which had, of course, been placed on the hearth before the dome was constructed. The dome itself would have a vent hole, or even a small clay chimney, through which the products of combustion could escape and thus maintain a through draught in the kiln. In the course of repeated firings the hearth and the sides of the combustion chamber, and the chimney, would become hard and more or less vitrified. These fired and fully shrunk sections of the kilns would be the parts which the potters would take with them on moving to a new site, because they would facilitate the construction of a new kiln and enable it to carry a useful charge of ware, even on its first firing, without risk of the hearth collapsing (which could happen with a new, unfired clay hearth). To retrieve the fired ware the dome would be carefully broken away after each firing, and it would have to be rebuilt for the next run. A New Forest kiln is shown in Fig. 37 opposite page 37.

Kiln Types

Kilns of more sophisticated design are found near settlements and military sites, but in general, excavation and discovery have not revealed any sequence of development towards the ideal kiln; different methods of construction are found side by side on the same site and have apparently been in use in all periods. W.F. Grimes has classified the various types of kiln.(1) He puts the kilns into two categories according to the way in which the hot gases moved through the structure:

A. Updraught kilns

B. Horizontal-draught kilns

Updraught kilns consisted of two superimposed chambers as in the New Forest kiln already described, the lower providing the combustion space and the upper the firing space or oven; the products of combustion passed upwards from the fire through holes in the oven floor and then through vents or a chimney in the topmost part of the oven.

(1) W.F. Grimes, "Holt, Denbighshire: The Works-Depot of the Twentieth Legion at Castle Lyons", Y Cymmrodor 1930, XLI, 53.

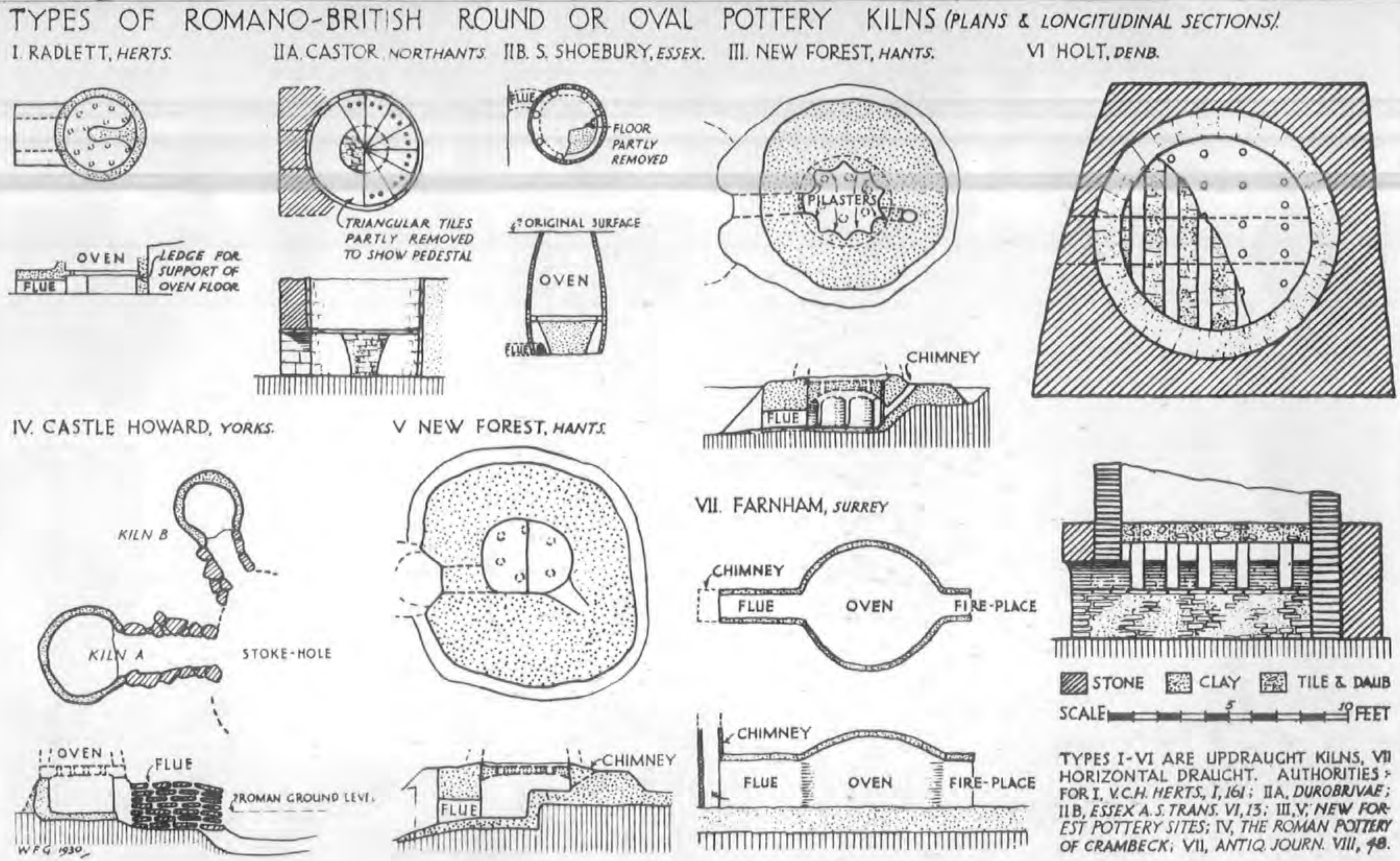
TYPES OF ROMANO-BRITISH ROUND OR OVAL POTTERY KILNS (PLANS & LONGITUDINAL SECTIONS).
I. RADLETT, HERTS.
IIA. CASTOR, NORTHANTS.
IIB. S. SHOEBURY, ESSEX.
III. NEW FOREST, HANTS.
VI HOLT, DENB.
OVEN
FLUE
LEDGE FOR SUPPORT OF OVEN FLOOR
TRIANGULAR TILES PARTLY REMOVED TO SHOW PEDESTAL
FLUE
FLOOR PARTLY REMOVED
? ORIGINAL SURFACE
OVEN
FLUE
PILASTERS
CHIMNEY
FLUE
IV. CASTLE HOWARD, YORKS.
KILN B
KILN A
STOKE-HOLE
OVEN
FLUE
? ROMAN GROUND LEVEL
W F G 1930
V NEW FOREST, HANTS.
FLUE
CHIMNEY
VII. FARNHAM, SURREY
CHIMNEY
FLUE
OVEN
FIRE-PLACE
CHIMNEY
FLUE
OVEN
FIRE-PLACE
STONE
CLAY
TILE & DAUB
SCALE 5 10 FEET
TYPES I-VI ARE UPDRAUGHT KILNS, VII HORIZONTAL DRAUGHT. AUTHORITIES: FOR I, V.C.H. HERTS., I, 161; IIA, DUROBRIVAE; IIB, ESSEX A.S. TRANS. VI, 13; III, V, NEW FOREST POTTERY SITES; IV, THE ROMAN POTTERY OF CRAMBECK; VII, ANTIQ. JOURN. VIII, 48.

Fig. 22.

The oven was either dome-shaped or built with high vertical walls. In the latter case some sort of vented roof would be necessary, but the exact nature of the superstructure is difficult to conjecture because so little of any of these kilns has survived above the first foot or so of their height. The vertical-walled ovens were probably used in the larger tile kilns which were generally rectangular in shape. These rectangular kilns fired tiles and pottery, but the round or oval kilns - which are commonest in Britain - seem to have been used only for pottery and never for tiles, perhaps because they are too small to have accommodated a useful load of tiles.

The combustion chamber of these updraught kilns was usually constructed below ground level; this probably reduced the effect of variable winds on the fire, and enabled the floor or hearth of the oven to be at ground level which made for economy of labour in setting and drawing the ware. The pit forming the combustion space was often lined with stones, forming a solid periphery for supporting the oven.

The principal material of construction for all varieties of kiln was naturally clay, either in the raw or fired state. The potters would soon appreciate the superior strength of fired clay as a constructional material, and it is found in kilns either as tiles or bricks, or as a form of refractory 'concrete' which consisted of clay containing tile or pottery fragments. Large kilns were frequently strengthened by an external casing of masonry. Internally, the problem which faced the kiln builders was the supporting of the kiln hearth with its load of ware. Fig. 22 , taken from Grimes, illustrates some typical solutions in the case of round kilns, which we shall now describe:

In the Radlett kiln (I)* the hearth is supported by a tongue-like column extending from the back wall to the centre of the combustion chamber, in line with the fire-hole or flue. The periphery of the hearth is carried on the circumferential lining of the combustion space. In the Castor kiln (IIa) a central, isolated, pedestal is used to support a hearth of triangular, perforated tiles. The form of this pedestal varied; in some cases (e.g., London, St. Paul's) it was a simple cylinder, in others (Shoebury; Castor) it was an inverted, truncated cone. Instead of a central column, the New Forest kiln (III) had a series of circumferential columns ("pilasters") protruding from the wall of the combustion chamber. The Castle Howard kilns (IV) have no supports

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* Roman numerals in brackets are kiln type numbers (Grimes' classification).

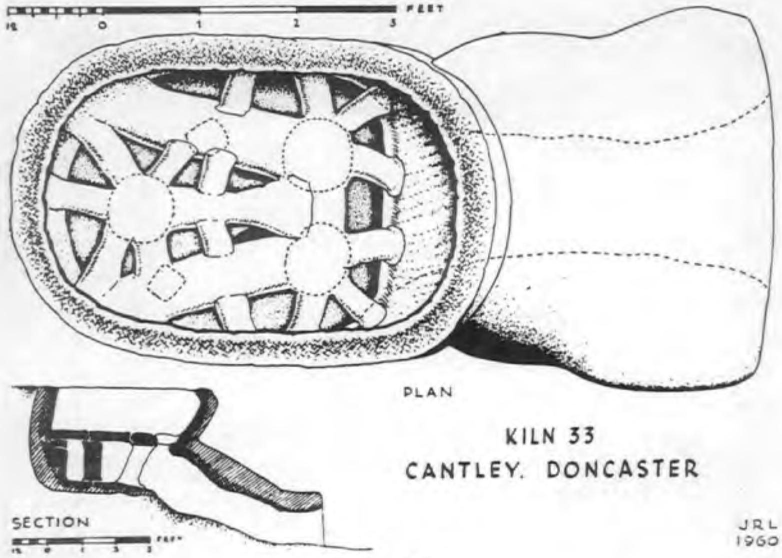

FIG. 23.

Drawn by J. R. Lidster for Doncaster Museum

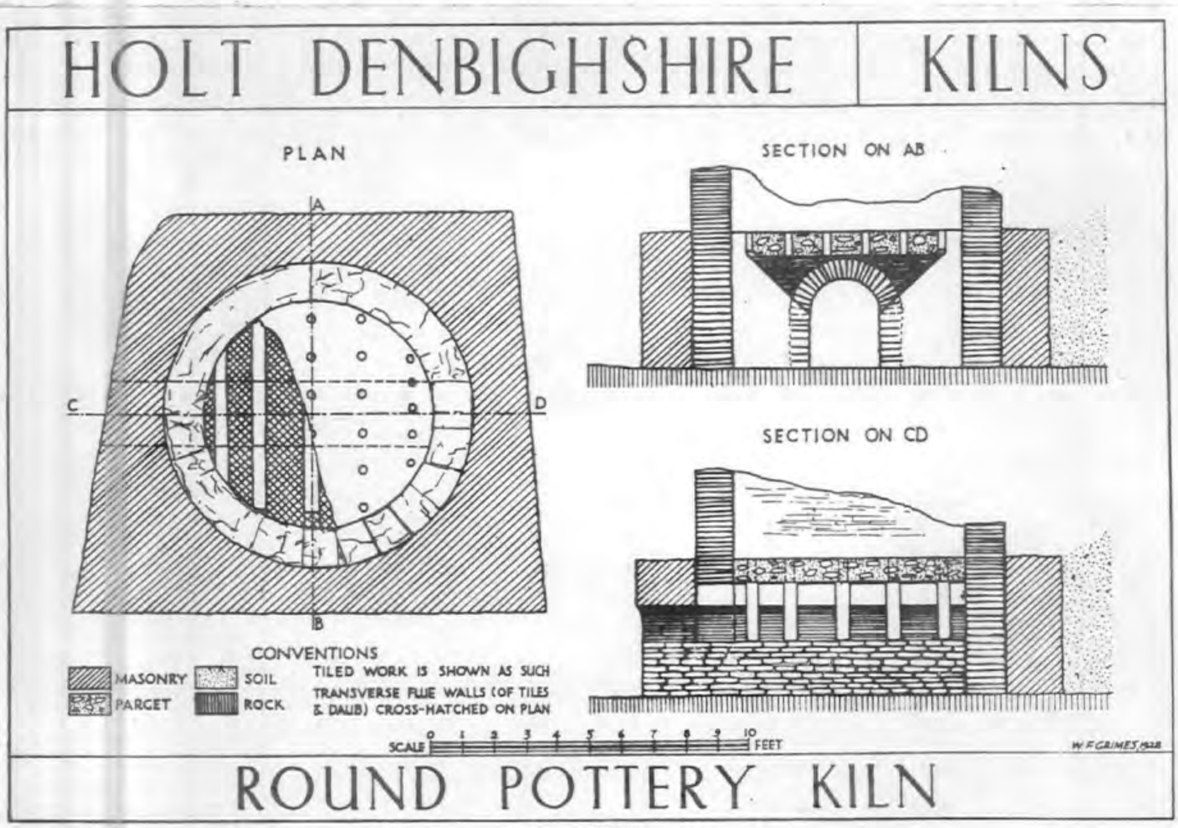

Fig. 24.

except in so far as the lining of the combustion chamber supports the circumference of the hearth. Probably the hearth was made thick for strength and was supported - for the first firing of the kiln - by a wooden framework which was gradually consumed in the course of the initial firing; afterwards the baked hearth would presumably be strong enough to stand alone. The Castle Howard kilns illustrate grouping around a common stoke-hole; this arrangement is also found at Silchester (1) and at St. Paul's, London. (2) The New Forest kiln (V) is illustrated to show a unique step in the floor of the combustion chamber, perhaps intended to force the hot gases upwards in the region furthest from the stoke-hole where the fire would be weakest. A complicated under-hearth structure was found in a kiln excavated at Cantley, near Doncaster, which had three permanent cylindrical plinths and two rectangular removable plinths supporting a floor of clay fire-bars (3) (see Fig. 23). The round kiln of most advanced design is that found at Holt (VI); here the oven floor or hearth is supported by several walls built across the combustion chamber. This kiln is shown in detail in Fig. 24 , and the superiority of its design in comparison with the other round kilns of Fig. 22 is evident. Not only is the hearth better supported, but the symmetry of the transverse supports permits a correspondingly uniform spacing of the hearth vent-holes; moreover, the vents can be more numerous without risk of weakening the hearth. The distribution of heat in the oven of this kiln must have been far more uniform than in kilns of the Shoebury type where the large central support for the hearth not only cuts off heat from the middle of the hearth but adversely crowds the relatively few vent-holes which can be safely allowed in the unsupported peripheral region.

The horizontal-draught type of kiln consisted simply of an oven with a furnace at one end and an exit flue at the other, all in line. Here there was no hot hearth to be supported, but the bottommost layer of pottery must have been in some way raised above the floor of the oven to enable the base of each piece to receive sufficient heat, otherwise the bottom layer of ware would be under-fired owing to the chilling effect of the unheated oven floor. One can imagine the imperfect ware or "wasters" from previous firings being arranged on the oven hearth to serve as supports for the lowest layer of "green" unfired ware. This type of kiln is illustrated by the Farnham kiln (VII) in Fig. 22 , which represents one of a group found

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(1) Arch., LXII, 327.
(2) R.C.H.M., Roman London, 140.
(3) J.R.S., 1960, L,220.

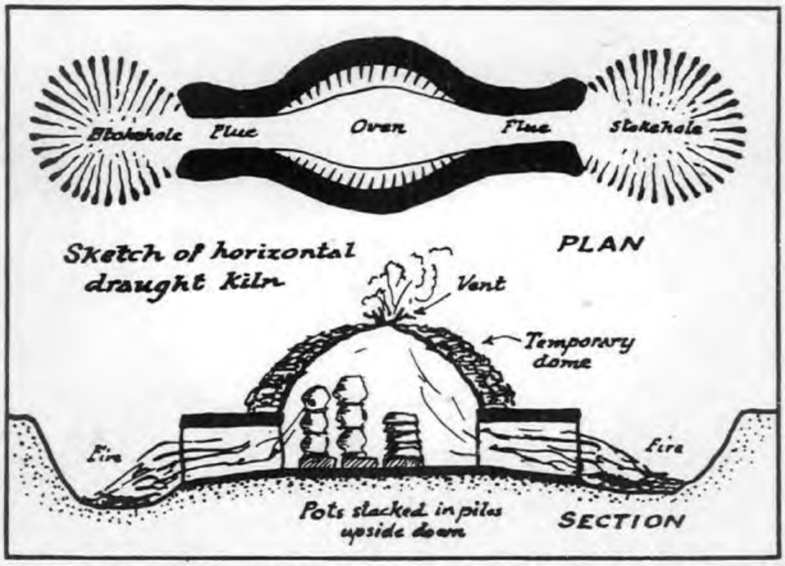
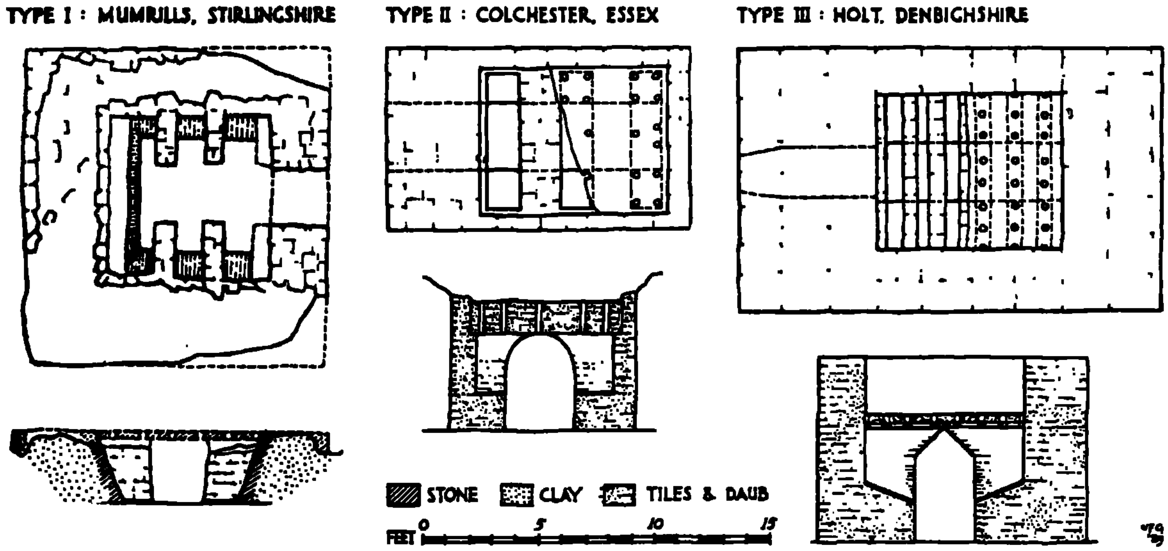


Fig.25a.A typical horizontal-draught kiln. Sketch plan and section

Fig.25b

Overwey, Tilford, Kiln I

TYPES OF ROMANO-BRITISH RECTANGULAR TILE & POTTERY KILNS (PLANS & CROSS-SECTIONS)



AUTHORITIES USED: FOR I. MACDONALD IN *PROC. SOC. ANTIQ. SCOT. XLIX*; FOR II. JOSLIN IN *ESSEX ARCH. SOC. TRANS. I (1878)*

NOTE: THE BOTTOMS OF THE CROSS-FLUES, WHICH FORM THE BASIS OF THE CLASSIFICATION, ARE SHOWN THICK IN SECTIONS

Fig. 26.

at Farnham, Surrey, and used for firing pottery.(1) The oval or circular oven was domed, and built of clay. The flues and fireplace were triangular in section and the fireplace was roofed with a rectangular tile. The chimney in the example shown was built of slabs of ironstone. *

Rectangular kilns are comparatively rare in Britain, but those recorded are similar in regard to the method of supporting the oven floor which, as in the Holt round kiln described earlier, was supported by walls built transversely in the combustion chamber. These walls divide the main combustion chamber into cross-chambers, or "cross-flues", and Grimes has classified rectangular kilns according to the position of the bottoms of the cross-flues relatively to the main flue which, of course, runs lengthwise along the combustion chamber and at right angles to the cross-flues. His three types are shown in Fig. 26 . In the Mumrills kiln(I) the bottoms of the cross-flues are level with the bottom of the main flue; in the Colchester kiln (II) the cross flue bottoms are horizontal but are above the base of the main flue; in the Holt rectangular kilns (III) the cross-flue bottoms slope upwards and are above the floor of the main flue. Compared with the others the Holt design has the advantage that ash would be unlikely to lodge in the cross-flues: the sloping bottoms would tend to return any ash to the floor of the main flue from which it could easily be removed at the end of a firing. A further point is that the upward slope of the cross-flues would aid the natural convection of the hot gases and so help towards an even distribution of heat in the oven.

The Works-Depot of the Twentieth Legion

At the beginning of this section reference was made to "factories" found in association with military sites. The term factory is particularly appropriate when describing the site at Holt, Denbighshire, which was the works-depot of the Twentieth legion.(2) Holt combines the advantages of excellent clay for pottery and tile-making, good building stone (the outcrops of the red Bunter sandstone, which occur on both sides of the nearby River Dee), and an easy waterway to Chester. Here the legion garrisoning Chester established, in the later part of the first century, a tile and pottery works for its own use and in connection with the re-building in stone of the earlier earth and timber fortress. It is interesting to record that when the site was identified(3) and excavations began,

(1) Surrey Arch. Colls., XII I51; V.C.H.Surrey, I, 362.
(2) This account is based on W.F. Grimes, op.cit..
(3) By A.N. Palmer, Arch. Camb., 1906, 217-40.

* See also Overwey, Tilford Kiln (Figs. 25a & b); P. Corder, Arch.Jour. 1957, CXIV, 24 and A.J. Clark, Surrey Arch. Colls., 1949, LI, 29.

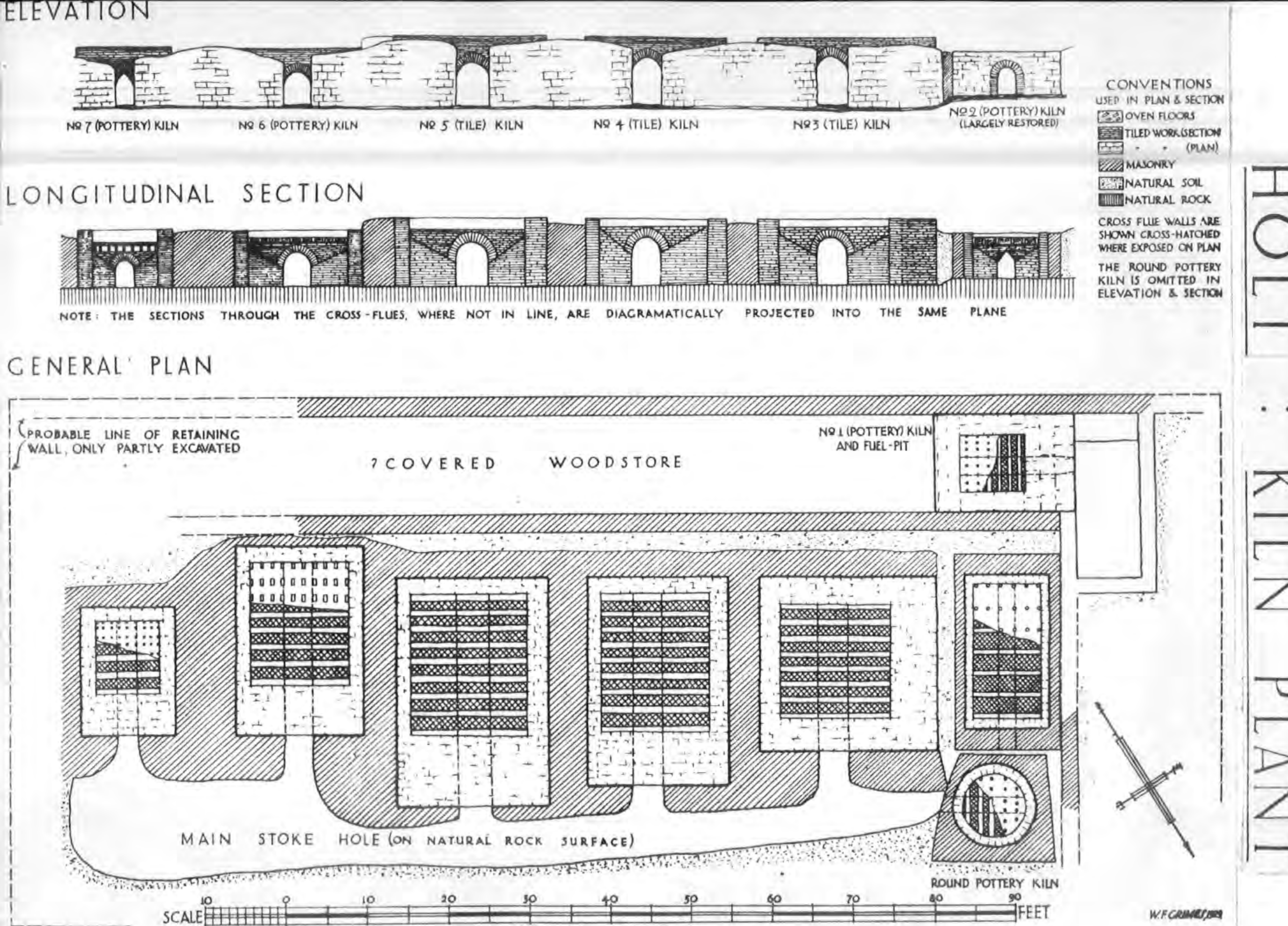

HOLT : KILN PLANT
ELEVATION
Nº 7 (POTTERY) KILN
Nº 6 (POTTERY) KILN
Nº 5 (TILE) KILN
Nº 4 (TILE) KILN
Nº 3 (TILE) KILN
Nº 2 (POTTERY) KILN (LARGELY RESTORED)
CONVENTIONS USED IN PLAN & SECTION
OVEN FLOORS
TILED WORK (SECTION)
" " (PLAN)
MASONRY
NATURAL SOIL
NATURAL ROCK
CROSS FLUE WALLS ARE SHOWN CROSS-HATCHED WHERE EXPOSED ON PLAN
THE ROUND POTTERY KILN IS OMITTED IN ELEVATION & SECTION
LONGITUDINAL SECTION
NOTE: THE SECTIONS THROUGH THE CROSS-FLUES, WHERE NOT IN LINE, ARE DIAGRAMATICALLY PROJECTED INTO THE SAME PLANE
GENERAL PLAN
PROBABLE LINE OF RETAINING WALL, ONLY PARTLY EXCAVATED
? COVERED WOODSTORE
Nº 1 (POTTERY) KILN AND FUEL-PIT
MAIN STOKE HOLE (ON NATURAL ROCK SURFACE)
ROUND POTTERY KILN
SCALE 10 0 10 20 30 40 50 60 70 80 90 FEET
W.F.GRIMES 1929

Fig. 27.

a Bronze-Age urn-burial was discovered within a few yards of the outer boundary of the site, which suggests that the local clay was worked long before the Romans.

The result of the excavations was to reveal an elaborately planned industrial settlement for the manufacture of tiles and pottery, covering some twenty acres. The buildings fall into two main categories:

1. Domestic buildings.
   - (i) The workmen's barrack-blocks
   - (ii) The bath building
   - (iii) A dwelling-house

2. Industrial buildings.
   - (i) Two sets of workshops and a drying-shed
   - (ii) A double-flue kiln
   - (iii) The main kiln-plant
   - (iv) The clay-pits

In addition, the ground in the immediate neighbourhood of the kilns revealed a complex of subsidiary sites on which many of the processes must have been carried out.

The double-flue kiln [ ] was a massive structure with an oven floor about 18 ft. 6 in. square. It had the excellent system of cross-flues characteristic of all the Holt kilns, and it was used for firing pottery. The outside was protected by a casing of sandstone masonry within which the kiln proper was built of tiles, not the ordinary tiles manufactured for the use of the fortress, but crudely made tiles of various sizes and thicknesses, those in the kiln-lining being 15 inches square. W.F. Grimes considered this kiln to be unique, among all Roman kilns, in having double flues; in his opinion it was probably an experiment on the part of the Holt potters at building a kiln of exceptionally large capacity, on the lines of the single flue cross-walled type but having two fires to provide the extra heat necessary.

The main kiln-plant (Fig. 27) had an overall length of 136 feet and a maximum width of 58½ feet. There were originally seven kilns, four devoted to pottery and three to tiles. At a later date the round pottery kiln (already described when discussing kiln types) was built in such a position as to block the access to No. 2 pottery kiln; it was, therefore, either the result, or the cause, of No. 2 kiln being abandoned. The plant as a whole is one of the most interesting ever excavated, and it is a remarkable tribute to the technical skill of the Romans as kiln builders. We shall see later that it also provides evidence of their ability as potters.

a large-size ... within a few yards of the ... of the site, which suggests that the local clay ... [illegible]

[illegible] ... an elaborately ... of tiles ... into two ... [illegible]

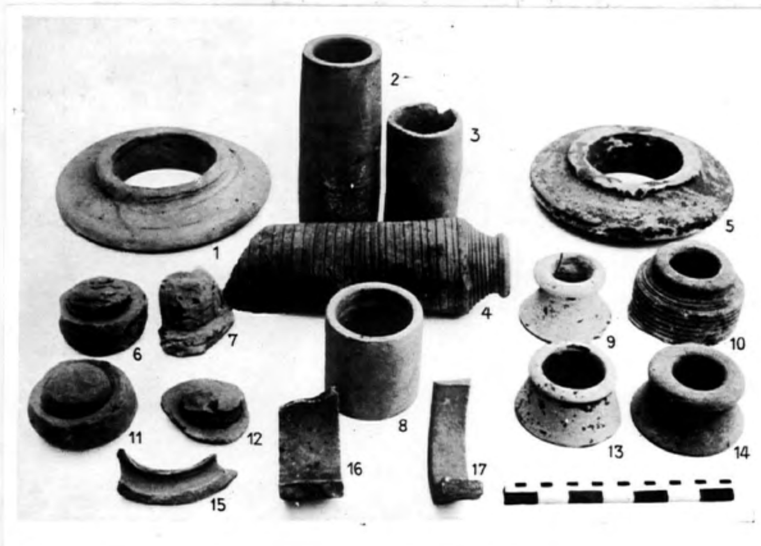


Fig.28

In addition, the ... in the immediate neighbourhood of the kilns revealed a number of subsidiary sites on which many of the processes must have been carried out.

The double-flue kiln (Fig.) was a massive structure, with an oven floor about 18 ft. 6 in. square. It had the excellent system of cross-flues characteristic of all the Holt kilns, and it was used for firing pottery. The outside was protected by a casing of sandstone masonry within which the kiln proper was built of tiles, not the ordinary tiles manufactured for the use of the fortress, but crudely made tiles of various sizes and thicknesses, those in the kiln-lining being 15 inches square. W.F. Grimes considered this kiln to be unique among all Roman kilns, in having double flues; in his opinion it was probably an experiment on the part of the Holt potters at building a kiln of exceptionally large capacity on the lines of the single flue cross-walled type but having two flues to provide the extra heat necessary.

The whole kiln-plant (Fig. 27) had an overall length of 136 feet and a maximum width of 58½ feet. There were originally seven kilns, four devoted to pottery and three to tiles. At a later date the round pottery kiln (already described when discussing kiln types) was built in such a position as to block the access to No. 7 pottery kiln; it was, therefore, either the mouth, or the whole, of No. 7 kiln being abandoned. The plant as a whole is one of the most interesting ever excavated, and it is a remarkable tribute to the technical skill of the Roman kiln builders. We shall see later that it also provides evidence of their ability as potters.

Colchester Red-gloss Ware kiln.

In 1933 a kiln for firing red-gloss ware ("Samian" or "Terra Sigillata" ware, see Appendix I) was excavated at Colchester. This kiln, so far the only red-gloss kiln to be found in Britain, was the largest of a plant of four kilns built in a pit dug into the hillside at Sheepen Farm and enclosed by a retaining wall. Only the vaulted stoke-hole and the lower part of the central flue, 15 ft. long, had survived intact, the upper part had been entirely fused into a saucer-shaped mass of burnt clay, about 7 ft. in diameter. On the site there was a very large number of heavy and carefully made pottery rings, "an incredible quantity of pottery tubes of different diameter, clay luting obviously used in conjunction with them, curious stoppers and discs which fit to them, and small objects like chimney-pots".(1). In Fig. 28 ., typical rings are depicted at 1 and 5, tubes at 2, 3 and 8, stoppers at 6, 11, 12 and chimney-pots at 4, 9, 10, 13 and 14.

M.R. Hull(1) points out that on the Continent tubes and rings of the above type are found only on sites where red-gloss ware has been made, and by comparison with Gaulish red-gloss kilns he has reconstructed the Colchester kiln (Fig. 29). The oven was round, and its circumference was lined with many vertical stacks of tubes, each stack touching its neighbour (typical stacks are shown at A,A and also in the left-hand section of the plan view, Fig. 30). Supplementing these circumferential flues were nine columns of tubes rising through the floor of the kiln (e.g., B, C, D, in Fig. 29 ; B illustrates a stopper, C and D chimney-pots); these 'central' columns of tubes were sleeved by tubes of slightly larger diameter with their joints staggered relatively to the internal tubes, the effect being to increase the stability of the column. Finally, each column was capped by one of the heavy rings, E, which helped to support a tiled roof F (the imprint of a tile was found on one ring). The object of the whole assembly was to provide a 'muffle' kiln in which none of the smoke or gas from the furnace could touch the ware, thus ensuring the truly oxidising atmosphere which is essential for the firing of red-gloss ware.

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(1) M.R. Hull, "The Roman Potters' Kilns of Colchester", Research Report XXI, Soc. Antiqs. London, 1963. (Hull excavated this and other Colchester Kiln and burial sites).

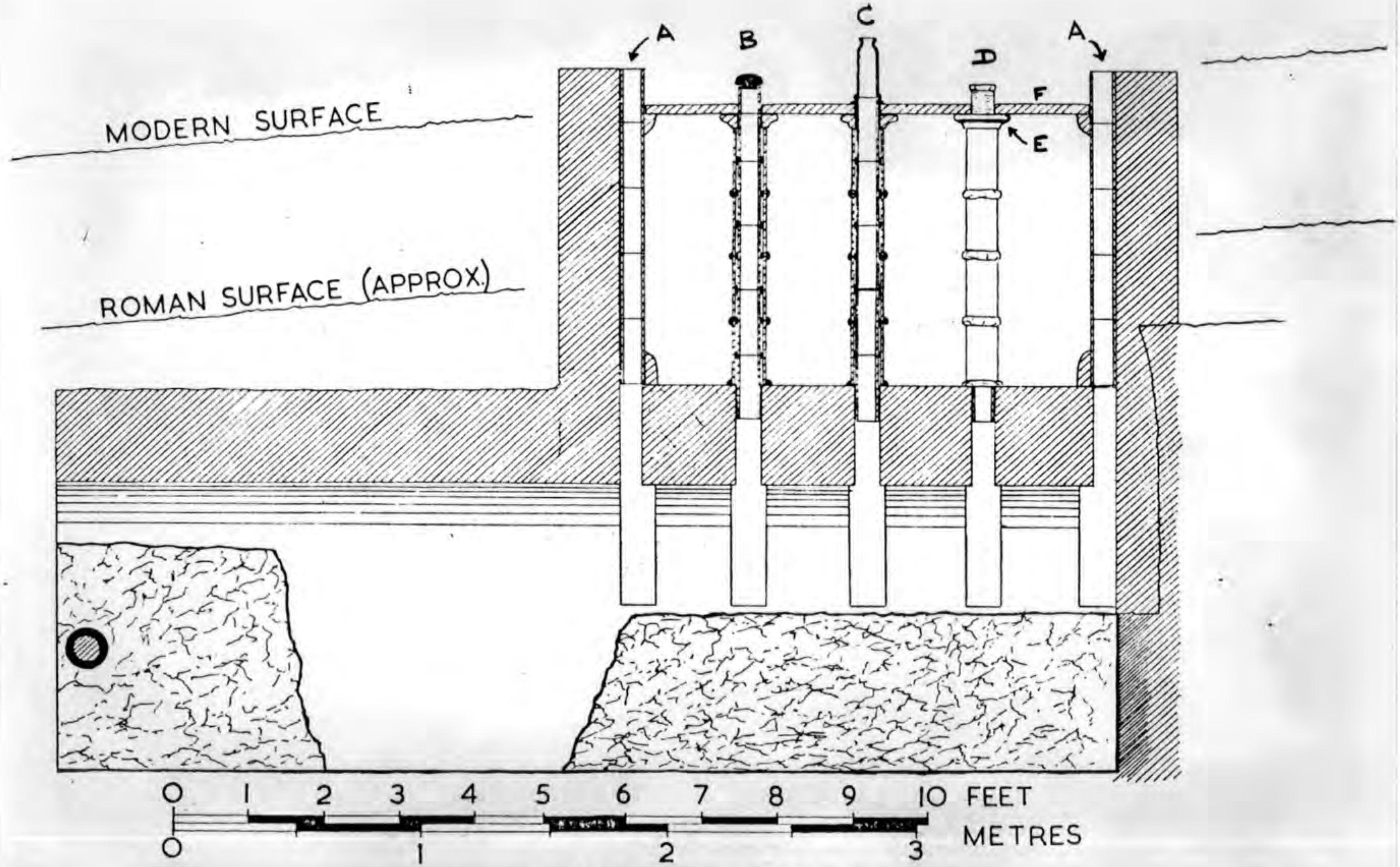

FIG. 29. Restored section of kiln 21 (p. 26).

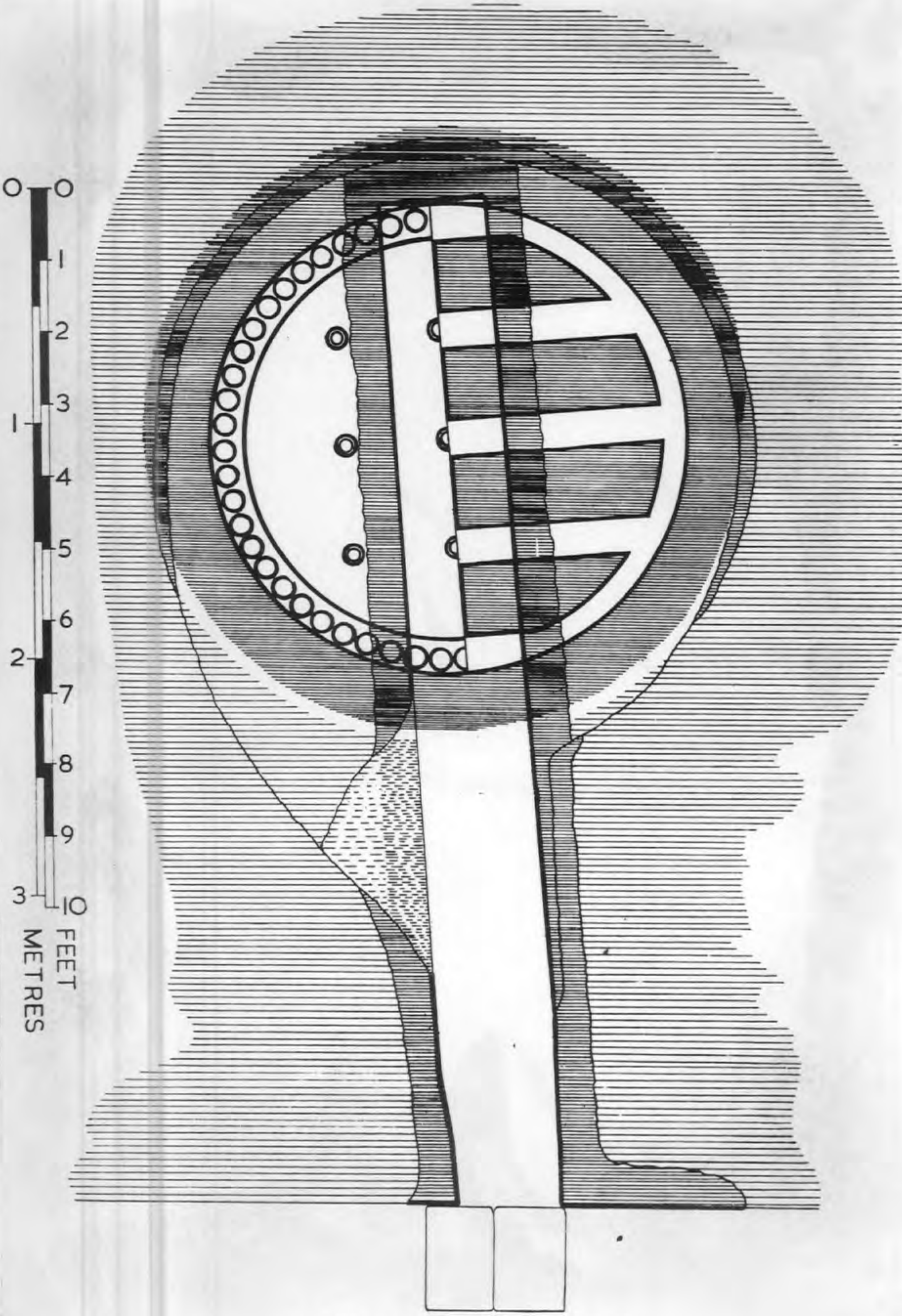

FIG. 30. Plan of Samian kiln (No. 21) (p. 26).

Temperatures attained in Romano-British kilns.

In 1954 and 1956 some instructive experiments were carried out at Wattisfield, Suffolk, by F.J. Watson, Miss M. Bimson and J. Belshé, when replicas of a simple pedestal type of kiln were constructed and fired.(1) A nearly circular pit some 21 in. deep and 42 in. diameter was dug near a disused gravel pit which was to serve as a stoke-hole. The pit was lined with 3 to 4 in. of clay, and the walls were carried some 15 in. above ground level. In the centre a pedestal, 20 in. by 22 in. and 8 in. high was constructed. No fire-bars were used because it was found possible to bridge the gap between the pedestal and the kiln wall with unfired pots. These served to support the remainder of the charge, and by careful placing of the rest of the pots it was discovered that the dome of the oven could be made much flatter than has hitherto been considered normal for ancient updraught kilns. Grass and twigs were placed on the "rounded off" topmost layer of pots to prevent direct contact with the dome, which was made from a thin layer of the same clay as the walls.

Firing occupied about 26 hours. For the first 14 hours only a slow temperature rise was permitted; hard firing began at 7 a.m. on the second day and was continued for 12 hours. The fuel was wood and brushwood, "using pieces as thick as a man's wrist in the earlier stages and finishing with faggots of brushwood." Temperatures were measured by thermocouples placed in various parts of the walls during the construction of the kiln.

In September 1954 the maximum temperatures attained were 950° to 1000° C, but in October 1956 only 850° was achieved: "This time wet weather had spoilt the firewood, which needs to be tinder-dry. For such firing July or

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(1) F.J. Watson, "Romano-British Kiln: Building and Firing a Replica", Pottery Quarterly, 1958, V, 72. (A talk on "The Wattisfield Kiln Experiment" was given by M. Bimson and J. Belshé to the Society of Antiquaries on Oct. 24. 1957).

August would be a better time than late October."[1] This suggests that the firing of pottery in primitive kilns may have been a seasonal affair, conducted perhaps mainly in the period mid-summer to early autumn.

In the Wattisfield experiments, reddish-coloured ware was obtained when the firing was done under oxidising conditions, and grey ware when an oxidising fire was followed by a period under reducing conditions. The latter effect was achieved at the end of the peak firing period by carefully sealing all vents and cracks in the kiln dome, also the furnace mouth, with a mixture of clay and sand, when there was still enough wood in the stokehole to create and maintain a reducing atmosphere.*

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(1) Ivan McMeekin, "A Wood-burning Kiln," Pottery Quarterly, 1958, V, 59; describing a modern brick-built kiln for use in the wilds of New South Wales, says "The wood must be seasoned. It should be cut and split uniformly to the right size."

* See also page 34.

CERAMICS:
ROMANO-BRITISH POTTERY

Historical (1)

Any survey of Romano-British pottery would be incomplete if it were not related to the historical background of ceramic development in Europe. We have earlier stressed the extreme antiquity of potting; from burials in Britain it is clear that ware of a primitive kind had been made in this country from the earliest times, but archaeologists have established that it was in the Eastern Mediterranean that the ceramic arts first attained technical eminence, and it was from the Eastern Mediterranean, probably Asia Minor, that these advanced methods spread westwards across Europe.

The ware which has the longest lineage, and which in ancient Europe perhaps exerted most influence artistically, is the famous Terra Sigillata, or red-gloss figured ware.(2) The earliest appearance of a red-gloss finish was on "Pergamene" pottery (3), chiefly large plates, bowls and cups, which appeared in Athens in the sixth century B.C. and has been found elsewhere in Greece, in Asia Minor, Palestine and Syria, Egypt and North Africa, and Cyprus. This distribution suggests a manufacturing centre with easy access to the sea, probably at the eastern end of the Mediterranean. The ware had a dark red non-porous skin with a moderate gloss; the decoration was seldom in relief but mainly impressed or incised. Towards the end of the third century B.C. "Megarian" bowls became known in the eastern Mediterranean. These bowls had, at first, a black-gloss finish, and most important of all, they were decorated in relief by pressing the clay into a mould. Their manufacture spread rapidly over the Hellenistic world: moulds have been found, for example, at Antioch, Sparta and in South Russia. In the course of the second and first centuries B.C. red usurped black as the fashionable colour, and so red-gloss figured bowls became established.

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(1) Bibliography for this historical introduction:
Anthony Birley, "Life in Roman Britain", (London, 1964).
R.J.Charleston, "Roman Pottery", (London, 1955).
F. Oswald & T.D. Pryce, "An introduction to the Study of Terra Sigillata", (London, 1920).
I.A. Richmond, "Roman Britain", (Pelican History of England, 2nd edn. 1963).

(2) The terms are explained in Appendix I

(3) So-called because it was once thought to have originated from Pergamum in Asia Minor.


SKETCH-MAP
SHOWING THE
SITES OF MANUFACTURE
OF
TERRA SIGILLATA
WITH INDICATIONS OF THE MAIN TRADE-ROUTES
Potteries are shewn thus: LEZOUX.x.
Other Roman sites, e.g.: Lyons, Haltern, VESONTIO
Roman roads:
Limes: =====
ANTONINE WALL
HADRIAN'S WALL
York
Lincoln
Chester
Leicester
London
Cologne
REMAGEN
TRÈVES
Rouen
Paris
COMPIEGNE
LAVOYE
RHEINZABERN
LA MADELEINE
HEILIGENBERG
ITTENWEILER
Strassburg
LUXEUIL
MANDEURE
Rennes
Orleans
Nantes
WESTERNDORF
Augsburg
BREGENZ
WINDISCH
Chalon
ST RÉMY EN ROLLAT
VICHY
LEZOUX
Lyons (LVGDVNVM)
Aosta
Milan
ARVERNI
Bordeaux
BANASSAC
Genoa
MONTANS
LA GRAUFESENQUE
RVTENI
Nimes
Arles
Marseille (MASSILIA)
Narbonne
AREZZO (ARRETIVM)
F. OSWALD DEL.

Fig.31

During the period described above, a pottery industry was growing in Italy, and Italian bowls similar to the Megarian type were being made from at least the second century B.C.. A centre of production of black-gloss wares was Arretium (modern Arezzo, in the province of Tuscany). Quite suddenly, about 30 B.C., fine red-gloss Terra Sigillata emanated from Arretium. This beautiful Arretine ware appears so abruptly in ceramic history that it must have resulted from a complete change in outlook at the place of its origin. Pottery stamps show that the first products were from the firm of Perennius, and that the artists in the firm were Greeks. Charleston suggests that one Marcus Perennius Tigranus brought a team of Greek potters to Arretium between 30 and 25 B.C., having chosen Arretium, with its already established ceramic industry, as the centre offering the best scope for producing 'Grecian' red-gloss ware. The victory at Actium (31 B.C.) and the fall of Alexandria (30 B.C.) had shifted the centre of political and economic power from the East to the West, and an enterprising master-potter could have migrated accordingly.

The manufacture of Terra Sigillata and red-gloss ware at Arretium lasted from about 30 B.C. to about 30 A.D.; during this period Arretine pottery found its way all over the Roman Empire and even to Britain and India. Then for some unknown reason Arretium declined in status and Mutina (modern Modena) rose in importance as a centre for red-gloss ware. But all the time there seems to have been a steady migration of skilled red-gloss potters from Northern Italy into Gaul, and gradually factories appeared, first in southern Gaul and then spreading northwards as the pottery industry moved nearer to its best customers, the Roman legions and the newly romanised provinces. Eventually, during the second and third centuries A.D., small 'Samian' or red-gloss potteries were in production in eastern Gaul and Germany.

Oswald and Pryce, in the map opposite, have depicted the many places where Terra Sigillata was produced. During the first and second centuries A.D. Britain imported most of its tableware from Gaul. Lezoux ware came to Silchester and Corbridge; La Madeleine ware has been found at South Shields, and Lavoye and Trier at Corbridge, to mention only a few instances (1)

(1) Oswald and Pryce give an exhaustive list of Gaulish Sigillata finds in Britain, with potters' names.

Between 150 and 190 A.D. a cargo of ware, evidently on its way into the Thames estuary, was wrecked off the north Kentish coast on a rock which subsequently became known as Pudding Pan Rock. (1) During the early years of the second century the imports of coarse pottery (used for cooking) into Britain were giving way to home production. Then in 197 many Gaulish potteries were destroyed by the victorious Severan troops plundering after the defeat of Albinus. As a consequence, after the end of the second century little red-gloss Gaulish ware reached Britain, and finally, in the third century, barbarian invasion and civil war ruined the surviving factories in Gaul and the Rhineland. The stage was now set for the emergence of distinctive Romano British wares, and in the course of time the position became completely reversed so that ultimately we find Castor ware being exported to the Rhineland.

Scope of the present Survey

From the enormous number of specimens examined and classified in the course of archaeological research into the pottery of Roman Britain, certain distinctive types of ware have emerged which can be attributed to four important regions of civilian production:

1. The Nene Valley
2. The New Forest
3. Crambeck (North Yorkshire)
4. Colchester

In addition to these, one military centre, that at Holt, Denbighshire, must be included because of the unique nature of the finds made there. We shall discuss each of these regions in turn, concluding with an account of the evidence for the existence of a maker of imitation Samian ware (the "Aldgate Potter").

Before proceeding, it should be mentioned that the above areas of production probably represent only a few of the large potteries in Roman Britain. For example, at Farnham in Surrey there were kilns which supplied ware to the Thames Valley market, but it is certain that other potteries, not at present located, contributed to the same market. There are also vast quantities of cooking-pots which

(1) For an account see R.A. Smith, P.S.A., XXI, 268 & 599; XXII, 395.

cannot as yet be attributed to a particular pottery site; among these are Derbyshire Ware and Dales Ware. Derbyshire Ware, first distinguished by R.G. Collingwood by its rim-type and fabric, and studied as to distribution and date by J.P. Gillam (1), cannot so far be attributed to a definite centre in Derbyshire. Dales Ware, identified by Gillam (2) and so named because of its more frequent occurrence in the Pennine dales, has no known place of manufacture, although its distribution suggests that it might have come from the colony of York. The inference is that there are still important centres of pottery production yet to be discovered. Writing in 1930, W.F. Grimes (3) published a topographical list of 101 Romano-British Pottery sites; since then more evidence has been gathered and there is obviously scope now for a comprehensive account of potteries and pottery. However, as we are dealing with crafts it is proposed to confine the present survey to those sites which have produced either a highly characteristic ware or which illustrate a definite feature of the potter's technique. 'Rustic' ware deserves inclusion on these grounds, and it is described in Appendix II.

The Nene Valley

Peterborough is the principal modern city in the Nene Valley region which we are now about to consider. Aerial photography has shown many small sites of Iron Age type in the Nene Valley, and there was already an appreciable population in the area when the Romans reached it, about A.D. 44-46, during the conquest of Britain. The building of a Roman fort at Durobrivae, Water Newton, to guard the crossing of the Nene, and the construction of Ermine Street, linking the political capitals of London and York, would give an impetus to local civilian settlement and would provide commercial outlets encouraging the development of the excellent Jurassic clays of the region. During the Roman occupation the Nene Valley was one of the most highly industrialised areas in Britain. There was extensive iron mining and smelting in the Wansford district, widespread quarrying of stone for building and for the stone coffins common in the east Midlands, and potteries stretching along the valley to the west of Peterborough. At least 70 kiln

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(1) J.P. Gillam, "Romano-British Derbyshire Ware", Antiqs. Jour., 1939, XIX, 429.
(2) J.P. Gillam, "Dales Ware: A distinctive Romano-British Cooking-pot", Antiqs. Jour., 1951, XXXI, 154.
(3) W.F. Grimes, op.cit..

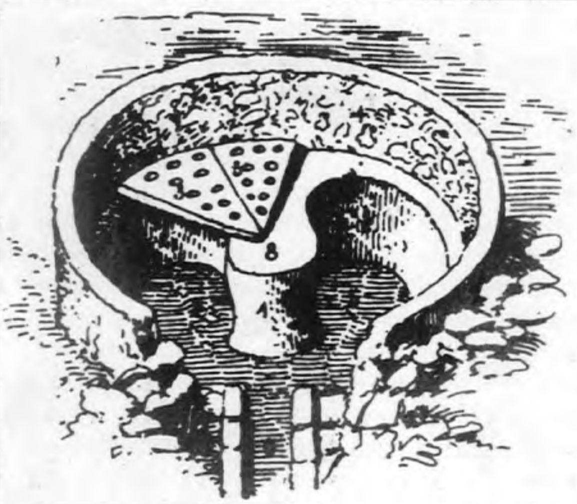

Fig.32. Sibson, Northants, 1844. Plan of kiln

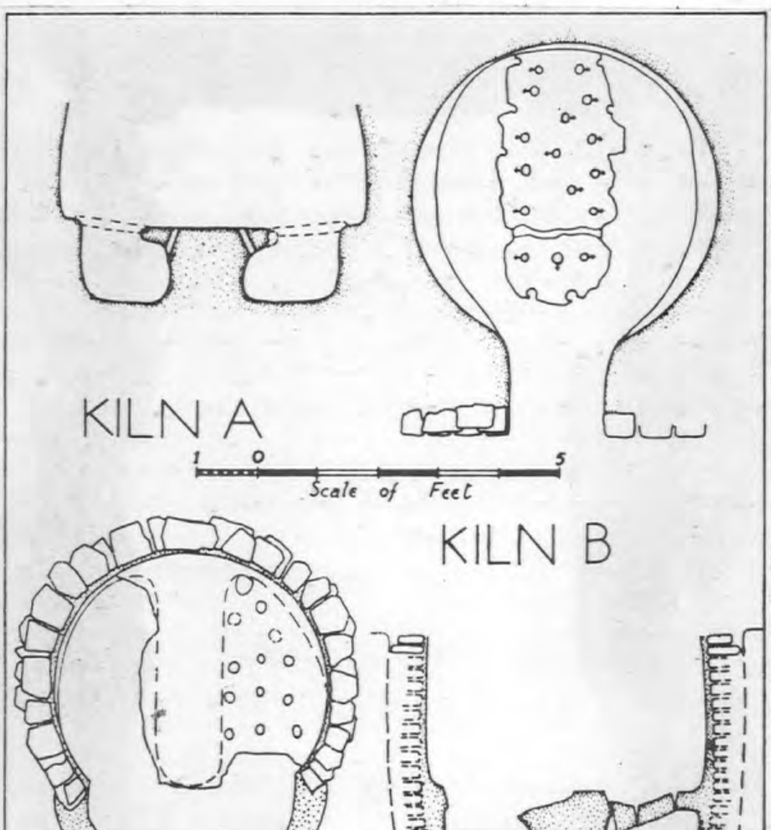

Fig.33. Stibbington kilns

sites have been excavated, and it is believed that many more exist, so that the Nene Valley must have been one of the chief centres of pottery production in Roman Britain.

The first excavations were made in the early 19th century, starting about 1820, by E.T. Artis who was Agent to the Fitzwilliams of Milton. His work from 1820 to 1827 was published as a volume of engravings (1), and he continued excavating until his death in 1847. Unfortunately his manuscripts are lost, but some of his pottery finds are in Peterborough Museum. Modern excavations (1957-59) supervised by G. Webster, J.P. Gillam and B.R. Hartley have been recorded by Hartley (2).

All the Nene Valley kilns excavated so far are circular in plan, about 4 ft. in diameter, and they are of the up-draught variety. In practically all cases a single tongue-shaped pedestal projects from the back wall of the furnace, as in Grimes' Type 1, Fig. 22. This tongue is clearly shown in the sketch (Fig. 32) of a kiln excavated at Sibson in 1844 (3). In one unique case, 'A' kiln at Stibbington, the tongue was perforated to provide additional ingress for the hot gases into the oven (Fig. 33) (4). At Water Newton a kiln was found, abandoned, with pots still inside it (Fig. 34) (5), the photograph suggests how the pots were grouped around the vents in the hearth: they would be placed so as not completely to obscure the vents, and they would serve as supports for the second layer of pots which in turn would support another layer, and so on, the hot gases from the furnace rising through the layers to the outlet in the kiln dome.

The Nene Valley kilns turned out a wide range of products which can be grouped into three classes: coarse ware, mortaria, and colour-coated ware. The coarse ware, probably intended mainly for local use, was made in grey, and occasionally, buff fabric. The commonest form is a wide-mouthed jar (Fig. 35, 4), which may have been the

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(1) E.T. Artis, "The Durobrivae of Antoninus Identified and Illustrated", (London, 1828).
(2) Brian R. Hartley, "Notes on the Roman Pottery Industry in the Nene Valley", Peterborough Museum Society, Occasional Papers No.2, (Peterborough, 1960). Earlier reports on the Nene Valley potteries are F.Haverfield, V.C.H. Northants., I,166, and M.V.Taylor, V.C.H. Hunts., I,225.
(3) J.B.A.A. II (1847), 164.
(4) Brian R. Hartley, op.cit..
(5) Brian R. Hartley, op.cit., Plate B.

Water Newton, Kiln C, showing pots left when the kiln was abandoned

Fig. 34

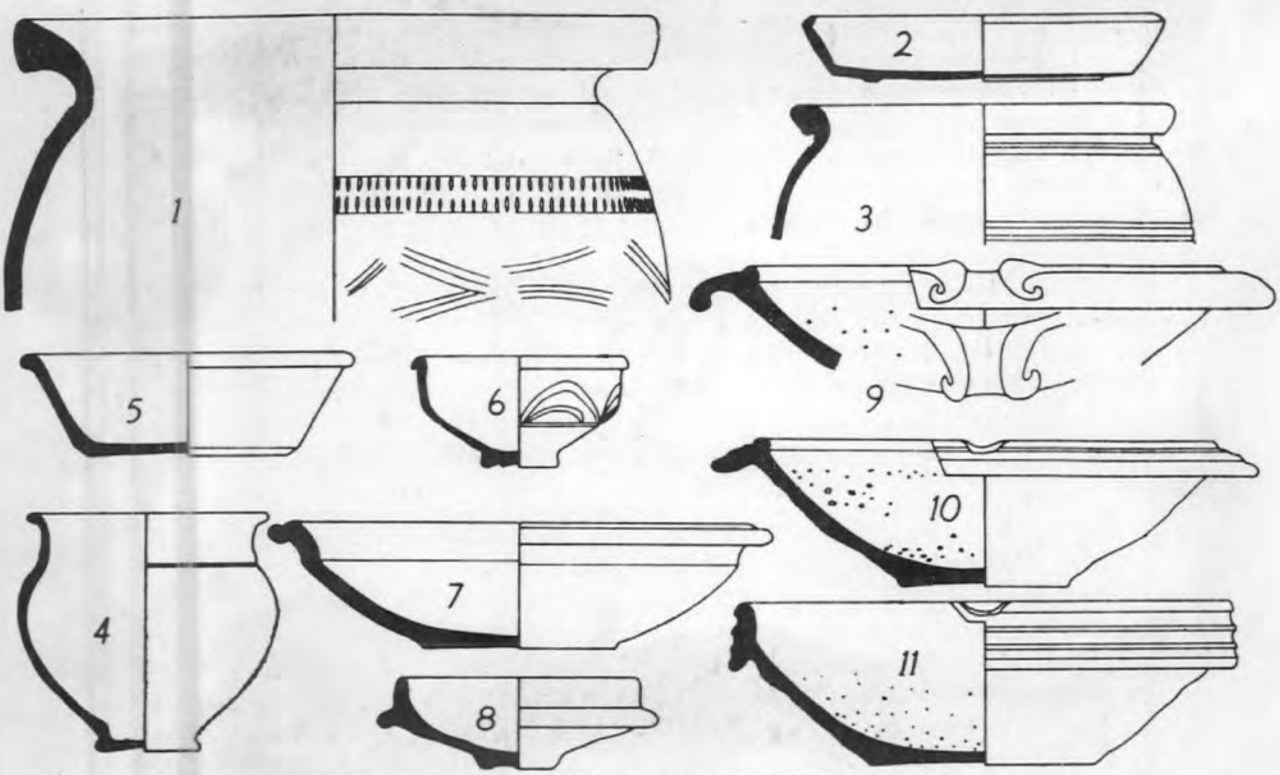

Fig. 35. Coarse ware, except 6-8 which are colour-coated. Scale ¼

standard cooking-pot of the region. Next in order of frequency are straight-sided dishes and bowls, of which 5 in Fig. 35 is a typical example.

Roman cookery recipes demanded much mashing and grinding of the ingredients (1) which was done in wide, shallow mortars studded on the inside with particles of grit to facilitate the process. Mortaria are therefore found in all inhabited areas, but their manufacture seems to have been confined to a relatively few potteries which specialised in their mass production. In consequence, the mortaria made in a given locality tend to have a wide distribution, and those from the Nene Valley have been found all over the eastern counties and even on military sites in the north, e.g., Corbridge.(2) The grit which was embedded on the inside of mortaria, before firing, varies in nature according to the locality and the period of production. Calcite (natural calcium carbonate), fine gravel, and coarse sand were often used. In the Nene Valley products the grit is invariably angular fragments of the local ironstone. Mortaria were traditionally made in light colours; those of Nene Valley origin are of white or cream body with a buff or brownish coating.

It is for colour-coated pottery, which has become known as Castor ware (from the name of the village to the north of the site of Durobrivae), that the Nene Valley is most famous. Castor ware exhibits a large range of forms and of decorations, but all examples are characteristic in having a surface colour contrasting strongly with that of the body. The colour of fired clay depends largely on its iron content and the state of oxidation of the iron after firing. A ferruginous clay fired in an oxidising atmosphere will turn red, tan or brown according to the amount of iron present and the temperature of the fire. If the same clay is fired in a reducing atmosphere its iron oxide is reduced to lower states of oxidation and the result is a grey, blue-grey or almost black colour. The Nene Valley clay is relatively low in iron content and therefore tends to fire off-white or buff. The coloured coating seems to have been produced by the application of a special slip made from a more ferruginous

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(1) B. Flower & E. Rosenbaum, "Apicius: The Roman Cookery Book", (London, 1958).

(2) See Page 208, J.P. Gillam, "Types of Roman Coarse Pottery Vessels in Northern Britain", Arch. Ael., 1957 4th Series, XXXV, which gives a most comprehensive account and also mentions many finds of colour-coated Castor ware.

clay. Thus Hartley records (1) that at the Sibson site a large dump of clay containing ironstone was found near the kilns, and judging by the fragments of severely weathered pottery in it, the dump had been turned over from time to time. Neither the clay nor the ironstone is native to the site, and the inference is that the gradual weathering of the ironstone would increase the iron content of the clay which could then be made into a slip with water for coating the pottery. The coating seems usually to have been applied by holding the pieces by the base and plunging them into the slip; many pots in Peterborough Museum bear the potter's fingerprints in the colour-coat around the base. Careless dipping of an inverted pot could result in an internal airlock, so that part of the inner surface would never come in contact with the slip. The Museum has many specimens showing partial internal coats of this kind. Sometimes, during firing, jars were stacked so that the base of one sealed the mouth of the one on top of it, thus forming a space to which entrance of oxygen was restricted, the result being that the inside of the upper jar, and the base part of the outside of the lower jar, fired to a colour different from the rest of the coating.

Much Castor ware was undecorated, such as the imitations of plain Samian forms shown at 7 & 8 in Fig. 35. Moulded and stamped decoration is relatively scarce, but rouletted decoration is found on many forms. The "Castor box" (a dish, 17, with fitting lid, 18, Fig.36) illustrates this kind of decoration, produced by holding a toothed cylinder against the plastic ware whilst it was spinning on the potter's wheel(2).

Perhaps the most outstanding type of decorated Castor ware is that on which the decoration is by trailed slip ("barbotine decoration"). A thick slip, probably of the consistency of toothpaste, was trailed over the surface of the ware before dipping. This kind of decoration lends itself naturally to flowing scrolls, and particularly to

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(1) Brian R. Hartley, op. cit..

(2) No roulettes appear to have been found in Britain, but specimens in baked clay and in bronze have been found in France (where the preferred term is "molette"). See pages 45-47, G. Chenet, "La céramique gallo-romaine d'Argonne du IVe Siècle et la terre sigillée décorée à la molette," (Macon, France, 1941).

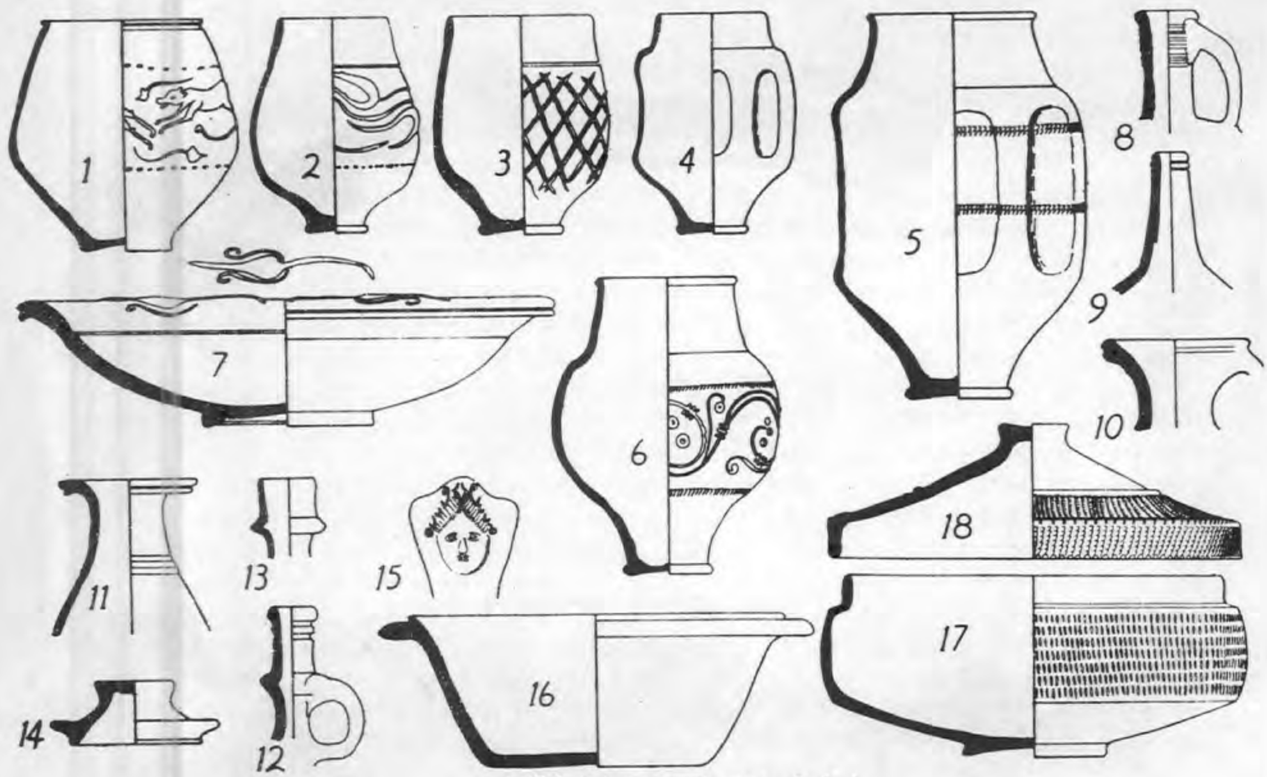

Fig.36. Colour-coated ware. Scale ¼

Beaker of dark-coated light clay, decorated with rouletting and trailed white slip. Found at Duston, Northants. British Castor ware

Fig.36a. Slip-trailed decoration (cf.6 above).

'Hunt cup' of dark-coated light clay decorated with trailed slip. British (Castor ware); late 2nd or 3rd century A.D. Ht. 4in.

Fig.36b

running animals as on the so-called hunt-cups (1 on Fig. 36 , and the photograph, Fig.36b). Writing of slip-decorated Castor ware, Charleston[1] says "The scrolled forms may be compared with those of Celtic metalwork, and the rendering of animals in the figural themes is vividly reminiscent of, for instance, the Witham shield in the British Museum. It is curious, and perhaps significant, that in rendering gladiatorial and circus subjects, possibly because they were Romanised features of Romano-British life with which he was unfamiliar, the potter seems hampered and ill at ease, whereas in the hunting-scenes the figures come urgently to life and press with vivid movement round the perimeter of the pot. The indebtedness of these wares to the Gaulish barbotine-decorated red-gloss pots can easily be detected, both in their subjects and by the presence on both of the ivy-leaf motive, but the Castor potter seems to revel in the emancipation from moulded decoration which the Gaulish potter had only tentatively begun." Birley[2] points out that "The fantastically elongated form of the animals is in the true Celtic tradition, with the favoured spiral form reappearing in the shape of leaves...... In the end, the Celtic style survived, and was to reappear in the fifth and succeeding centuries. Ultimately, with new vigour given from Ireland it was to have a powerful effect on Anglo-Saxon art."

Before the end of the first century at least one kiln was active at Water Newton, and recent study suggests that the production of colour-coated ware began in the second half of the second century, although no second-century kilns have been located in recent work. Early third century kilns are found at Water Newton, and by mid-third century others were in use at Sibson. Late third and fourth century kilns are known at Chesterton and Stibbington. Production at Sibson continued during the fourth century, but it is not certain whether the Nene Valley output continued into the fifth century. However, the period late-second century to late-fourth is a remarkable span. The distribution of the ware would be aided by the River Nene, which gave access to the east coast through the Wash; and by the Car Dyke, the Roman canal which crossed the Cambridgeshire and Lincolnshire Fens, joining the Nene near Peterborough, and offering barge transport to Cambridge on the one hand and York on the other;

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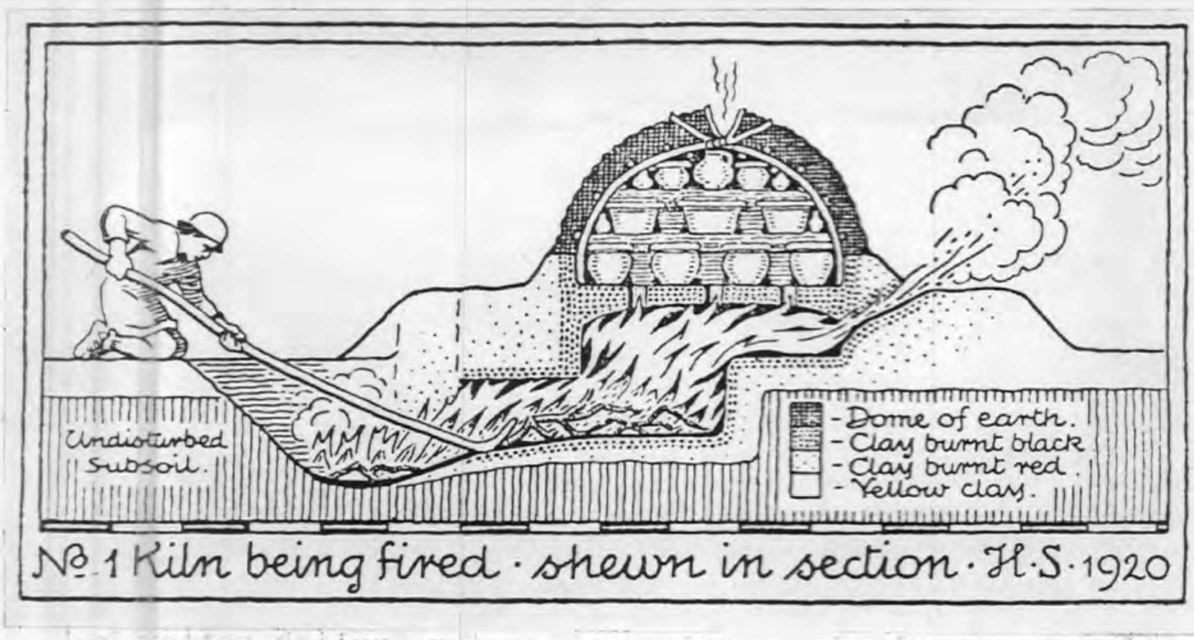
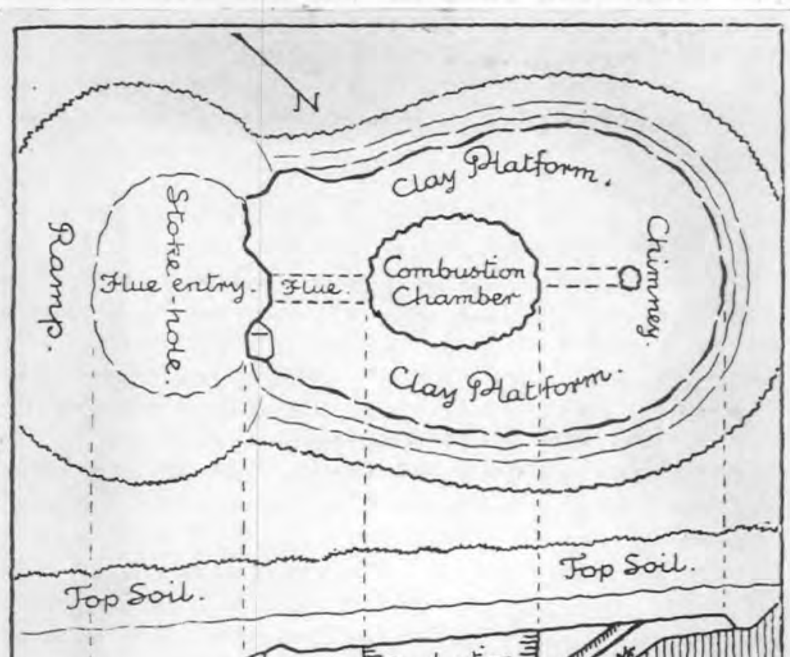
(1) R.J.Charleston, "Roman Pottery", (London, 1955), page 35.
(2) Anthony Birley, "Life in Roman Britain", London, 1964, pages 159-160.



№ 1 Kiln being fired · shewn in section · H·S·1920

Fig.37



Plan & Section of Pottery Kiln in Rough-piece, Linwood. H.S. 1925.

Fig.38

and possibly by Ermine Street which gave road access to both London and York, but perhaps produce as fragile as pottery was entrusted to water transport rather than to (springless) carts. Gillam (1) has recorded many finds of Castor ware in the north of England. Castor ware was even exported, notably to the Rhineland (2). The only Nene Valley potter known to us by name is SENNIANVS, from a large third-century mortarium, in Peterborough Museum, bearing a unique painted inscription on the rim: SENNIANVS DVROBRIVIS VRI(T), i.e., "Sennianus fired this at Durobrivae."

The New Forest

Early excavations, about 1860, were made in the New Forest by J.P. Bartlett and J.R. Wise, but most of our knowledge is due to Heywood Sumner who excavated in the first quarter of the present century (3).

The New Forest kilns were either pilastered (Grimes Type III, Fig.22), or had an unsupported 'platform' hearth (Grimes Type V, Fig. 22), although at Linwood Sumner found a kiln in which a rounded tongue projected into the combustion chamber to give additional support to the hearth above (cf. Grimes Type I, Fig. 22). Fig. 37 is Sumner's reconstruction of No.1 kiln, Sloden Inclosure, being fired; it is obviously similar in construction to the Rough-piece, Linwood, kiln illustrated in Fig.38 .

At Islands Thorns, near a kiln site excavated in 1852, Sumner discovered evidence for a potters' hut. Six post-holes (some 9 in. by 8 in. by 9 in. deep, others 6 in. by 5 in. by 8 in.) with decayed wood still adhering to them suggested the plan of a hut measuring 15½ ft. by 11 ft., with entrances C & D to west and east respectively (Fig. 39). Sumner's restored section, showing wattle-work resting on lean-to principals fixed in the floor and covered with skins or turf,

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(1) J.P. Gillam, op.cit., Ref.2 on page 34 .
(2) Anthony Birley, "Life in Roman Britain", (London, 1964,) page 128.
(3) Heywood Sumner published "A descriptive account of Roman Pottery made at Ashley Rails, New Forest" (London, 1919), and "A descriptive account of Roman Pottery sites at Sloden and Black Heath Meadow, Linwood, New Forest" (London, 1921). In 1927 these books were out of print and Sumner then re-issued them, with new matter, in a combined volume "Excavations in New Forest Roman Pottery Sites, with Plans and Illustrations of the Construction of the Pottery Kilns, of the different Wares made, and of a Potter's Hut" (London, 1927).

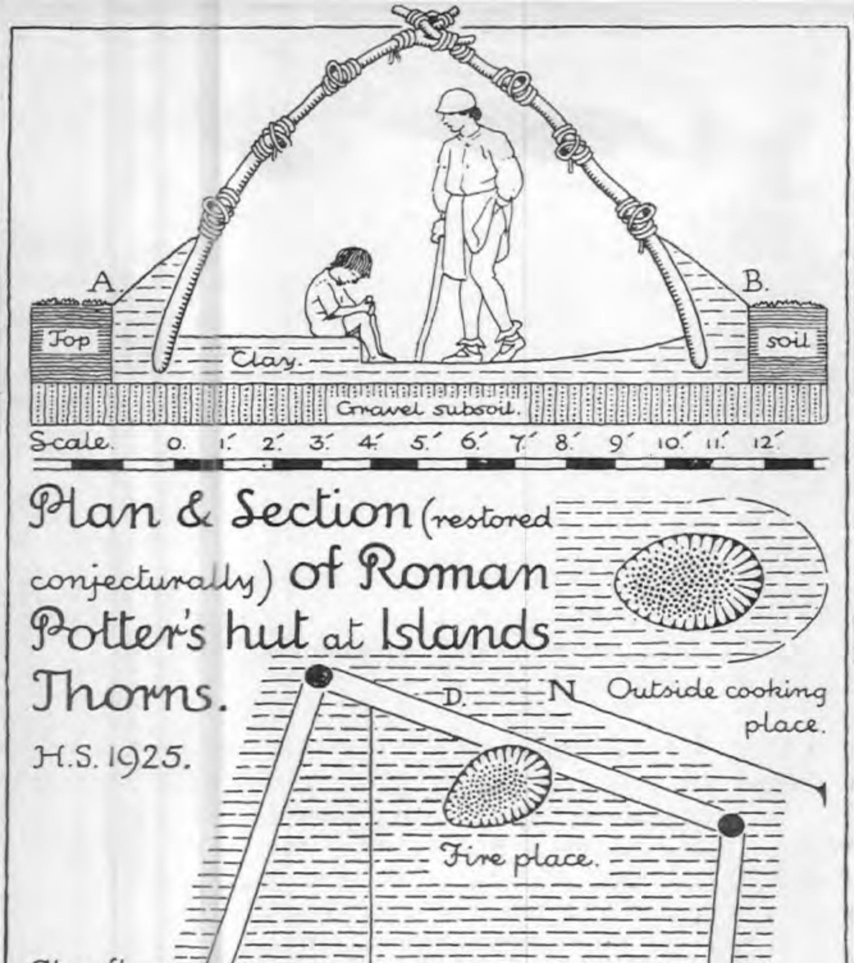

A.
B.
Top
soil
Clay.
Gravel subsoil.
Scale. 0. 1.' 2.' 3.' 4.' 5.' 6.' 7.' 8.' 9.' 10.' 11.' 12.'
Plan & Section (restored conjecturally) of Roman Potter's hut at Islands Thorns.
H.S. 1925.
D.
N
Outside cooking place.
Fire place.
Clay floor ceases on the North
A.
Platform.
Clay floor.
B.
and South sides of the hut
but extends on the West side.
C.

Fig.39

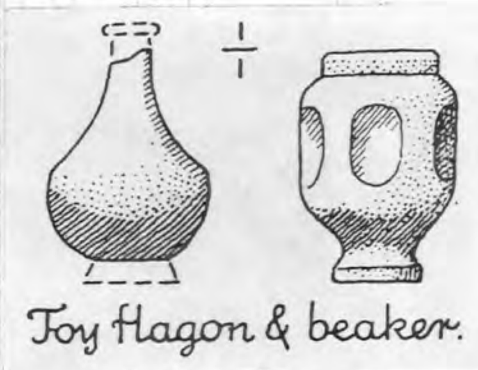

1/1
Toy flagon & beaker.

Fig.40

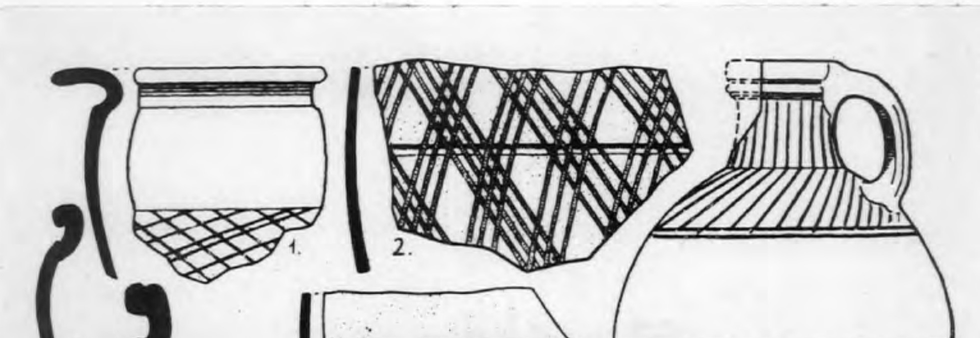
the whole surrounded at ground level by a low buttress-like wall of clay, was based on the existence of an irregular clay bank rising 6 to 9 in. above the surrounding ground and 1 ft. 3 in. above the hut floor. The latter was of trodden clay laid on the undisturbed gravel subsoil. At the eastern entrance to the hut there was a fireplace measuring 2 ft. 2 in. by 1 ft. 9 in., and sunk 8 in. into the floor. A remarkable find was made amongst the rubbish in the fireplace: a toy flagon and beaker (Fig. 40).

New Forest pottery comprised a wide range of forms: flagons, vases, goblets and even candlesticks, in addition to the coarse pottery common to many Romano-British pottery sites, that is, jars, cooking pots and mortaria. A distinctive feature was the simplicity of its decoration and the complete absence of life, human or animal. Whereas the Castor ware potters often depicted hunting scenes and occasionally (and somewhat clumsily) the human form, those in the New Forest kept to very simple running scrolls or triangular patterns, to scored lines on the sides of the vessels or stamped rosettes. Scrolls and patterns were in white or red trailed slip. Fig. 41 shows a typical New Forest bottle of dark earthenware with trailed white slip decoration, and Fig. is typical of ware with scored line ornamentation. Heywood Sumner, however, remarks on the New Forest potters' fine instinct for plastic form; their ware is shapely and they handled clay with a natural feeling for their medium. Thus in Fig. 42 the handle of the jar 'grows' out of the clay; it is not merely 'stuck on'. Among the varieties of simple colour treatment noted by Sumner are: Buff body, coated red or brown, or with a fumed black surface. Grey body, with brown-purple metallic gloss, or fumed black. Dark grey body, or reddish body, coated white outside.

Sumner hoped to connect his New Forest sites with late Celtic production, but he found no evidence "that British potters preceded Romanised potters here, or that after the Roman evacuation, subsequent potters worked on New Forest sites". He thought that "A.D. 250-350 marked the culmination of prosperous settlement (and of New Forest pottery production) in this part of Roman Britain." Further excavation might, of course, modify these statements. An interesting point is that although the products of New Forest kilns are found on almost every important Roman site in Southern Britain, their distribution seems to be confined to the South; they do not appear in the Midlands and the North, and they never reached the military market.

Bottle, dark earthenware with trailed white slip decoration. Found and made in the New Forest; 4th century A.D. Ht. 5 in.

Fig.41



Kiln at Rough-piece Linwood. All ⅓ linear. HS

Fig.42

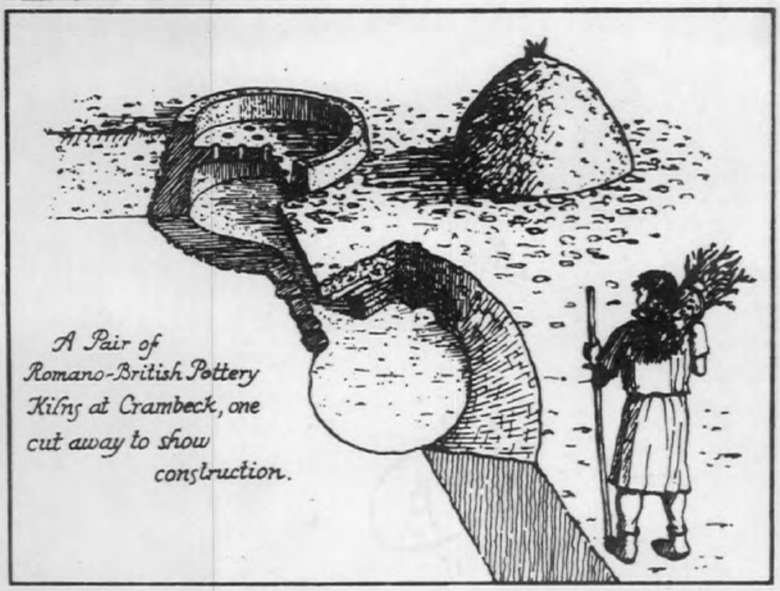


Fig.43. Crambeck. Reconstruction drawing of a pair of kilns

Crambeck

In 1927 two pairs of Romano-British kilns were discovered near the Crambeck, about thirteen miles north-east of York and five miles from the fortress of Malton(1). Earlier finds of kilns in the same neighbourhood were then recorded, and these, with the quantity of pottery found, indicated that pottery manufacture had been extensive in the district. In 1936 two more kilns were found,(2) and the importance of Crambeck ware and its wide distribution in the northern military area is now recognised.

The Crambeck kilns were circular, not more than 3 ft. 6 in. in diameter, and were fired in pairs from a common stoke-hole (See Grimes, Type IV. Fig.22). The small diameter permitted the use of an unsupported clay floor the formation of which has already been described (page 23). Before the first firing, holes were made in the floor to allow the gases from the furnace to enter the oven proper, and it is evident that the absence of any supporting pillars under the floor has the great advantage of permitting the heat to penetrate evenly over the entire area of the floor. Fig.43 shows the construction of the Crambeck kilns very clearly. (3)

The Crambeck potters made a variety of bowls, dishes, jars, bottles and flagons, usually in a light grey or black body, with an incised 'line' decoration of vertical and horizontal lines, wavy lines, or lines in a chevron pattern; 'SS' and pot-hook patterns also occur. One type of beaker is rouletted. There was also a smooth white or yellowish-white fabric on which the decoration was painted in orange-red, the patterns being similar to those used for the incised decoration.

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(1) P. Corder, "The Roman Pottery at Crambeck, Castle Howard, 1928" (Roman Malton and District Report No.1).

(2) "A Pair of Fourth-century Romano-British Pottery Kilns near Crambeck (Philip Corder), with a note on the Distribution of Crambeck Ware (Margaret Birley)", Antiqs. Journal, 1937, XVII, 392.

(3) After Philip Corder, "The Structure of Romano-British Pottery Kilns," Arch. Jour., 1957, CXIV, 10 (Figure from page 15).

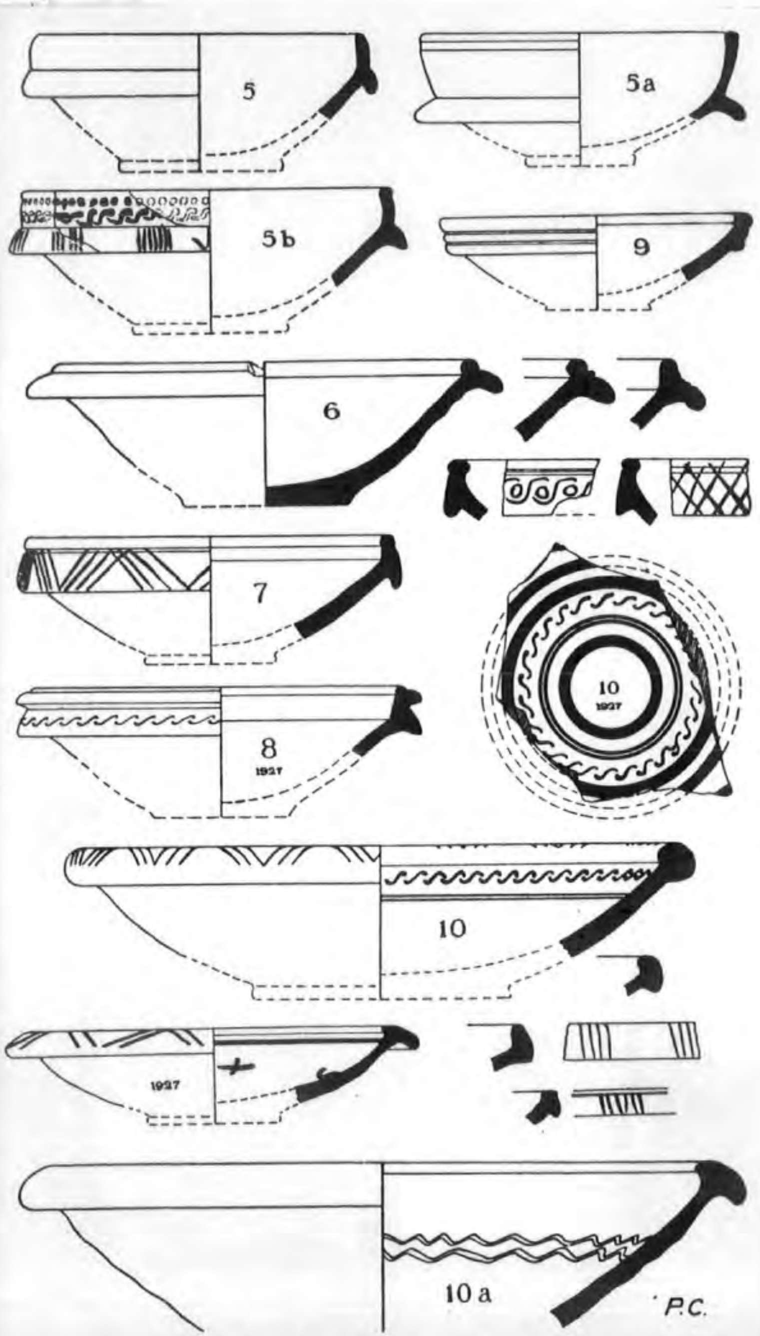

FIG. 45. Crambeck Ware, Types 5–10 *a* (¼)

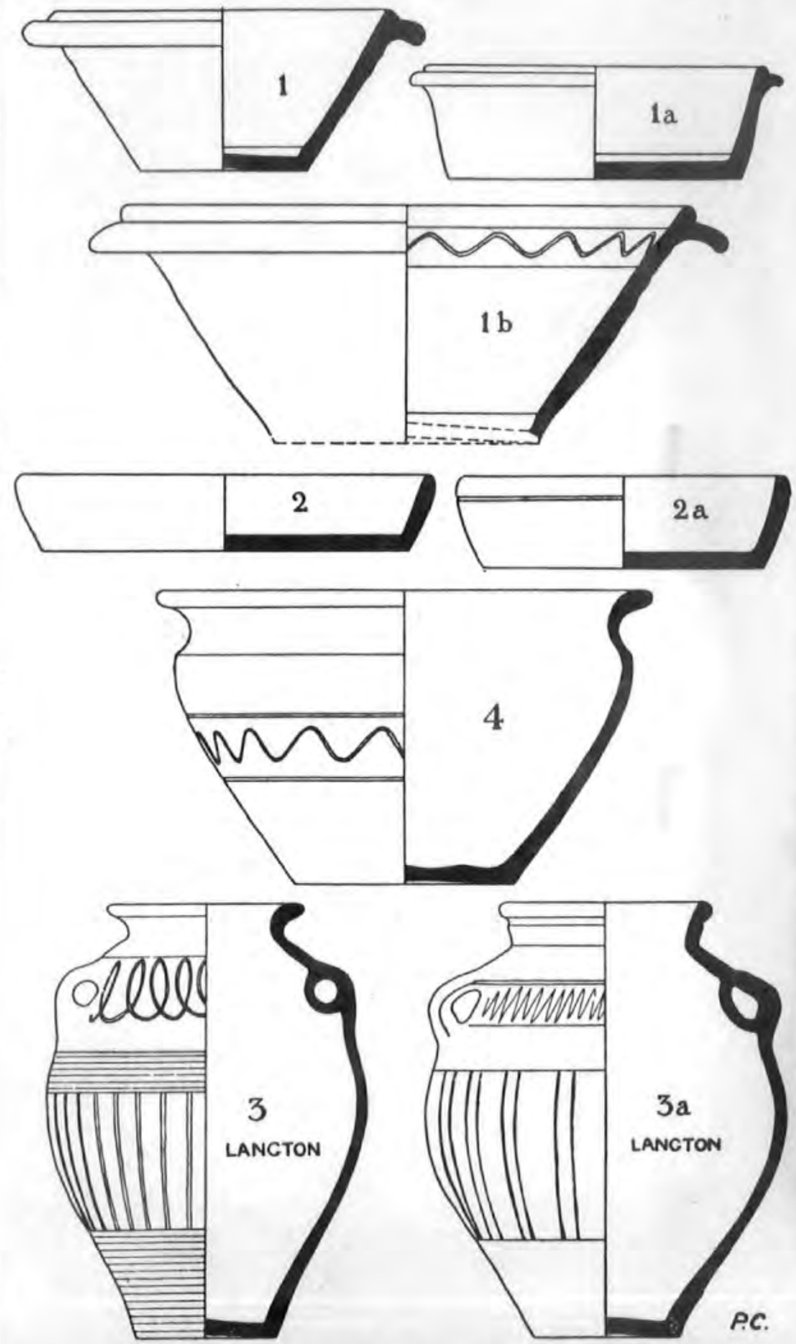

FIG. 44. Crambeck Ware, Types 1–3 *a* (¼)

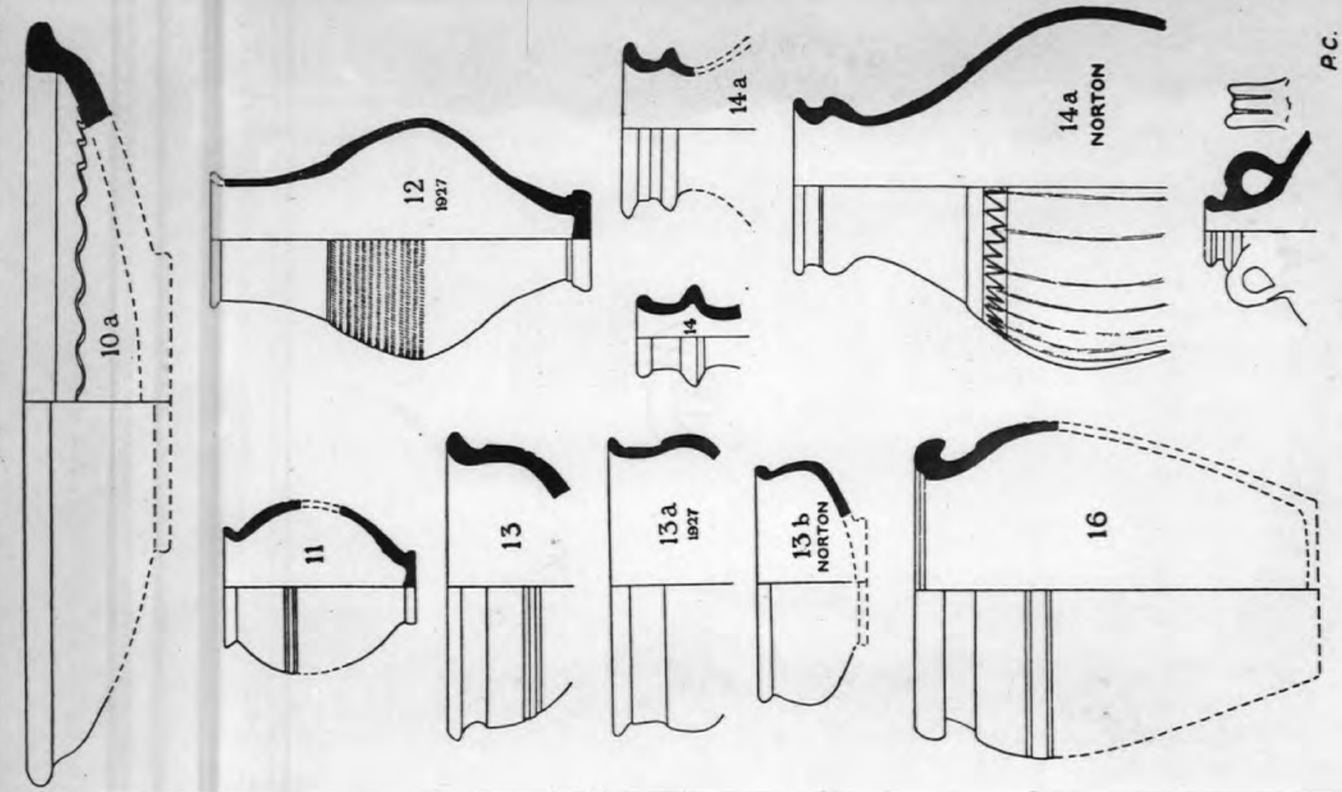

FIG. 46. Crambeck Ware, Types 10 *a*–16 (¼)

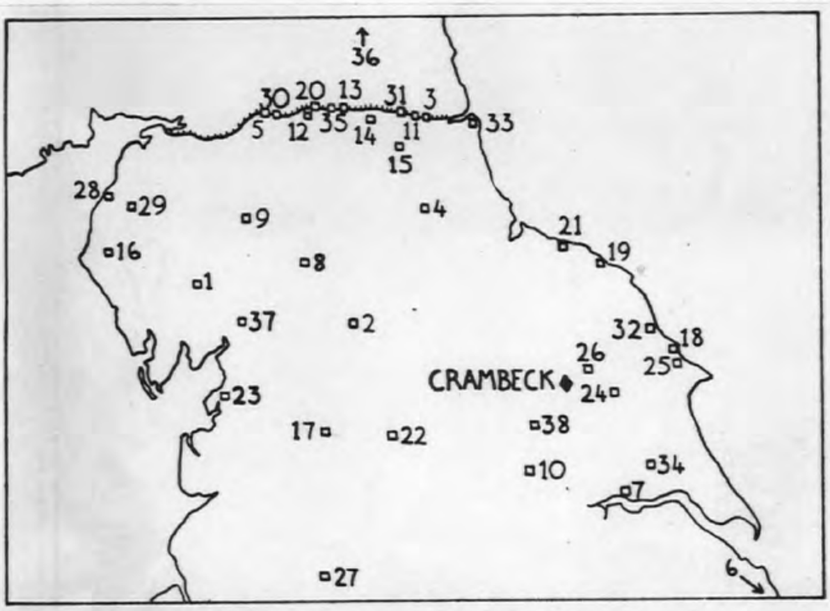

FIG. 47. Sketch-map showing distribution of Crambeck Ware

The various types are shown in Figs. 44 , 45 and 46 .[1] What seems to have been a Crambeck speciality was a hemispherical bowl in an orange-red body of fine texture, "a tolerable imitation of Samian ware" (see Type 5, Fig. 45). Some vessels bearing human faces are known to have been manufactured, and at Malton "a spirited representation of a stag was found, as well as a series of stars and circles."[1]

Crambeck ware has been found all along the Wall, and as Fig. 47 [1] shows, it had a wide distribution in the north of Britain, extending even over the frontier into Scotland (without naming every occurrence in Fig. 47 , we might mention 36, Traprain Law[2]; 27, Manchester; and 6, Brancaster in Norfolk).[3]

Considering now the dating of Crambeck ware: Prof. Eric Birley, writing in 1932, said[4] "It is becoming increasingly clear that the potteries near Malton, so far from suffering from the disaster of 368, were able to capture virtually the whole of the northern market in the last phase of the Roman occupation." This view has been confirmed by Margaret Birley's study of Crambeck ware [5]; she writes "There can therefore be no longer any doubt that the Crambeck potteries were in full production after the disasters of the Picts War of A.D.367" and "It is certain that the most flourishing period of the industry may be assigned to the last thirty years of the fourth century, when the reorganisation of the northern defences of the province by Count Theodosius led to an increased demand for these wares."

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(1) Margaret Birley, op.cit. in Ref. 2 on page 39 .
(2) An isolated hill near Haddington in East Lothian, some twenty miles east of Edinburgh.
(3) See Appendix III for the full distribution.
(4) Eric Birley, Cumberland & Westmorland A. & A. Trans., XXXII, 135.
(5) Margaret Birley, op.cit..

Kitchen-mortar ('mortarium') of hard greyish-white earthenware

Fig.48 Colchester mortarium, diameter 10½ in..

Mould of Potter B. Diameter 7¼ in.

Fig.49

Colchester

M.R. Hull has reported on the Colchester region.(1) Colchester (Camulodunum) was one of the centres where mortaria were manufactured; as already mentioned, these heavy and rather specialised pieces seem to have been 'mass produced' at a relatively few potteries. Those from Camulodunum are known by the stamps of the Colchester potters, and it is certain that mortaria bearing these stamps were in use in the north before the end of the second century; they have been found on the Antonine Wall, at Corbridge and at South Shields. The northern frontier systems, and south-east Britain appear to have been the principal markets for Colchester mortaria. Fig. 48 illustrates a typical specimen (Colchester & Essex Museum, Colchester). Platters, bowls, jars and cooking pots were made in a grey ware, but apparently only to a limited extent; by far the greatest in bulk and weight of the pottery fragments found at Colchester was a buff ware, some of which bore a red painted decoration.

Colchester, like the Nene Valley, produced a colour-coated ware, but none of the large number of sherds found had a painted decoration. There was, Hull says, "some considerable variation in finish and form. Some vessels show magnificent potting and design, among them some finished a fine shining black; others are a deep, slate-grey. These finer vessels commonly have multiple bands among the decoration. Some of the smaller beakers could be described as 'egg shell' ware and are every whit as fine as the best of the first century. In all cases the colour-coated vessels are remarkably light in weight.... The decoration used included various forms of barbotine-work, rouletting and sanding or rough-casting."

However, it is for its red-gloss or Samian ware that we have included Colchester in this survey. The kiln excavated by Hull has already been described (page 26). Fig. 49(2) shows a Samian ware, or Terra Sigillata, mould found at Colchester. Terra Sigillata moulds were made in one piece and were virtually thick-walled bowls of fine clay, the interior having the shape of the lower exterior profile of the vessel required. After the mould had been

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(1) M.R. Hull, "The Roman Potters' Kilns of Colchester," Soc. Antiqs. of London, Research Report XXI (Oxford, 1963). Hull published an earlier brief account: "Eine Terra-sigillata-Töpferei in Colchester", Germania, 1934, 18, 27.

(2) Reproduced from M.R. Hull, op.cit. above.

'thrown' on the potter's wheel, and whilst the clay was still plastic, the interior was decorated by impressing it with stamps, each stamp bearing a separate unit of the pattern. In all preserved examples these stamps are of baked clay; they could thus be used repeatedly, in any combination or order. Finally, the gaps in the pattern were filled-in freehand, using a stylus to incise such details as scrolls, or the stalks joining the flowers and leaves in a wreath. Rows of beads, or the ovolo pattern, were probably done with a wheel, as in rouletting. Although a skilled craftsman would probably do most of this work by eye, a Terra Sigillata mould found at York shows a faint guiding line through the rosettes at the bottom of the mould. After decoration, the mould was allowed to dry and was then fired, producing a hard, durable piece in which many pieces of ware could subsequently be shaped, each reproducing in cameo the intaglio design of the mould. Obviously, the mould could be no more than hemispherical otherwise the shaped ware could not be extracted from it, and for the same reason any deep impressions in the mould would have to lie well below the 'equator'. Also, the foot of the vessel had to be added after removal from the mould.

M.R. Hull considers that the Colchester kilns operated from about A.D.60 to about 350. He has no data to indicate when the Sigillata kiln was worked. The ware seems to have been used only locally.

Holt

The excavator of the tile and pottery works of the Twentieth Legion at Castle Lyons, Holt, Denbighshire was T. Arthur Acton who began digging in 1906 and died in 1925 before publishing a report. It was left to W.F. Grimes to study the site and Acton's collection, and his comprehensive survey was published in 1930(1). Acton's collection is now in the Welsh National Museum at Cardiff.

Grimes concluded that the tiles and pottery made at Holt were primarily intended for the legionary fortress. On the Continent, tileries for the supply of building materials to the legionary and auxiliary forts were common in all

(1) W.F. Grimes, Y Cymmrodor, 1930, XLl, 1-235.
F. Haverfield made a preliminary report in "Roman Britain in 1914", British Academy Supplemental Papers III (London, 1915).

Fig.50 ($\frac{3}{4}$)

Fig.51 (4/5)

military areas, and examples are found at Rheinzabern,(1) Nied and Bonn, but these works apparently did not manufacture pottery presumably because the many potteries situated near to the military centres rendered it unnecessary for the German troops to make their own. The manufacture of pottery at Holt, therefore, suggests the absence of a local, or conveniently situated, civilian pottery during the period of greatest activity at Holt (which, from the coins discovered, was probably from late in the first century to mid-second).

The Holt potters made a wide variety of products, from coarse ware and mortaria to 'eggshell'(2) and fine ware, the latter including imitations of Samian forms for which the legionary potters seem to have had a partiality. Coloured slip as a decoration was employed much as elsewhere in Roman Britain, except for an imitation Samian slip of red or red-brown colour, applied apparently with a brush. At Holt some ornamentation (leaves, human figures, etc.) was carried out in an applied as distinct from a moulded, technique.(3) Fig. 50 shows a circular stamp in fired clay, found at Holt, with the head of Silenus in low relief. Haverfield, and Grimes, suggest that this was a master die intended to be used for making the potters' sunk dies in which little clay casts would be made and subsequently 'applied', in relief, to the ware. The opposite of applied ornamentation is stamped decoration. This form of decoration is not uncommon in Roman Britain; it has already been mentioned in connection with New Forest pottery (page 38), but while the New Forest potters kept almost entirely to rosettes the Holt stamped decorations were copied, as to design, from Samian prototypes. For this reason Grimes considers that Holt stamped ware must be regarded "as an independent departure of the Holt potters in a new direction, which cannot be correlated with other stamped wares, apparently of later date, produced here and on the Continent." Fig. 51 illustrates a typical fragment of the Holt stamped ware.

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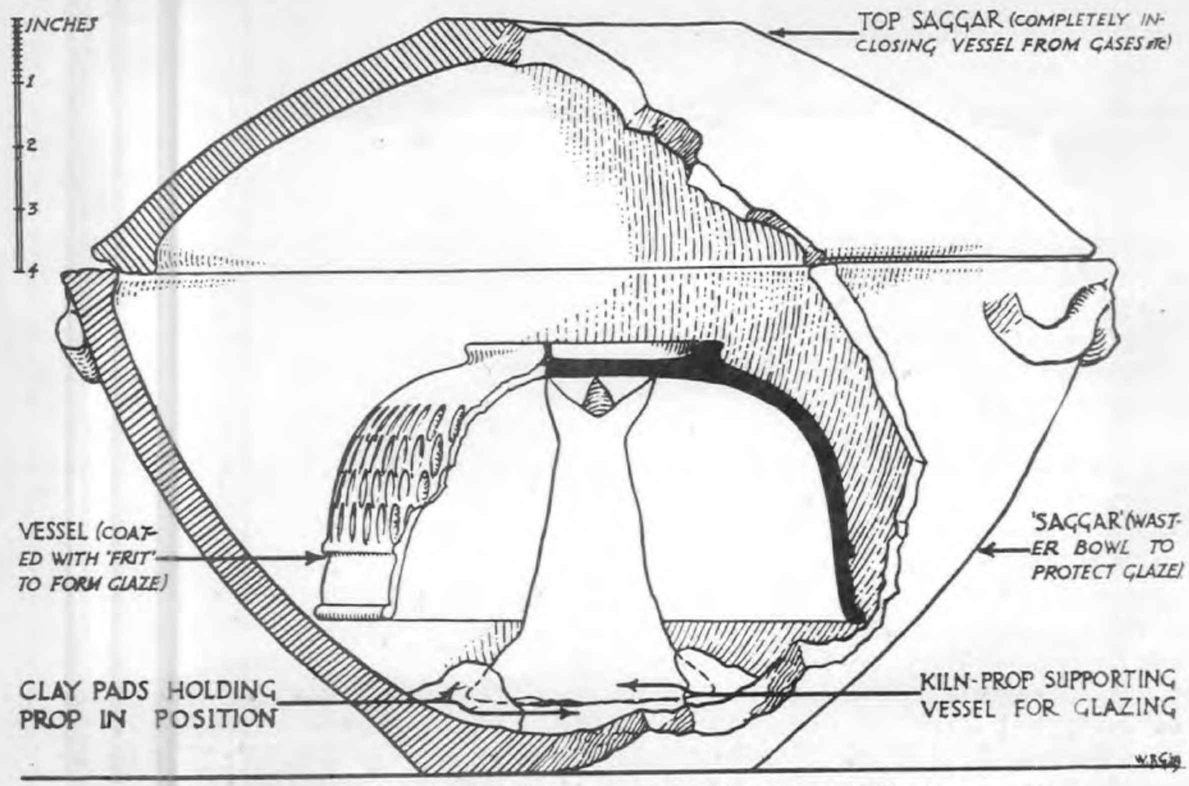
(1) See map, opposite page 30. Grimes points out remarkable similarities between the Holt kilns and those at Rheinzabern and Nied.

(2) The term is used to describe the thin, fine white pottery found on several Romano-British sites. That at Holt was probably made from residual clays of light colour which are associated with the carboniferous limestone of Flintshire and Denbighshire.

(3) 'Applied' technique was not, of course, peculiar to Holt; examples occur elsewhere in Britain. In 1938 a mould for the purpose was found at Kettering, Northants. (see J.R.S., 1939, XXIX, 199).



Reconstruction of the method of firing green-glazed wares at Holt.

Fig.52

Kiln pads used in stacking mortaria at Holt

Fig.53(approx.1/10)

Fig.54 (4/5)

Interesting as the Holt pottery is in its own right, the outstanding feature of Holt, from the ceramic aspect, is the light which it throws on the technique of glazing employed by the potters. Excavation revealed various vessels which had been glazed with green, brown or yellow glaze, and in the case of green glazed ware Acton found saggars with a supporting piece and clay pads which enabled Grimes to produce the restoration shown in Fig. 52 . The ware to be glazed was first of all fired to the porous "biscuit" state. The pieces were then coated with the glaze, probably by dipping them in a suspension of the glaze constituents, and they were then re-fired to fuse the glaze to the body. During this second (modern "glost") fire the glaze had to be protected from any dust and ash which might be deposited on it from the hot gases circulating in the kiln. The ware was therefore placed inside two bowls which, put mouth to mouth, formed a "saggar". The ware could not be stood on its base, otherwise the glaze, when molten, would cause the piece to stick to the saggar. It had therefore to be supported, from its unglazed inner side, by what Grimes calls a "kiln-prop" (modern "stilt"), and to prevent the stilt from falling over it was fixed in pads of clay. Even if the inside of the vessel were also glazed, the three prongs of the stilt, making only point contact, would leave little blemish. The remarkable feature of this procedure is its close similarity to modern practice,(1) demonstrating the antiquity of ceramic technique. The glaze used at Holt contained lead, as shown by the presence of lead deposits around the stilt and base of the saggar.

Another find at Holt was a stack of mortaria (Fig. 53) separated by clay pads, the function of the pads being to allow the mortaria shrink freely during the firing process. Without the pads the natural firing shrinkage would be impeded and the pieces might crack or split. Elsewhere, sand is reported to have been used for the same purpose.(2)

Fig.54 shows the mortarium stamp of the potter IVLIVS VICTOR, found on the Holt site. It was unused, and none of the mortaria found bore his name; perhaps he was a late-comer to the site, just before it was abandoned.

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(1) See Ernst Rosenthal, "Pottery and Ceramics", (Pelican Books, 1954).
(2) At Lincoln; see J.R.S., 1937, XXVII, 233.

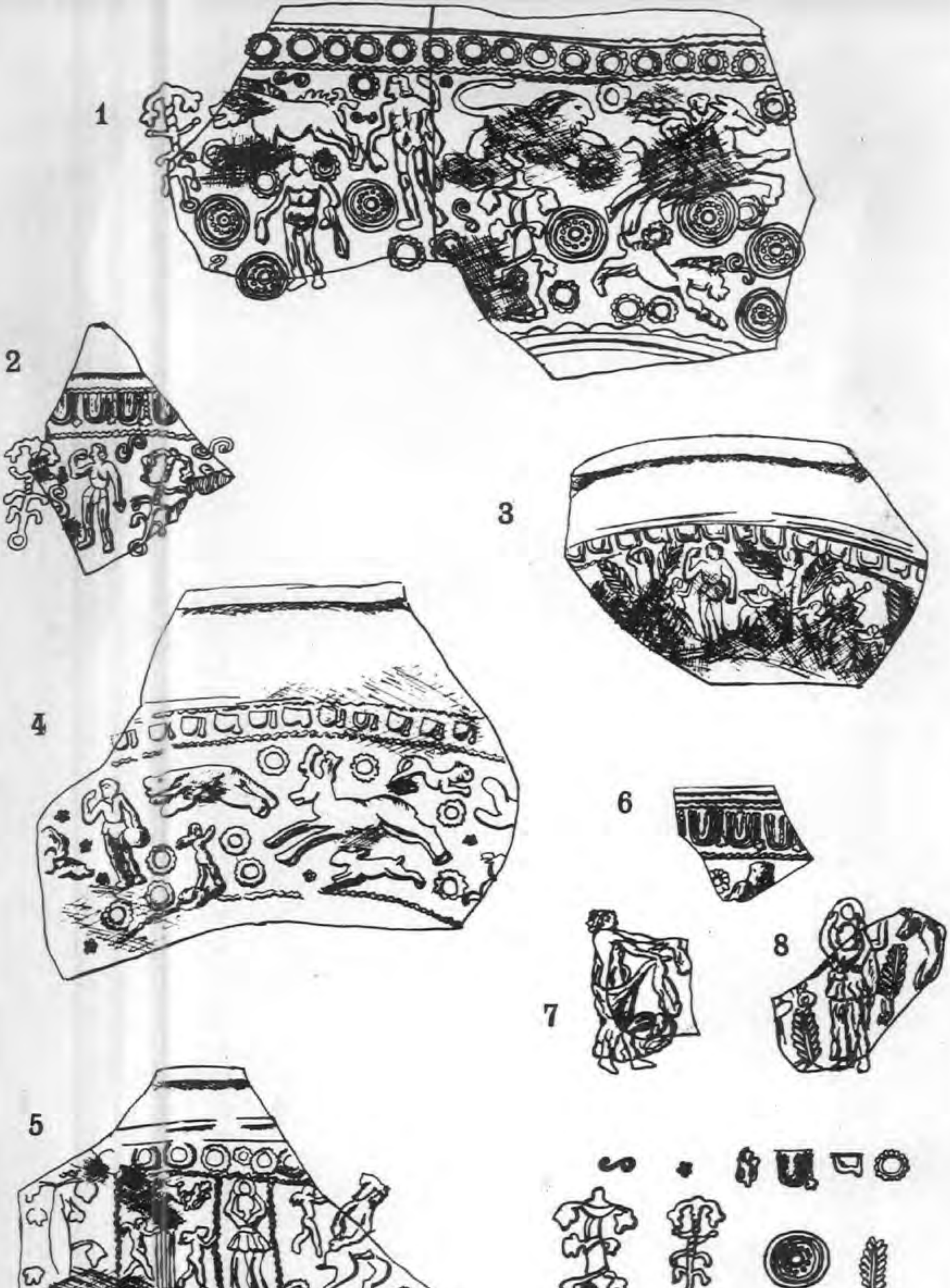

FIG. 55. SAMIAN WARE FRAGMENTS WITH DESIGNS ATTRIBUTED TO A BRITISH POTTER. c. ½.

The Aldgate Potter

In 1882 a fragment of Terra Sigillata, or figured Samian ware, was found somewhere in Aldgate, London, during an extension of the Metropolitan Railway. This was from a coarsely-made bowl, warped and crazed in firing, and obviously a "waster"; it was accepted into the British Museum collections. Since then other fragments have been found, and in a Roman villa near Pulborough, Sussex, three small pieces of Samian moulds were discovered which gave the casts shown at 6, 7 and 8 in Fig. 55. Grace Simpson(1) has assembled all the evidence in Fig.55 where the pieces are

1. Found in Aldgate, London (Dept. of Archaeology, Durham).
2. Found in London, site unknown (British Museum).
3. Found at Silchester, Hants. (Reading Museum).
4 & 5. Found at Chichester, Sussex.
6, 7 & 8. Casts from Pulborough moulds.

The shading in Fig.55 is intended to give an impression of the smears and finger-marks which characterise the poor quality of the ware.

By studying the designs and the general character of the fragments, Grace Simpson has concluded that they all represent the work of one man whom she terms, for convenience, the "Aldgate" potter. This is not to suggest that there was a pottery making Terra Sigillata in what is now Aldgate; it is simply naming the potter after the place where the first specimen was found. Nevertheless, as this piece was a "waster" it would not have been imported from the Continent, and moreover it would probably have been thrown away at least in the neighbourhood of the pottery where it was made. At all events, wherever the pottery was situated, it would seem that here we have another Romano-British source of Terra Sigillata in addition to the Colchester production.

There is an excellent Terra Sigillata mould in the Yorkshire Museum at York, but this is generally considered to have been made on the Continent, probably at Lezoux, because it is in the style of a Continental potter, and there

(1) Grace Simpson, "The Aldgate Potter: A maker of Romano-British ware," J.R.S., 1952, XLII, 68.

is no evidence of any manufacture of figured Samian in the region of York. Grace Simpson suggests that the York mould was left by someone from the Continent who was 'scouting' for a suitable site for a Samian ware factory, whereas the Aldgate waster is strong evidence of actual production in Britain.

GLASSMAKING

Historical

The origin of the craft of glassmaking, like that of potting, is lost in antiquity. The earliest literary records[1] about glazes and glasses are two sets of inscribed clay tablets; the earlier set is Babylonian and is dated by its translators[2] as not later than 1700 B.C.. It contains four recipes for glazes in each of which the major constituent is "zuku-glass", a glass apparently already known at that time. The second set is Assyrian, from the Royal Library at Nineveh established by Assur-bani-pal (668-631 B.C.); these[3] record a considerable number of glass recipes. Lead is mentioned as a constituent of the glazes in the Babylonian chemical text, and it occurs once in the Nineveh glass formulations.

It is clear from the number and variety of glass products which have come down to us, that glass was in regular production in Egypt of the XVIIIth Dynasty (1580-1340 B.C.), and it is probable that Egypt was exporting glass during this period. Thus over a thousand years before the conquest by Rome (30 B.C.), Egypt had attained eminence in the art of glass-making, although the products were probably used only by the wealthier citizens or for ritual purposes. As with pottery, technical proficiency seems to have spread westwards from the east, ultimately aided by the extent of the Roman Empire.

By the first century A.D. glass was being developed for its everyday utility. Pliny[4] tells us that a very white sand from the mouth of the River Volturnus in Italy was employed for glassmaking. It was prepared for use by pounding it in a mortar or grinding it by millstones, which done, it was mixed with three parts of nitre, and fused to give a mass termed "ammonitrum". These lumps or "massae" were broken up and re-melted in another furnace to give "vitrum purum" which was then worked into shape. Glass-making thus required a series

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(1) Quoted by Prof. W.E.S. Turner in "Studies in Ancient Glasses and Glassmaking Processes", Jour. Soc. Glass Technology 1954, XXXVIII, 436T, 445T; 1956, XL, 39T, 162T, 277T.
(2) C.J. Gadd & R. Campbell Thompson, "A Middle-Babylonian Chemical Text", Iraq, 1936, 3, 87.
(3) Translated by R. Campbell Thompson, "The Chemistry of the Ancient Assyrians", (London, 1925); "Dictionary of Ancient Assyrian Chemistry and Geology", (Oxford, 1936).
(4) Natural History, XXXI Chapter 46, and XXXVI, Chapters 65 & 66.

Fig.56

of furnaces, particularly as the craftsmen had to prepare their own raw materials and therefore additional furnaces were required for calcining sand to render it more friable, for roasting chalk to obtain lime, and so on. In the provinces, glass-making became established on an industrial basis. Sidonians and Alexandrians worked in Gaul; inscriptions on grave reliefs and on glass objects show that other foreign workers were established in the Rhine and Rhone valleys(1), and the Frontinus factory in Cologne mass-produced barrel-shaped flasks with distinctive mould marks which are found on many sites in western Europe(2).

In Britain, from the discoveries at Glastonbury(3), we know that glass in the form of beads was being made in pre-Roman times. The finds are beads and a lump of greenish-blue fused glass, the latter indicating that glassworking was done within the area of the Village. The bead specimens show that quite a variety of colours was being made:

Dark to pale blue.
Sea green; translucent green.
Dark Yellow.
Purplish brown, veined.
Clear white, grooves filled with yellow glass.

After the Conquest, glass became more common and it is found on many Romano-British sites in the form of vessels of various shapes, and as window glass. Fig. 56 shows a group of 4th-5th century glass vessels found in a pit at Burgh Castle, Somerset(4).

Furnaces

Despite the widespread evidence for the manufacture of glass on the Continent in Roman times, there is so far no certain evidence for the discovery of a glass furnace; many probable sites of manufacture have been recorded, but on none of these can it be said without doubt that an actual furnace has been found. In Britain, on the contrary, there is evidence for several glass furnaces. The first finds were made by Thomas May at Wilderspool and Stockton Heath, near Warrington(5). As will be seen, the evidence is circumstantial rather than direct, because May did not find glass in any of his furnaces. He describes five "workshops", three of which were at Wilderspool whilst the remaining two were at Stockton Heath.

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(1) M.L. Trowbridge, "Philological Studies in Ancient Glass", (Univ. of Illinois, 1930).
(2) A. Hartshorne, "Old English Glasses", page 11 (London, 1897); D.B. Harden in "Ebvracvm: Roman York", 1, 136, (R.C.H.M., London, 1962).
(3) Arthur Bulleid & H. St. George Gray, "The Glastonbury Lake Village", 2, 353, (Glastonbury Antiquarian Society, 1911).
(4) J.R.S., 1962, LII, 178.
(5) Thomas May, "Warrington's Roman Remains", page 37 et seq., (Warrington, 1904).

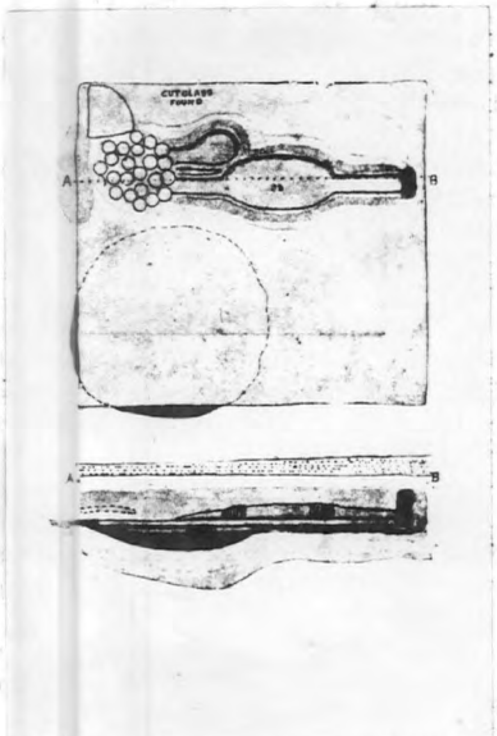

Fig.57

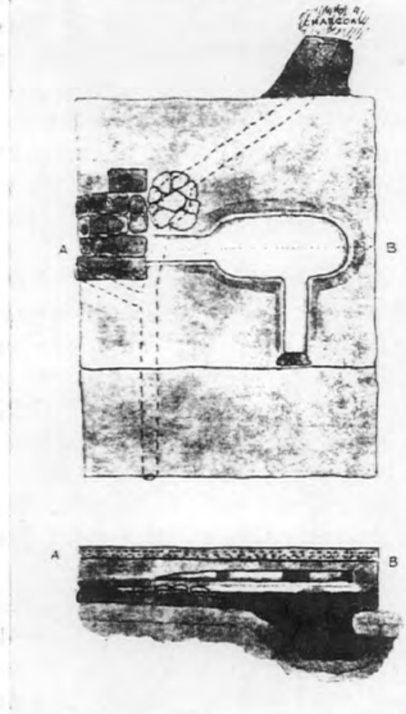

Fig.58

The furnace in the first workshop had an oval cavity 3 ft. 6 in. long, 3 ft. wide, with a stokehole 3 ft. long, 8 to 12 ins. wide. It had been subjected to intense heat, and from a 13 oz. lump of partly calcined flint "a material foreign to the district", May concluded that the furnace had been used for calcining flints for the production of clear glass, 'crystallinum', and that this was a flint glass maker's workshop.

The second workshop had two massive clay platforms containing furnace cavities which were of more elaborate construction than those on the rest of the site. May has two cramped sketches of these "oval ovens" which are reproduced in Figs. 57 and 58 ; both contained remains of overarched coverings. The first oven, Fig. 57 , had an oval trough 4 ft. 6 in. long, 2 ft. wide, and 10 ins. upright sides. Adjacent to it was a smaller, more rounded cavity "resembling the base of a furnace for heating a cauldron or melting pot". Both troughs or cavities had outlets facing "a ring-ornamented hearth of baked clay, 3 ft. in diameter" (this is shown near A on Fig. 57). The second oven, Fig. 58 , was 5 ft. long, 2 ft. 3 in. wide, with upright sides 4½ ins. high. It had two outlets at right angles, and underneath, a tubular flue 6-7 ins. diameter (shown dotted) communicating with an external fire-hole, (top right hand corner of sketch) and having a circular chamber at roughly mid-length before forking into two branching flues; all the flues were soot-blackened.

Near the first oven were found two fragments of crystal cut-glass goblets having wheel-cut ornamentation(1). Sixty feet away from this workshop was found a glass-cutter's wheel of very hard, fine sandstone, 1 3/8 ins. diameter, 3/8 in. thick, whose periphery fitted the facets on the cut-glass specimens. This wheel was in a rubbish pit along with "sandiver or glass-maker's scum" which was analysed and identified as such. As there was no evidence of any other industry in the vicinity of this workshop, May concluded that only glassmaking could be associated with these ovens, and he decided that the smaller cavity in Fig. 57 was for heating a glass pot, the two large ovens were lehrs for annealing the products made from the contents of the pot. No remains of a glass pot were found, but an earlier excavator (J.P.Rylands) said that in 1869-70 he had found a piece of molten glass,

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(1) May remarks that pieces of similar vessels of white glass with cut oval facets had earlier been found at London (Apsley Pellat, "Curiosities of Glassmaking", page 136, Plate III, Fig. 13), and at Birrens (Anderson & Curle, Proc. Soc. Antiq. Scotland, 1896, page 189 et seq.).

and a portion of what appeared to be a large crucible, in neighbouring sand pits. Warrington sand, May observes, is better than it looks, and could have been used for glassmaking.

The third workshop at Wilderspool contained two more "curious pairs of furnaces". Beads found on the spot suggested bead-making as a possibility. A piece of chalk, weighing 1 lb., was discovered in one furnace. May thought that one furnace in each pair was used either for melting sand, chalk, etc., into massae, or for re-melting massae in clay pots for working, while the other furnace was used as a lehr. On this area there were found glass beads, $\frac{3}{4}$ inch discs of black glass, crystal glass rod, amorphous lumps of semi-fused glass, a piece of blue enamel or frit, and leaden weights.

The two Stockton Heath workshops disclosed further furnaces, fragments of bottles and other vessels, and four fragments of flat window glass, dull on one side and fire-polished on the other(1). On the Wilderspool and Stockton Heath sites May claims to have found fragments of "more than a gross of different glass vessels". Whether the various furnaces had in fact the functions which May attributes to them is open to question, but there seems no doubt that the two sites were connected with glassmaking, in which the furnaces played parts which, strictly speaking, cannot be ascertained for want of direct evidence.

Some thirty years later, Prof. D. Atkinson discovered a glass furnace at Caistor near Norwich(2). On the site there was a furnace of horseshoe shape in a ruined state, with nothing to indicate its purpose, and two rectangular furnaces set back to back. One of these was almost entirely destroyed, but it had evidently been exposed to considerable heat. The other rectangular furnace was about 4 ft. 10 in. long and 2 ft. wide. The bottom consisted of a slightly concave floor of clay 7 ins. thick, on which was a layer of sandy ash containing calcined flints and fragments of fused and splintered glass. Above this layer was a mass of burnt clay which evidently was the remains of an upper floor of the furnace. On the clay blocks constituting the side walls of this upper part of the furnace "there was visible a band of fused glass, about 1 inch wide, adhering to the sides". Two of these clay blocks, about 2 ft. 6 in. long, 1 ft. wide and 4 ins. thick, still with some adherent glass, are in the museum at Norwich. In one corner of this furnace, slanting downwards into the

(1) A.K. Kisa, "Das Glas im Altertum", Vol. 2, 364 says that Roman window glass was made by pouring the molten 'metal' on to a slab covered with fine sand, thus producing the characteristic frosted appearance on one side.
(2) D. Atkinson, "Caistor Excavations, 1929", Norfolk Archaeology, 1932, XXIV, 108-112.

space below the upper floor, there was a small cavity 3 ins. diameter, possibly for the provision of a blast.

Bearing in mind the fact that window glass was being used on the site in the fourth century, Atkinson suggested that the rectangular furnace was an annealing oven or lehr, possibly for window glass. The molten glass would be poured on to the upper floor, with a hot fire underneath in the lower section of the furnace, and annealing would take place as the fire was gradually diminished. This is an ingenious suggestion, but it does not account for the calcined flints found on the lower floor of the furnace. May, for example, might have said that as there were two furnaces back to back, they were perhaps used alternately for calcining flint, and for melting; one melting whilst the other was calcining. However, whatever the true explanation may be, here for the first time was a furnace which showed visible evidence of having contained molten glass.

Evidence of molten glass has come from other Romano-British sites. At Silchester, glass has been found adhering to the sides of pots used as crucibles; this, with partly-fused scraps of glass and some pieces of window glass, has been taken to indicate that rough types of glass products, such as window-panes, were made at Calleva, perhaps from scrap glass or 'cullet' rather than from primary materials[1]. In 1954, a Ministry of Works emergency excavation carried out at Chew Stoke in Somerset, before the archaeological sites in the Chew Valley were submerged under a new reservoir, uncovered a piece of refractory material or stone which had apparently fallen into molten glass and had subsequently been retrieved from the melt, perhaps when a glass furnace was drained. The glass coating around the stone was thick and had penetrated the stone to some extent, showing that the stone had been immersed in the molten glass for some time. Chemical analyses of the glass and the stone established that the glass could not have been made by melting the stone, hence the inference that the stone had accidentally fallen into a glass furnace. This conclusion is not unreasonable, but it has to be remembered that the mere finding of melted glass, in the absence of other indications, cannot be taken as evidence of glass manufacture. Accidental domestic fires would not be unknown, and when once started amongst timber buildings would be almost uncontrollable. Melted glass of this provenance has, for example, been found at Colchester[2]

(1) G.C. Boon, "Roman Silchester", 145-6, (London, 1957).
(2) M.R. Hull, "Roman Colchester", 154, 157 (Soc. Antiqs. Res. Report XX, Oxford, 1958).


THE
MINING REGIONS
of
ROMAN BRITAIN
HADRIAN'S WALL
YORKSHIRE LEAD
YORKSHIRE LEAD
PARYS MOUNTAIN COPPER
DERBYSHIRE LEAD
GREAT ORME'S HEAD COPPER
WILDERSPOOL
FLINTSHIRE LEAD
LLANYMYNECH COPPER
COLSTERWORTH
SHROPSHIRE LEAD
TIDDINGTON
DOLAUCOTHY
GOLD
FOREST of DEAN IRON
MENDIP LEAD
THE WEALD IRON
CARNANTON TIN

Fig.59

METALS: PREPARATION

There is little doubt that the metals of greatest importance during the Roman occupation were iron and lead. Iron was being exported from Britain before the occupation, and under the Romans the production of iron was greatly expanded, although probably mainly for use in the province. Within six years of the invasion in A.D.43 the Mendip lead mines were under Roman control, and apart from the many uses of lead as a metal it is important to realise that the only source of silver known in Roman times was extraction from lead. Iron and lead therefore take priority in any consideration of Romano-British metal working; in each case we shall deal first with sites of production and then with methods of smelting. The map "Mining Regions of Roman Britain"(1) shows the principal sites for these and other metals.

Iron: Sites

There is, or has been, a fairly wide distribution of iron ore deposits in England and Wales, and Roman exploitation of British deposits was quite extensive. Caesar mentions iron: "in the coastal regions of Britain, but in small quantities".(2) He almost certainly must have meant the deposits in the Weald. Strabo states that British iron was exported regularly to the continent.(3)

The Wealden iron deposits have been worked from the earliest times: at Playden, near Rye, typical cinder has been found in association with primitive pottery, and on several sites near Hastings flint implements have been gathered beside bloomeries. The entire period of Roman occupation is accounted for in the coin and pottery evidence. Many furnace sites have been discovered, and the piles of refuse, slag and cinders are numerous over the whole area. Thus at Beauport Park, Battle, there were cinder heaps fifty feet high and two acres in extent, yielding coins of Trajan and Hadrian.(4) Roman roads at Maresfield, Hempstead near Bevenden, and Slinfold, are partly constructed of slag.(5)

Of almost equal importance, to judge from the extent of the refuse heaps, were the mines in the Forest of Dean, on the

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(1) Reproduced from R.A. Peel, "Mining and Minerals in Roman Britain," (Univ. of Durham, B.A. Dissertation, 1957).
(2) Caesar, De Bello Gallico, V; 12.
(3) Strabo, Geography, IV, v, 2.
(4) E. Straker, "Wealden Iron", (London, 1931).
(5) O. Davies, "Roman Mines in Europe", (Oxford, 1935).

Welsh border north west of the Severn estuary. The slag heaps have yielded coins and pottery ranging from the late first century to the fourth century in date.(1) Like the Wealden iron, the deposits here must have been exploited soon after the conquest, when it is considered that this region was invaded only between 74 and 76 A.D. The evidence from Weston-under-Penyard points to increased mining activity in the latter half of the third century, and the fourth century.(2) The two principal centres, as far as we know, are both on the western edge of the areas, Lydney and Weston-under-Penyard. The former was underground and evidence shows third century working.(3) The site is a hill which has revealed very intensive working. The labourers lived in a hut village, evidence showing second and fourth century settlement, on the summit, and this was on the site of an ancient hill fort. At Western-under-Penyard an area of two hundred acres was covered with slag heaps.(4) Within the Roman settlement two buildings were excavated, the smaller containing an iron furnace. The floor was paved with flags resting on red clay, and below this, to a depth of two inches, was a layer of gravel, containing a lot of small iron clinker.(5) The industry, to refer to one modern author, attained greatest importance early in the fourth century and then dwindled until the end of the occupation.(6) In the rest of this region, piles of "scoriae" and cinders exist in St. Weonard's, Hentland, Peterstow, Tretire, Bredston, Dangarron, Walford, Goodrich, Welsh Bicknor, Ganarew and Whitchurch. Frequently, these heaps of refuse are between twelve and twenty feet in thickness. On Peterstow Common hand bloomeries containing partly melted ore have been found.(7) At Great Doward the hill site has shown extensive working, much of it underground.(8) In the Roman villa at Chedworth, Gloucestershire, three iron blooms weighing 256, 356 and 484 lb. were found; no doubt they originated from the Forest of Dean.(9) It has been claimed that Roman mines have been discovered in the Forest of Dean at Coleford and Redbrook, on the River Wye.(10)

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(1) R.G. Collingwood, "Economic Survey of Ancient Rome",iii, 41.
(2) I.A. Richmond, "Roman Britain", 158, (Pelican History of England, 1963).
(3) R.E.M. Wheeler, "Excavations at Lydney", 1932, 18-22.
(4) I.A. Richmond, loc.sit..
(5) J.R.S., 1921, XI, 207.
(6) L.C. West, "Roman Britain and Objects of Trade", (London,1931)
(7) L.C. West, op.cit..
(8) R. Hunt, "British Mining", 28 (London, 1884).
(9) Arch. Jour., 1887, 322.
(10) Coleford: Fryer, Cardiff Naturalists' Society Trans., 1886, XVIII, 50.
Redbrook: L.C. West, op.cit..

The Midlands offer many instances of iron mining. At Stratford-on-Avon, Warwickshire, during the excavation of the industrial settlement, considerable quantities of iron slag and nails were discovered, in addition to traces of ore washing and furnaces; perhaps this was a pre-Roman industry, working extending into the Roman period. At any rate, the evidence showed working throughout the Roman occupation.(1) In Northamptonshire slag heaps with Roman remains have been frequently located.(2) At Clipsham, Rutlandshire, a refuse heap of iron slag and charcoal in a layer two feet thick, was found.(3) A large bloomery furnace was unearthed at Woolsthorpe, near Colsterworth in Lincolnshire.(4) The site yielded coarse pottery, the general character of which was first and second century. At Saltersford, four miles away, a hoard of Roman iron tools was found(5). In the same county Roman sherds have been found in a slag heap at Claxby(6), while there is good evidence for working deposits in the vicinity of Scunthorpe.(7) Again, at Beeston Regis, near Cromer, Norfolk, sherds in slag heaps have been noted.(8)

Evidence has been limited in Wales. During excavations at Caerwent, Monmouthshire, iron slag together with a ladle used in manufacture were discovered. Associated with these objects were iron shears and an iron spear head.(9) Further west, in Glamorganshire, evidence appeared at Ely, near Cardiff. The excavation report reads: "Abundant traces of iron working were observed, and the earlier excavators claimed to have found two of the actual hearths on which the ores were smelted.(10) Partially fused slag was actually used as a paving for the open space immediately east of one building, and it may be noted that a similar paving was used for the main streets of the Roman fort at Cardiff".(11) Some of the ore at Ely was in association with manganese. In north Wales, at Anglesey, iron was found in Din Lligwy and other hut villages; also at Holt in Flintshire.(12)

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(1) J.R.S., 1925, XV, 230.
(2) Kendall, "Iron Ores of Great Britain & Ireland"; Trollope, Associated Architect. Society Reports 1859, V, 97.
(3) J.R.S., 1926, XVI, 223.
(4) I.C.Hannah, Antiqs. Jour., 1932, XII, 262.
(5) I.C. Hannah, loc.cit..
(6) Key, Mining Journal, June 1896, 734.
(7) I.A. Richmond, op. cit., 158.
(8) V.C.H., Norfolk, I, 313.
(9) Arch., 1911, LXII, 439, "Excavations at Caerwent, Monmouthshire, 1909-10.
(10) Cardiff Naturalists' Soc. Trans., 1893-4, XXVI, 4.
(11) J.R.S., 1921, XI, 79.
(12) R.G. Collingwood, op.cit., iii, 41.

In northern England there are a variety of places where iron working was in existence in Roman days. In forts, traces of iron working have come to light; at Templebrough and Newsteads, where a hoard of ninety-six iron objects represents the contents of the camp forge.(1) At Housesteads iron slag was found inside the fort(2), and at Great Chesters, the report states: "An extensive range of buildings was found erected against the outer camp wall between the western gateway and the north-west angle of the camp. Of these, the most northerly appears to have been a smithy; in it close to the hearth was the stone trough to hold the water used in tempering the iron".(3) In the arsenal at Corbridge, in the third and fourth centuries, smelting was carried on regularly in the production of weapons, nails and holdfasts.(4) The source of the ore must have been the Redesdale deposits situated near the Risingham fort.(5)

In Yorkshire, observers in the eighteenth century noted large heaps of clinker in association with late third century and fourth century coins, at West Bierley, near Cleckheaton.(6)

The discovery of a smelting hearth has been recorded at Graystock, Cumberland(7), and further south, at Warrington, extensive remains of Roman iron working have been found.(8)

Iron: Furnaces.

It is important to realise that there are two distinct methods for the production of iron:

1. The 'direct', or bloomery process.
2. The blast furnace process for producing cast iron.

Describing the second method first, because it does not concern us here, we may say briefly that it consists in

(1) T. May, "Excavations at Roman fort of Templebrough, near Rotherham," 1922.
J. Curle, "Newstead, A Roman Frontier Post and its People," 1911, 277.
(2) Arch. Ael., 1904, XXV, 241.
(3) Arch. Ael., XXIV, 33.
(4) J. Collingwood Bruce, "Handbook to the Roman Wall", 76-77, (ed. I.A. Richmond, Newcastle upon Tyne, 1957).
(5) I.A. Richmond, "Roman Britain", 159, (Pelican History of England, 1963).
(6) I.A. Richmond, op.cit., 159.
(7) Arch., 1893, LIII, 505.
(8) Thomas May, "Warrington's Roman Remains", (Warrington,1904).

Fig.60

Fig.61

roasting a mixture of iron ore, coke and limestone in a blast of hot air so that the iron ore is reduced to metallic iron at a temperature high enough to produce iron in a liquid state. The fluid iron is run off and cast into 'pigs' of 'cast iron'. These hard, brittle pigs have subsequently to be treated to convert them either into wrought iron or steel; the blast furnace process is thus 'indirect' in that it does not yield an immediately useful product (excluding the limited range of articles which can be cast from cast iron).

In the bloomery process, as anciently practiced, the iron ore was reduced by roasting it with admixed charcoal. The temperature was lower than in the indirect process, and the iron never became fluid. The product was a pasty mass of iron containing slag and cinder which had to be expressed from the spongy mass of iron by hammering, the result after repeated re-heating and hammering being a 'bloom' of more or less pure iron.

The earliest bloomery hearths in the Weald were probably similar to contemporary furnaces in Westphalia of which some records exist. They were of the 'bonfire' type, and consisted of a clay hearth on which alternate layers of charcoal and washed cleaned ore(1) were piled in a conical heap which was covered with a thick dome of clay with a hole in the top. The bottom-most layer of charcoal would be ignited, and air blown in, by bellows, through holes near the base of the dome. After several hours of blowing, the iron would settle in a spongy mass on the hearth while the other constituents of the ore would remain above the iron as slag and may have been partly run off through suitable openings. If by accident the temperature became too high, something akin to cast iron would be produced and would have to be thrown away because no one knew how to convert it to ordinary iron. Pieces of cast iron are sometimes found among bloomery refuse.(2)

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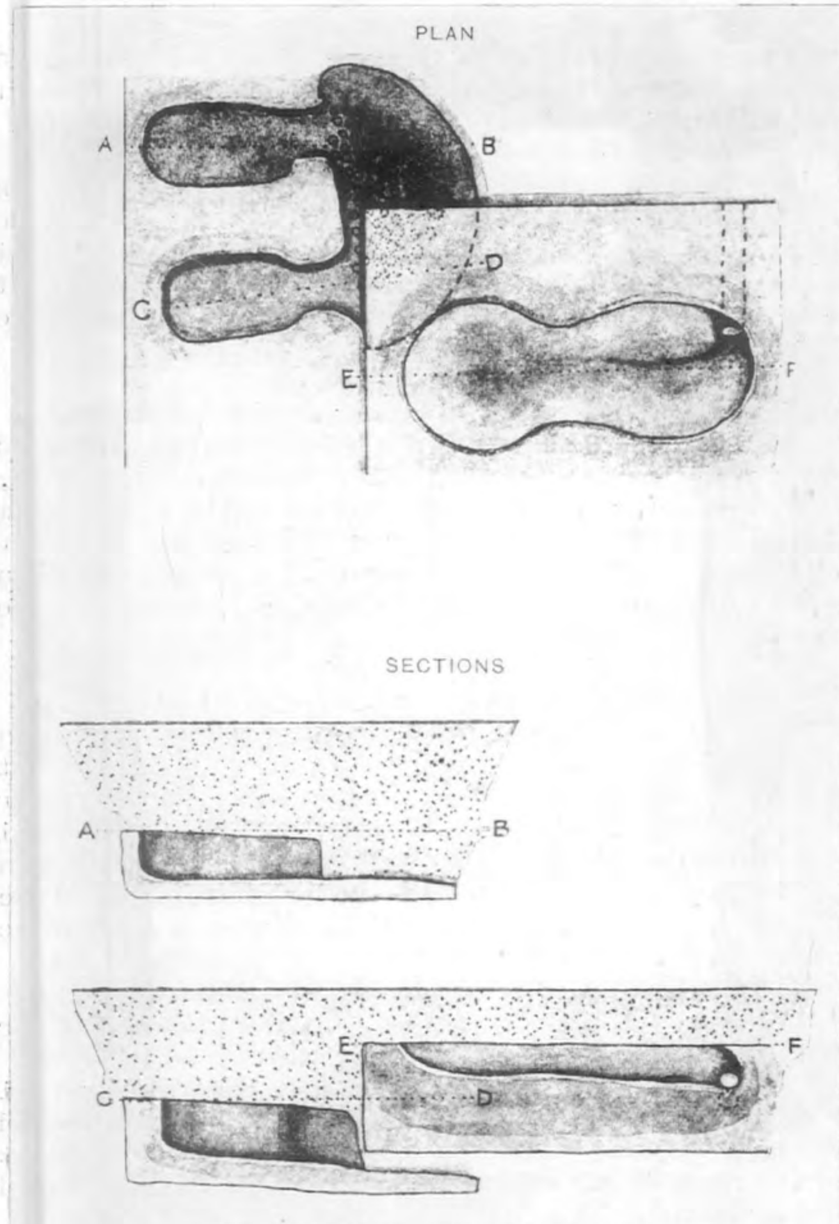
(1) Probably pre-calcined to make it easier to break into small pieces for more rapid smelting.

(2) Thomas May ("Warrington's Roman Remains") asserted that the Romans actually cast iron, taking as part of his evidence a cast iron statuette said to have been dug out of the Romano-British slag heaps at Beauport, near Hastings. This was first described by the notorious Charles Dawson in Sussex. Arch. Collections XLVI, 4. E.Straker in "Wealden Iron" had doubts about its authenticity, and modern opinion is that the statuette was a forgery and that the Romans did not cast iron. True blast furnaces for making cast iron probably first appeared at Namur in the fourteenth century (see Rhys Jenkins, Trans. Newcomen Soc., V, 17).



DOUBLE FURNACES AND IRON SMELTING HEARTH.

Fig.62

A remarkably large ingot of iron was discovered at Corbridge in 1909.(1) The excavation report states: "The bloom is a mass weighing just over three hundredweights and measuring thirty-nine inches in length; it was found standing upright, with the smaller end downwards, in a small circular furnace on the north side of Corstopitum ..... Small blooms of spongy iron, doubtless procured by smelting with charcoal at various points in southern Northumberland where the 'black band' ironstone crops out, were brought to Corbridge and there welded and built up into a mass by successive and alternate heating and hammering. At the bottom a foundation piece must have first been formed; then two small blooms were added to it and the mass was heated and welded by hammering; more small blooms were then added, similarly heated and welded by hammering, thus the bar or column of iron was formed. The hammering was not, however, sufficiently heavy to prevent some cavities being left in the centre, and, in the upper part of the mass, where it was rather thicker than at the bottom, the force was not sufficient to weld the whole together right through. Only the outside, indeed, was really formed into first class iron. It seems probable that the bloom was still in process of development when the work was, for some reason, interrupted."(2)

Fig.60 shows an external view of the bloom as found, and its internal appearance after being sawn in two. Careful tracings were made of the individual small blooms then distinguishable in the mass, and these when assembled provided Fig. 61 which illustrates clearly how the large bloom was built up.(3) The use of this bloom is unknown.

An extensive iron working site at Wilderspool, on which furnaces much more highly developed than the primitive bonfire bloomeries were used, has been described by Thomas May.(4) Fig. 62 is May's illustration of two of the numerous smelting hearths discovered at Wilderspool; one of these (see right-hand part of plan view) was constructed partly on top of an older furnace (which can be seen at A,B and C in the plan view). The newer hearth was in the form of two intersecting ovals giving an overall axial length of 6 ft. 4 in., each oval having a width of about 2 ft. 6 in., the whole cavity

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(1) Arch. Ael., 1910; 240, 265. (2) Arch. Ael., 1912; 207.
(3) See Hugh Bell, "Notes on a Bloom of Roman Iron found at Corstopitum," Jour. Iron & Steel Institute, 1912; 118.
(4) Thomas May, "Warrington's Roman Remains," (Warrington, 1904).

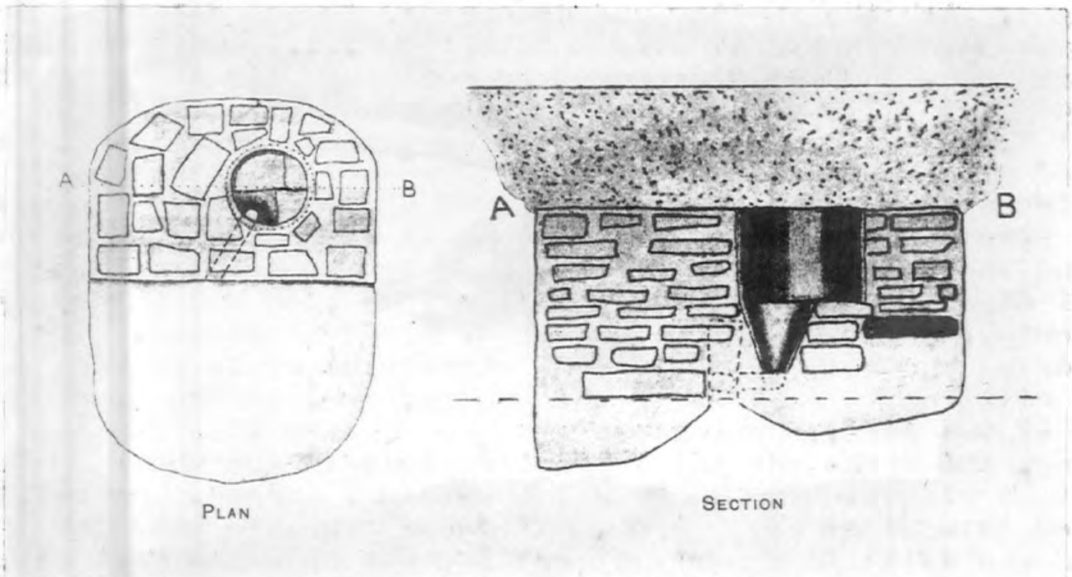

Fig.63

being contained in a massive oblong clay platform 8 ft.9 in. long, 4 ft. wide and 1 to 1½ ft. thick. The sides of the ovals sloped towards the major axis which itself sloped down to a tubular duct, 4½ ins. diameter, 1 ft. 10 in. long, leading out through the clay platform. The inside of the duct was calcined, indicating that molten metal had been run through it. The purpose for which the hearth was employed was made certain by the finding of a strip of iron (analysing 99.876% Fe) in a crack near the duct, and by the discovery underneath of a mass of red haematite ore in the clay platform of the earlier furnace.

Many lumps of slag were unearthed in the neighbourhood of this furnace and other adjoining furnaces. May makes the interesting point that one of these lumps, when analysed, was proved by its high alumina and silica contents to be from clay ironstone, i.e., from impure "clayband" ore, and in his opinion this demonstrates that the workers at Wilderspool knew that a mixture of pure (haematite) and impure (clayband) ores was more fusible and gave a better yield than when each was smelted separately "the one supplying what the other lacked in the form of a flux to run off the combined silica and set free the iron."

Refining furnaces or smithy hearths were also discovered at Wilderspool. One of these, probably of late first, early second century use, consisted of a roughly semi-circular stage or platform, built up from five courses of broken bricks and tiles set in still boulder clay, and enclosing a cylindrical pit or crucible (Fig. 63) lined with calcined clay. This fire-seat or crucible had a diameter of 11 ins. and a depth of 9 ins.; from its base a funnel 6 ins. wide at the top and 2 ins. at the bottom, lined with broken tiles, communicated through a duct with the front of the hearth. This appeared to be a tap-hole for running out the cinder or scoria. On the floor in front of the hearth there was unspent charcoal and a few pieces of cannel coal. Nearby there was a small block of iron and a deposit of "cinder" (iron silicate), and in the wall of the crucible there was a globule of glassy cinder which on analysis was iron silicate, suggesting to May that the furnace was used for the refining of iron.

It will be noticed that the two furnaces in Fig. 62 are of quite different shapes. In contrast with these, a third furnace described in detail by May was T-shaped. He does not describe all the furnaces discovered in the Warrington area, but the existence of these three differing shapes suggests that with iron furnaces, as W.F. Grimes observed with pottery kilns, different types existed side by side.

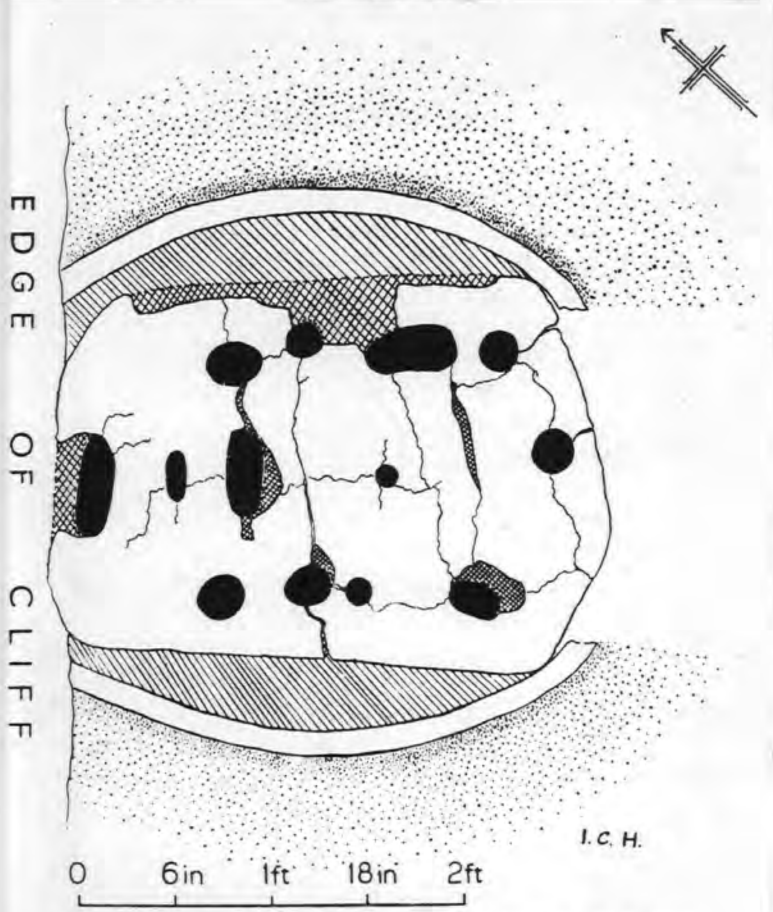

FIG. 64. Plan of furnace, showing circular pit with walls of clay and (dotted) baked earth

Fig.65

A furnace of more advanced design was discovered in January, 1932 when men quarrying iron ore for the Frodingham Iron & Steel Co. unearthed at Woolsthorpe, near Colsterworth in Lincolnshire, a Roman blast furnace or bloomery in a remarkably good condition.(1) It was hand-moulded from clay of the local Upper Lias formation, and the approximate dimensions were length 3 ft., width 23 in., depth increasing from 15 in. at one end to 21 in. at the other, the slope being presumably from the charging end to the pouring or tipping end. The roof (shown in plan in Fig. 64) was roughly arched and was pierced by circular and oval holes. When the furnace was excavated, these holes were covered by pieces of coarse pottery of the first or second century. The furnace sides were at most 6" thick and in the middle of each was a tuyere hole about 6 in. diameter, sharply splayed. One tuyere opening is plainly visible in the photograph(2), Fig.65 (in this picture most of the furnace roof has disintegrated, due to frost). As found, the furnace had been sunk in a shallow pit with segmental spaces at the sides (singly cross-hatched in Fig. 64) evidently to accommodate the bellows for the tuyeres. The earth immediately behind the clay walls of the pit was baked hard, and had obviously been exposed to heat. The furnace had not been subjected to the same degree of heat, so it had probably been reconstructed in readiness for a further campaign which never took place.

Pieces of baked clay firebars, the fragments 4 to 8 in. long, of 3 by 2½ in. section, pierced by holes through their thinner sides, were found near the furnace, with a quantity of charcoal and wood-ash. There were also fragments of ironstone with slag runnings on their surfaces, and two small pieces of iron, one of which had been hammered "to something very near the consistency of the best modern wrought iron".(3) A metallurgical report on this piece reads "The general appearance of the specimen under the microscope gave the impression that the piece had been formed by direct reduction from the ore, and was composed of a number of small pieces welded together whilst working in the hearth. The higher carbon percentage shows that some portions of the piece were reduced from the ore at a higher temperature than others, resulting in a greater carbon absorption, or some of the pieces may have lain for some considerable time in contact

(1) See I.C. Hannah, "Roman Blast Furnace in Lincolnshire," Antiquaries Jour., 1932, XII, 262.
(2) Reproduced from an original kindly supplied by the Stanton & Stavely Sales section of the Stanton Ironworks.
(3) I.C. Hannah, loc. cit..

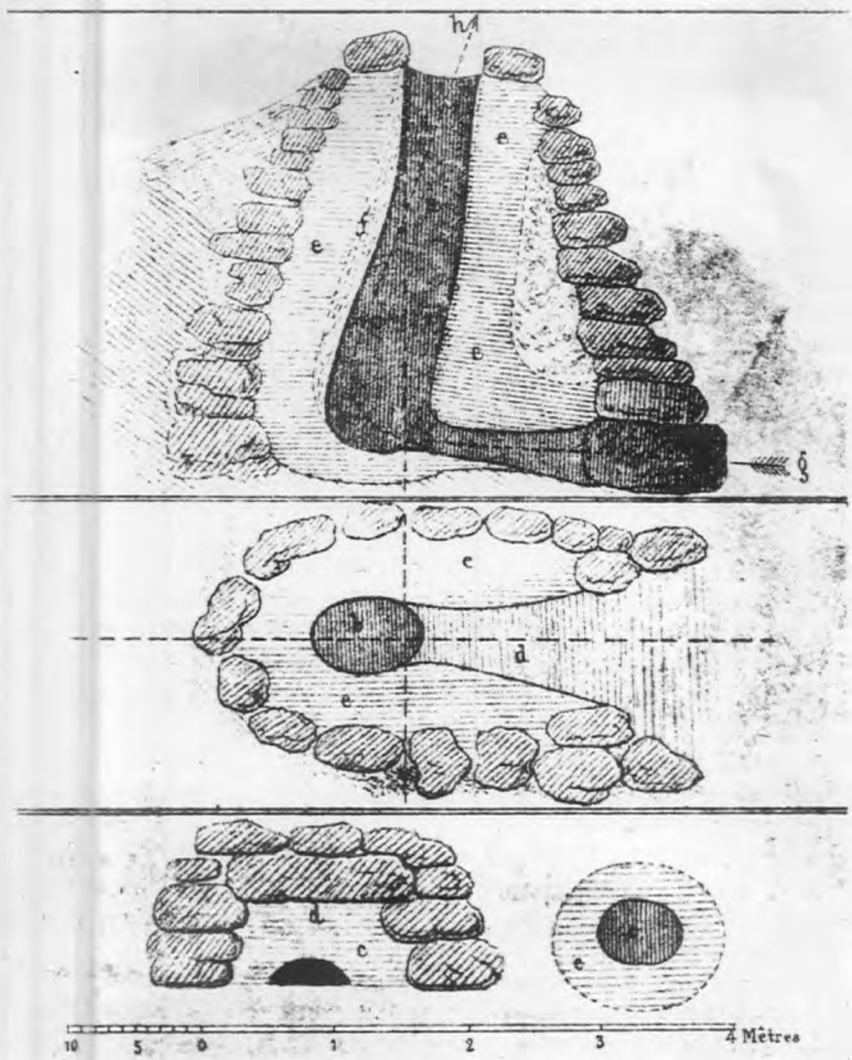

Fig.66a

Fig.66b

with red-hot charcoal and become carburised. When the several pieces were worked together in the plastic condition small globules or pieces of semi-molten cinder or slag would become entrapped in the mass and undergo distortion in the subsequent hammering that was given to the piece of iron. The structure is just what one would expect from a piece of primitive iron made by a direct reduction process."

It will be recalled that the vents in the roof of this furnace were all found to be closed by pieces of pottery when the furnace was discovered. There is an interesting and recent explanation of this.(1) It has been suggested that the bloom of iron, made as described above, was returned to the furnace at night and packed around with charcoal. With the vents closed the fuel would smoulder at red heat and partly carburise the iron to steel.

At Margidunum, Felix Oswald(2) found a series of rectangular pits in which iron had been smelted; lumps of slag containing as much as 40% of iron lay on the clay floors of these pits which had been baked red by the heat. These pits, however, were much larger than that for the Colsterworth furnace. At Colsterworth there was also a quantity of slag, rich in iron, as well as a certain amount of oolitic limestone, possibly used as a flux. Oswald noticed evidence of the use of a flux at Margidunum.

Finally, reference must be made to the "shaft furnace", a type of great antiquity, considered by Quiquerez(3) to date from 1000 B.C.. Quiquerez investigated many remains of shaft furnaces, in the Bernese Jura, near Lake Neuchatel in Switzerland, which may have provided the iron used by the lake-dwellers of La Tène. Fig. 66a is a reconstruction of one of these furnaces, consisting of a roughly cylindrical or oval shaft, about 7 ft. 6 in. high, with thick sides of clay, enclosed within a stone surround, the whole being constructed either in a bank of earth or having earth heaped around it, leaving an opening, 'g', at the foot of the shaft. Quiquerez suggested that the natural wind entered the furnace through this channel, but it is now generally thought that a forced draught, from bellows, would be essential. The slag and the bloom of

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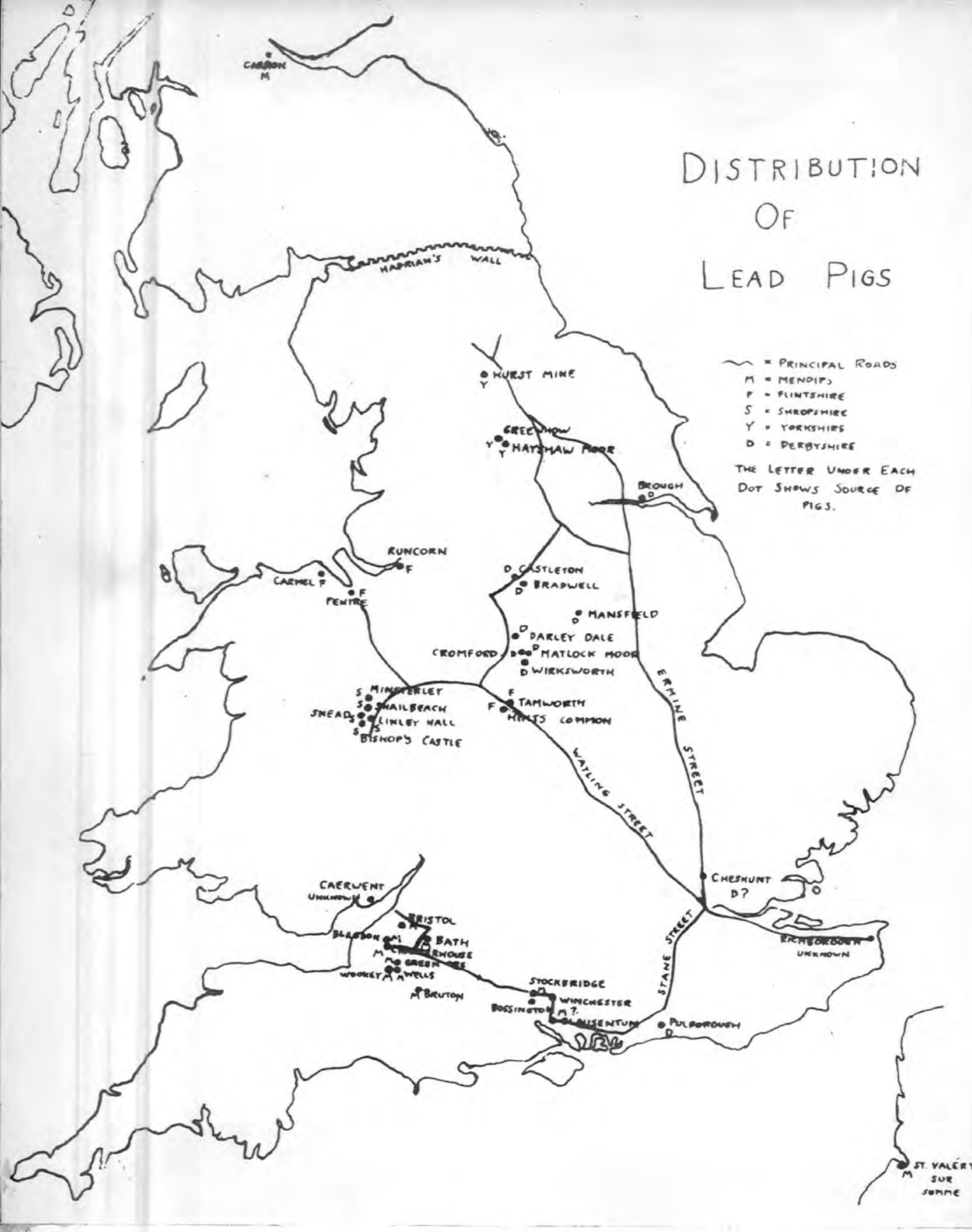
(1) See F.H. Henson, "Discovery", 1951, 12, 283.
(2) F. Oswald, "Report on Margidunum Excavations", (Nottingham Art Museum).
(3) A. Quiquerez, "Notice sur les forges primitives dans le Jura", Mittheilungen der Antiquarischen Gesellschaft von Zurich, 1871; 71.



DISTRIBUTION OF LEAD PIGS
= PRINCIPAL ROADS
M = MENDIPS
F = FLINTSHIRE
S = SHROPSHIRE
Y = YORKSHIRE
D = DERBYSHIRE
THE LETTER UNDER EACH DOT SHOWS SOURCE OF PIGS.
HADRIAN'S WALL
HURST MINE
BROUGH
RUNCORN
CARMEL
PENTRE
CASTLETON
BRADWELL
MANSFIELD
DARLEY DALE
CROMFORD
MATLOCK MOOR
WIRKSWORTH
TAMWORTH
SNAILBEACH
SNEAD
LINLEY HALL
BISHOP'S CASTLE
ERMINE STREET
WATLING STREET
CHESHUNT
CAERWENT
UNKNOWN
BRISTOL
BATH
WELLS
BRUTON
STOCKBRIDGE
WINCHESTER
PULBOROUGH
STANE STREET
RICHBOROUGH
UNKNOWN
ST. VALÉRY SUR SOMME

Fig.67

malleable iron would be extracted through the channel, using a long-handled iron crook. Shaft furnaces have been recorded in Britain at Ashwicken in Norfolk(1), and near Pickworth(2) which is three miles from Great Casterton and two miles from Ermine Street.(3) Fig. 66b shows the three Pickworth furnaces, the centre one of which was unfortunately destroyed. The principle of the shaft furnace may have been brought to Britain by the Celts, who overran the region of the Jura furnaces, possibly taking the art of iron making into France and Britain in their northerly progress. The Belgae, another branch of the same race, crossed the Rhine into northern France about 250 B.C., and according to Caesar invaded Britain, settling chiefly in the south-eastern counties.

<u>Lead: Sites.</u>

Britain must have been one of the chief lead producing regions of the Roman Empire, and its value and status as a rich mining province are attested by the highly profitable efficiency of the silver extraction carried out. Caesar and Strabo, while mentioning British silver, do not mention lead. However, it is mentioned by Tacitus(4) and in particular by Pliny, who says: "Lead is extracted with great labour in Spain and all the Gallic provinces, but in Britain is found in the upper <u>stratum</u> of the earth in such abundance that a law has been made prohibiting any one from working more than a <u>certain</u> quantity of it" (Words underlined are freely translated).(5) Evidence of working Mendip lead, although not of extracting silver, before the conquest of Britain has been discovered in the lake villages of Glastonbury and Meare.(6)

In Roman Britain there were six areas of lead production, the chief archaeological evidence consisting of the numerous lead pigs, bearing cast and stamped inscriptions, which have provided the information we have of mining organisation in the respective areas. The map "Distribution of Lead Pigs"(7) shows the find-spots of Romano-British pigs.

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(1) Norfolk Archaeology, 1960, XXXII, 142.
(2) J.R.S., 1962, LII, 173.
(3) The Colsterworth furnace was also near Ermine Street, and about 7½ miles from Pickworth.
(4) Tacitus, Agricola.
(5) Pliny, Natural History, XXXIV; 49.
(6) R.G. Collingwood, "Economic Survey of Ancient Rome", iii, 42.
(7) Reproduced from R.A. Peel, "Mining and Minerals in Roman Britain", (Univ. of Durham, B.A. Dissertation, 1957, where a list of lead pigs, and a commentary, is given).

The Mendip region has produced very little evidence of actual Roman mining operations, and apart from the information derived from inscriptions on the pigs, the remains of the settlement at Charterhouse provide almost the sole guide we possess of the extent and scope of the mining. The richness of the lead ore is the reason for this; post-Roman and medieval operations have removed all traces of the Roman workings.(1) However, this makes the evidence provided by the settlement all the more interesting, and the building materials at Charterhouse-on-Mendip, and, in particular the amphitheatre, are the only example (with the exception of Dolaucothy) of mining habitations of distinct Roman character.(2) Other British sites are purely native in type. The Charterhouse site has provided fibulae, pottery and coins mainly of the first and second centuries. There are few remains of third century date apart from an inscription to Septimius, but a hoard of coins of Numerian's date was found, together with many coins of Constantine.(3) This evidence, from what was obviously the administrative centre of the mining area, shows an early fourth century revival in working, but the settlement was probably deserted later owing to the insecurity of the Severn valley, which caused abandonment of villas about A.D.330.(4) But it is significant that a considerable number of silver coins dating from approximately the end of the fourth century have been found in, or close to, the Mendip region,(5). Collingwood considers this sound enough evidence that the lead industry was in operation until the close of the Roman occupation of Britain.

The argentiferous lead veins extend from the Wells district, to Worle Hill, north of Weston. The possibility of Roman working at Penpark, in south Gloucestershire, has not been proved.(6) In the Charterhouse district the working seems to have been fairly intensive to judge from the nature of the rubbish heaps from the mining operations. Heaps of ore, finely ground, and slag, show that lead was treated in the district - possibly being brought from neighbouring places where water was scarce. The sites in the Mendip region are(7) "marked by extraordinarily large accumulations of waste material and slags from the dressing

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(1) O. Davies, "Roman Mines in Europe", 148 (Oxford, 1935).
(2) Amphitheatre: Gough, "Mines of Mendip," 36-37.
Buildings: Gough, op.cit., 25-26.
(3) V.C.H., Somerset, I; 334.
(4) O. Davies, op. cit., 149.
(5) Evans, "Coinage and Currency in Roman Britain," Num. Chronicle, Series iv, Vol. XV, 499.
(6) O. Davies, op. cit., 150.
(7) Arch., 1901, LVII, 381-2.

of the ore. So vast, in fact, are these deposits that in recent times and for a long period the chief supplies of lead from the district have been obtained from them. In excavating these heaps for smelting purposes, Roman remains such as mining tools, brooches, weights, coins, fragments of pottery, and the like, have been frequently unearthed."

The second region of lead production was in south-west Shropshire, and the Welsh border, principally centring around Shelve, Snailbeach and Minsterley, near Shrewsbury.[1] "In Shropshire the most important Roman mines were situated on a series of veins of galena on the west of the range of hills known as the Stiper Stones in the neighbourhood of Shelve. The chief excavations, which are of a very remarkable and extensive character, are at the Roman Gravels Mine; where three once open cuttings, each following a vein of ore, extend as huge furrows up the face of the hill and over its crest. Not far distant and next in importance are the Snailbeach and White Grit Mines, with Roman underground workings; but numerous shafts and adits occur all over the district. Others are also to be found distributed somewhat sporadically in the adjacent country, Montgomeryshire".[2] These parts of the lead field are near Llanidloes and Trefeglwys.

The evidence here consists of first and second century coins among slag. The principal numismatic evidence in Shropshire is representative of Pius' reign. In particular, the Montgomery mines contained many stone tools.[3]

The site of the Flintshire mines was in the Halkin Mountain district, about twelve miles west of Chester. "The galena occurs in two kinds of lodes. One is in the form of veins running along faults roughly in an east-west direction and the other consisting of cross courses of later origin about at right angles to the former. The veins tend to produce galena which is richer in silver than that of the iron courses. The richest veins are those of the Prestatyn-Holywell series where the veins have been formed under a cover of shale. It is one of these veins that occurs near the provenance of the lead pig at Carmel".[4].

The chief site concerned with production was the second and third century site of Pentre, on the eastern

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(1) V.C.H., Shropshire, 1; 263.
(2) V.C.H., Shropshire, 1; 383.
(3) O. Davies, op.cit., 159, 156.
(4) Graham Webster, "The lead-mining Industry in North Wales in Roman Times," Flintshire Historical Soc., 1952-53, 13.

side of the Halkin mountain. Here the smelting was carried out; there is no evidence of smelting as early as the first century, so therefore the pigs of Vespasian must have been produced on the mining sites themselves.(1) To the west, lead slag has been found in hill forts at Dinorben and Braich-y-Dinas, of Roman date.(2) At Talargoch the discovery of a coin of Gordian III has been considered not satisfactory evidence of mining operations; the coin could possibly have been left in the mine by natives using the working as a place of refuge in the disturbed conditions of the late Empire.(3) The alleged discovery of tools at Fos-y-bleiddiad cannot be proved.(4)

In contrast with the Shropshire mines, there is in Flintshire no definite discovery of mining tools of established Roman date.(5)

In considering the Derbyshire lead mines we are faced with the same problem as with the Mendip mines: lack of archaeological evidence as far as workings are concerned.(6) Medieval mining has obliterated all definite traces of Roman mining; our evidence is confined virtually to the pigs themselves. The mines appear to have been at Matlock, in Dovedale, and between Wirksworth and Castleton. What Roman remains there are, are mostly fourth century.(7)

In Yorkshire, the Roman authorities worked lead in the West Riding, at Greenhow Hill and Grassington.(8) Sherds have been found in old workings here,(9) and in addition a considerable amount of galena was found in the Roman fort of Slack.(10)

It is accepted that Roman lead working was in existence at Alston, but the evidence is almost negligible; lead sealings exist at Brough on Stainmoor, and perhaps these were of Alston origin.(11) It is well known that a Roman road in the Alston valley is in existence, and a Roman fort there, in which lead and fluorspar are stated to have been discovered, is situated overlooking the mining area.(12)

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(1) O. Davies, op. cit., 159.
(2) Dinorben: Gardner, Arch. Cambrensis, 1913; 191.
Braich-y-Dinas: Hughes, Arch. Cambrensis, 1922; 346.
(3) Graham Webster, op. cit..
(4) Alleged evidence: Smythe, Geological Survey of Cardigan and Montgomeryshire, Vol. 2, Part 2.
Conclusion: Graham Webster, op. cit..
(5) Graham Webster, op. cit.. (6) O. Davies, op. cit., 161.
(7) V.C.H. Derbyshire, 1; 227. (8) R.G.Collingwood, op.cit.iii;45.
(9) Yorkshire Arch. Jour., 1930, xxx, 81.
(10) Barber, Arch. Jour., 1867, XXIV, 289.
(11) I.A. Richmond, "Roman Britain," 153-4, (Pelican History of England, 2nd Edn. 1963).
(12) Fort: "Whitley Castle," Proc.Soc.Antiqs. Newcastle upon Tyne, Series iv, 1924, 1, 249-254.
Lead & Fluorspar: Arch. Ael., Series i, IV, 36.

Lead: Furnaces.

The principal lead ores are galena, lead sulphide, and cerussite, lead carbonate; of these, galena is the more abundant. Metallic lead is obtained from its ores by self-reduction. The ores are first roasted in air to convert them partially to lead oxides and lead sulphate, then a further calcination at a higher temperature, with the air shut off, causes the oxides, sulphate and residual sulphide to react, giving metallic lead and sulphur dioxide, the latter escaping as a gas. Such is the description of the production of lead given in chemistry text-books.

It is the simplest method, and therefore the ancient process must have been more or less identical. Unfortunately no Romano-British lead furnace has survived intact; the remains are fragmentary, although at Pentre, Flintshire, enough was found[1] to show that the foundation of the furnaces was stone blocks laid in clay and partially lined with clay. The furnaces had apparently been used for a series of heats, and were not rebuilt after each heat. A piece of slag was found which could have come from a tap-hole some 2 inches in diameter. Coal had been used as a fuel.

Gowland[2] suggested that the Romano-British lead smelting furnaces were "merely hemispherical holes in the ground, lined with some refractory material but without an outer wall of stones ... They were worked by means of a blast of air from a bellows ... through a twyer of clay resting on the (furnace) edge." He also thought that the layered structure of the lead pigs proved that the lead had been ladled from the furnace. (As will be seen later, the latter assumption was incorrect). Earlier in the same paper[3], however, Gowland says that if the furnace fire were enclosed within a low wall of stones, and a cavity were made in the ground to receive the lead, then "With this primitive arrangement and a slight breeze blowing through the apertures between the stones metallic lead could readily be obtained. The furnaces employed by the Britons were of this character, although in those which have been found the encircling stones have been dispersed and the cavities of the hearth alone remain." Here Gowland is on surer ground, because there is a tradition of lead smelting in the manner he has just described.

(1) Flint Hist. Soc. Trans., X, Part I, 7, 20-22; Part II, 6.
(2) W. Gowland, Arch., 1901, LVII, 398.
(3) W. Gowland, op. cit., 392.

Thus Joshua Childrey writes of Derbyshire lead-smelting[1] "They melt the lead upon the top of the hills that lye open to the west; making their fires to melt it as soon as the west wind begins to blow; which wind by long experience they find holds longest of all others. But for what reason, I know not, since I should think lead the easiest of all metals to melt, they make their fires extraordinary great." (This could well be true, having regard to the need for extra heat in the second stage of reduction). Bishop Watson wrote[2] "there are several places in Derbyshire called Boles by the inhabitants, where lead has been anciently smelted, before the invention of moving bellows by water. These places are discovered by the slags of lead, which are found near them," and Farey remarks[3] "The sites of these ancient Boles or wind-smelting places are easily found, from the sterility of the spots, and the want of any herbage except a few minute weeds upon the ancient slag and ashes." Boles, termed Bayle Hills, also occur in Northumberland, Cumberland and Durham, according to Westgarth Forster[4] and they were simply piles of stones placed around a fire, on the western brow of a hill, and so arranged as to leave openings for the admission of air and the escape of the products of combustion. Fuel was supplied from the neighbouring woods "Which on that account were called Hag-hill or Hag-bank".

Wind-smelting is quite feasible, since lead does not require as high a smelting temperature as iron; and, for reasons to be given when the casting of lead ingots is discussed, the furnaces must have been capable of being tapped. Therefore, if we combine the Pentre furnaces with Gowland's earlier description and also those of the 17th and 18th century writers, a rough picture of a Romano-British lead-smelting furnace emerges: a stone hearth covered with clay, rough stone walls lined with clay, but with openings through the stones and the clay to admit wind, a tap-hole near the hearth, and a clay cover over the furnace partly because heat has to be conserved but also because all openings must eventually be sealed for the final stage of the process.

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(1) Joshua Childrey, "Britannia Baconica: or, The Natural Rarities of England, Scotland and Wales," 112 (London, 1661).

(2) Bishop Watson, "Of the Smelting of Lead Ore, as practised in Derbyshire," Chemical Essays, 1782; quoted by John Percy, "The Metallurgy of Lead", 214-5, (London, 1870).

(3) John Farey, "General view of the Agriculture and Minerals of Derbyshire", I, 382, (London, 1811).

(4) Westgarth Forster, "A Treatise on a section of the Strata from Newcastle upon Tyne to the mountain of Cross Fell, in Cumberland", 364 (Alston, 2nd ed. 1821).

The Casting of lead ingots

The apparently laminated structure of Romano-British lead ingots, as shown by the horizontal markings on the side and end surfaces of many specimens, aroused curiosity at an early stage in archaeological enquiry. At one time it was suggested that they were reproductions of the grain of wood used as a pattern for the mould,[1] but in later years the striations have been regarded as evidence for the piecemeal casting of the ingots by ladling lead from the furnace. W. Gowland[2] advanced this view in 1901, and later writers have repeated the idea, even going so far in one instance as to calculate the capacity of the ladle used to make certain ingots.[3] However, experimental evidence and practical experience do not support the hypothesis of piecemeal casting.

Thus, when discussing the ingots found at Brough-on-Humber in 1940, J.A. Smythe[4] said "... the moulds were filled by continuous teeming of the metal, such as would result from the tapping of a furnace with a capacity at least equal to that of the mould".[5] G. Clement Whittick has now disclosed[6] that this statement was based on the results of a long series of experiments in which lead was cast into small moulds, made variously from sand, copper, marble, heat-insulating brick, and from fireclay (either dried or baked at 800° - 900° C), the casting being over a wide range of temperatures and at various pouring speeds. The surface appearance of the sides and ends of experimental ingots cast in this way, i.e., by a single steady uninterrupted pour, was found to vary according to the casting temperature.

(1) J.B.A.A., 1860, XVI, 350; Haverfield, V.C.H., Shropshire, 1908, I, 264.
(2) Arch., 1901, LVII, 398; also discussion in Proc. Soc. Antiqs. 1918, XXXI, 39.
(3) Those found at Green Ore on Mendip, reported in J.R.S., 1957, XLVII, 230; calculations made by L.S. Palmer & H.W.W. Ashworth, Proc. Som. Arch & Nat. His. Soc., 1956-7, CI - CII, 52-88.
(4) Then Reader in Metallurgy, King's College, University of Durham.
(5) Trans. Newcomen Soc., 1939-40, XX, 139.
(6) "The Casting Technique of Romano-British Lead Ingots", J.R.S., 1961, LI, 105. Whittick initiated the casting experiments after he had noticed that blocks of linotype metal, cast in one operation, exhibited surface markings similar to those on Roman ingots.

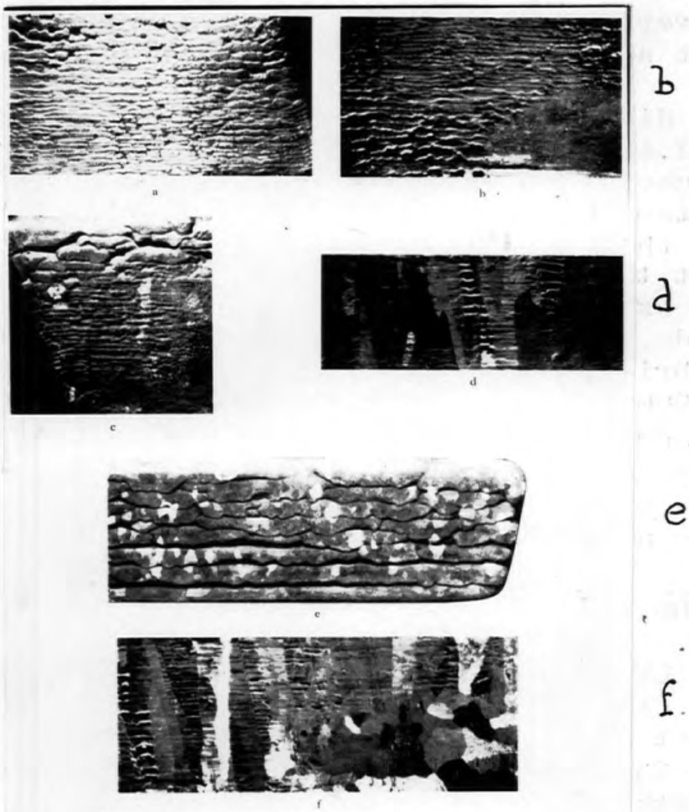

Fig.68

of the metal.

In explanation, Whittick says "The melting point of lead is 327° C. When a temperature considerably higher than this - say approximately 450° to 500° C. - was evenly maintained, these surfaces tended to emerge clear and relatively smooth throughout, showing fully in each of these areas what may be called 'flats'. Such 'flats' are thus produced when the molten lead is tapped at a temperature sufficiently high to enable it not to freeze immediately at any point where it comes into contact with the mould. But when the molten lead was poured at lower temperatures completely different surface effects appeared. In such conditions the lead freezes where it comes into contact with the side of the mould, forming there a curved meniscus outline similar to that of pure mercury in contact with a sheet of glass. Thus, at any moment, once casting has begun there is always a frozen fringe, or series of fringes, of meniscus all round the inner surface of the mould; as pouring proceeds, the level of the molten mass within these fringes, towards the centre of the mould, continues to rise until a further quantity floods across to form in turn at the side of the mould its own frozen meniscus, of which the lower edge is held back by the edge of the frozen fringe already there present. It is this process, constantly repeated as the mould is filled up, which is the true explanation of the apparent 'stratification' or 'lamination' of lead ingots, this being no more than a surface effect, essentially a contact phenomenon which involves no discontinuity of the metal within the body of any ingot cast entirely in one operation with a constant and uninterrupted flow. Such an effect may therefore more conveniently be known as 'striation', since no true strata or laminae are involved."

The various stages are illustrated in Fig. 68 (photographed from Whittick's paper[6]): 'a' shows typical fine striations corresponding to fairly hot metal; in 'b' the lead has been hot enough to form a 'flat' in the right-hand corner region whilst fine striations persist elsewhere. 'c' illustrates the effect of progressively decreasing the rate of pouring, so that the metal becomes more and more chilled by the mould: the striations change from fine at the bottom of the mould to coarse at the top. In 'e' the effect of low metal temperature has been exaggerated by making a slow pour of cool metal (c. 360° C.). To show that the striations are purely a surface effect, the metal in 'd' has been etched, revealing that the long crystals pass right through the striations. Specimen 'f' is also etched, and is of particular interest because there is a 'flat' in the lower right-hand corner: the cooler parts of the casting have favoured the growth of long crystals (again their continuity is unaffected by the striations), whereas in the hotter 'flat' there are granular crystals.

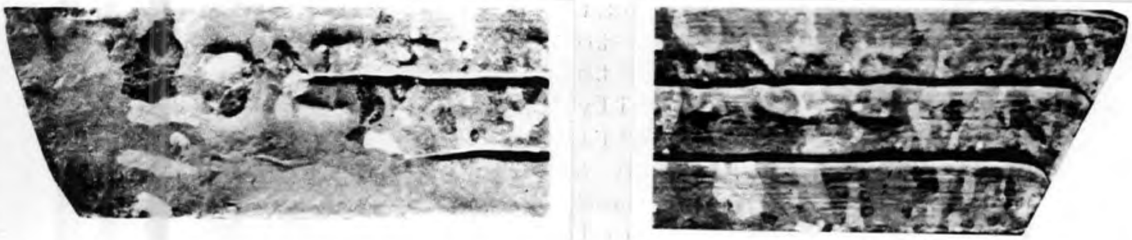

Fig.69

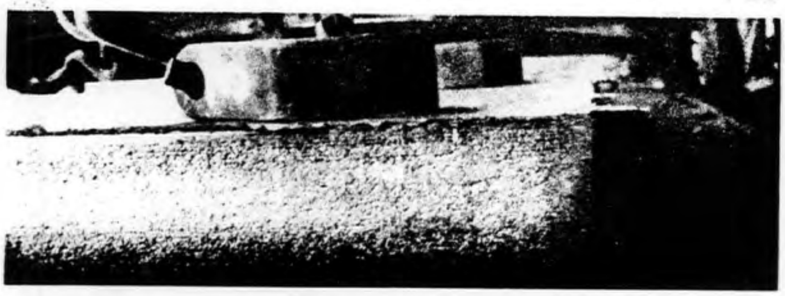

Fig.70

Fig.71

When the pouring is intermittent, and each layer of lead in the mould is allowed to solidify before the next is poured, a penetrating line of demarcation can be seen between the individual layers. The penetration is not complete, i.e., the layers are not completely separated, because the incoming metal of each new layer partly melts the solid surface of the previous layer, resulting in a kind of autogenous weld which binds the layers together. The higher the temperature of the incoming metal, the wider is the area of the weld. Nevertheless, there is always a sufficient peripheral gap between the layers to permit of their being separated by a few blows with a chisel, and the gaps are quite different in character from the striations which occur when the pouring is continuous. Thus Fig.69 shows an ingot cast in three separate operations with intermediate solidification: the right-hand view illustrates the deep 'laminations', the left-hand picture shows the welding together of the layers at the pouring point. It is interesting to observe that fine striations are visible on the individual layers; thus in the one specimen we have a demonstration that striations denote continuous pouring, and laminations indicate intermittent pouring.

In further support of his argument, Whittick reproduces (Fig. 70) a photograph of a modern lead ingot weighing 12 tons and measuring 10 ft. x 9 ft. x 9 ins. cast by the (normal modern) method of continuous pouring, in the Elswick Works of Associated Lead Manufacturers: the picture "gives convincing evidence that such methods produce striations and 'flats' of precisely the kind observable on Roman ingots".

In the course of his paper Whittick discusses many Romano-British ingots which provide evidence that continuous casting by tapping was a standard procedure, and he retracts his earlier support[1] of the 'piecemeal filling of moulds' theory. Amongst the ingots considered are some which have an internal contraction pipe, a feature which would be impossible if the ingots had been cast by intermittent pouring. The Richborough ingot[2] (Fig. 71) is one showing a pipe. Whittick's paper is an outstanding contribution to the study of Roman technology.

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(1) See his "Roman Mining in Britain", Trans. Newcomen Soc., 1931-2, XII, 62.

(2) J.P. Bushe-Fox, "First Report Richborough", Soc. Antiq. Research Rep., 1926.

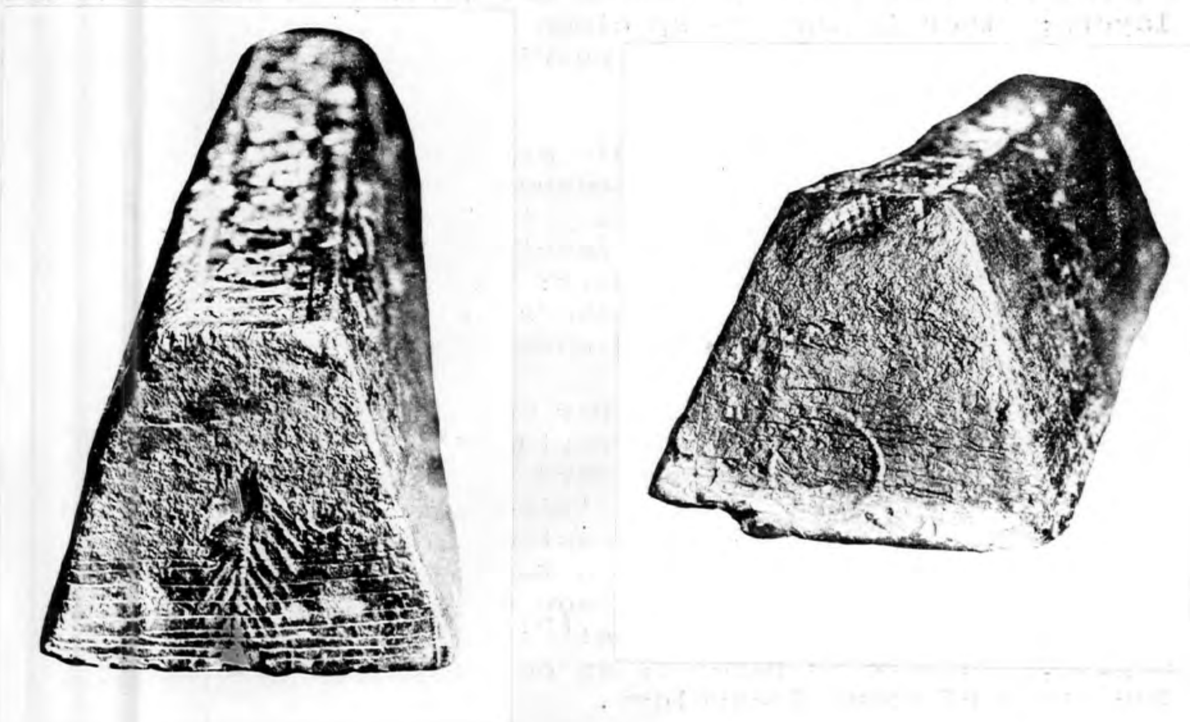

Fig.72

The Desilverisation of Lead

Lead can be desilvered by melting it at a low temperature on a sloping hearth so that the lead slowly flows away from the more infusible impurities copper, antimony, silver and so on. The process is known technically as liquation. The residue of impurities, containing the silver, is then reheated on another hearth at a higher temperature. All the contained metals, except the silver, then become oxidised and the oxides are either blown away or become absorbed into the hearth; the silver, which does not oxidise, remains behind as metal. This procedure is "cupellation". Analyses of specimens of pre-Roman lead shows that no desilverisation was attempted, whereas the Romans seem to have desilvered all their lead.(1)

Some pigs of lead bear the letters EX ARG or EX ARGENT. There has been considerable speculation about this. Does it mean "from the silver works" or does it mean that the lead has been desilvered? J.A. Smythe has shown (2) that some of the Derbyshire pigs marked EX ARG. could never have been cupelled, and that two pigs from Brough actually have embedded fragments of galena which could not possibly have survived cupellation. Thus the most likely meaning of EX ARG(ENTARIIS) is "From the silver works."

Whittick states that the possibility of supervision by mint officials in Mendip and Shropshire, at least in the second century, is suggested by the presence on the side of all the extant Shropshire pigs, and on the Mendip pig of Antoninus Pius, of a palm branch done in the casting - an emblem appearing at a later date on coins and bar gold as the official mark of the senior assay supervisor - and of a hammer mark with reticulated pattern (impressed after casting) on one Shropshire pig and on the Mendip pig. This last pig also has a circle cast on the other end.

The end faces of the Mendip pig are illustrated in Fig. 72 . The left-hand picture, in addition to the palm-branch, clearly shows the casting striations discussed under "The Casting of lead ingots."

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(1) G. Clement Whittick, "Roman Mining in Britain", Trans. Newcomen Soc., 1931-32, XII.
(2) J.A. Smythe, Trans. Newcomen Soc., XX, 142.

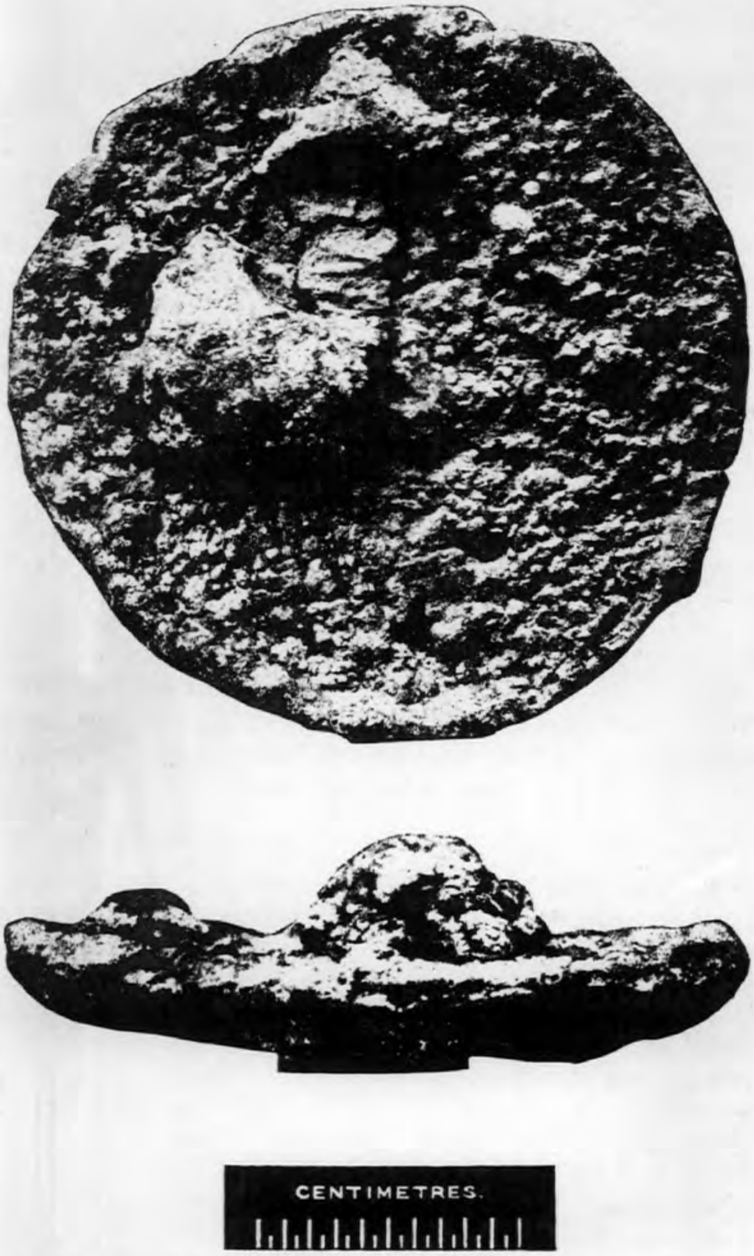

Fig. 73. Roman cake of copper, found at Amlwch, Anglesea. British Museum.

Copper: Sites

In Roman Britain copper was mined in Caernarvonshire and Shropshire. In Caernarvonshire the two areas were Amlwch in Anglesey, and at Great Orme's Head. The evidence is limited, and principally consists of a number of flat, round cakes of copper which have been discovered in North Wales and Anglesey. About fifteen have been found in the north and west of the island, some on sites of Romano-British settlements. These "bun-ingots" are circular, between 11 and 13 inches in diameter and 1½ to 2½ inches thick. The weight varies from about 25 to 50 lb.. A typical specimen, found together with two others at Amlwch, Parys Mountain, Anglesea, is shown in Fig. 73 . Its weight is 26 lb. 12 oz; diameter, 115/8 ins., thickness, about 1½ inches. Other bun ingots have come to light at Criccieth, on the south coast of Caernarvonshire; beside Carnedd Llewellyn, and a portion of one somewhere in North Wales.(1) In addition one has been found near Carleton, Wigtownshire, on the south-west coast of Scotland.(2) There are inscriptions on some of these copper cakes, but it is not possible to derive much information from them. There are no emperors' names inscribed, only what appear to be shortened versions of the names of private individuals: IVLI, IVLS, SATV or SACV. One, however, is inscribed SOCIO.ROMAE(3); this is considered to be a reference to a mining company and therefore the mines must have been leased to "conductores" or other private lessees.

In Anglesey the bun ingots are found in association with village settlements, as stated above. The principal one is Amlwch near Parys Mountain, although mining activity is known also at Aberffraw and Pengarnedd. As far as we can say no large industrial site was in existence: the ore was collected and presumably smelted somewhere in the villages themselves. W.O. Stanley says of Parys Mountain: "In the workings ...... are large boulders from the sea shore, bearing traces of having been used as pounding stones. Some of these are notched and grooved round the centre, for the purpose of fastening handles to them, bound probably with twigs or sinews. Charcoal was also found in abundance, as described by Tacitus. The early workers first heated the rock, then cast water on it, after which they easily detached the ore with stone hammers". "It does not appear that the

(1) R.E.M. Wheeler, Prehistoric & Roman Wales, 271-272.
(2) Proc. Soc. Antiqs. of Scotland, 1931-2, LXVI, 343.
(3) Corpus Inscriptionum Latinarium, VII, 1199, 1200.
Ephemeris Epigraphica, IX, 1258-1261.

Romans worked to any great depth; the process used by them was mostly surface working, as the ore thus obtained is usually more carbonaceous, and easier to smelt than the present ores, which require all the present appliances of art and skill to reduce them to metal."(1)

Copper mining in Anglesey has been associated, by one modern authority, with the continued occupation of the Caernarvonshire fort at Segontium after 367 A.D., although Chester was not occupied after this date. Habitation of the fort continued until 383. The fort, together with naval stations there, and at Holyhead, would guard the transports against raiders.(2) "That the mineral wealth of Anglesey in a great measure tempted the Romans to establish themselves in Mona, may indeed be argued with a fair probability of truth". "Copper, in Rome, was an article of the first necessity and being largely used in the manufacture of bronze and brass, and the supplies limited, each consignment from Britain was probably bought up with eagerness".(3)

The other Caernarvonshire copper mining site was at Great Orme's Head. Here there is evidence of mine workings (caves in this case) being inhabited, and the general character of the evidence shows third and fourth century working.(4) "Roman exploitation is shown by an Aurelianic coin from one working, a hoard ending at Carausius at the mouth of another, and coins of about A.D.330 in the vicinity The discovery of bones makes it probable that the men dwelt inside the mine as at Llanymynech".(5)

Copper: Furnaces

There is apparently no record of a Romano-British furnace for smelting copper; what evidence there might have been has presumably been obliterated by subsequent working on the same sites, and all we have left are the finds of bun ingots, or cakes, of the metal itself.

Gowland states that the cakes in North Wales were "obtained by smelting ores consisting largely, if not wholly, of pyrites or sulphides." He continues with a discussion of the furnaces probably employed: "presupposing that each

(1) W.O. Stanley, Arch. Jour., 1873, XXX, 59.
(2) I.A. Richmond, "Roman Britain", 155, (Pelican History of England, 2nd ed. 1963).
(3) W.O. Stanley, loc. cit., 59, 74.
(4) I.A. Richmond, op. cit., 154.
(5) O. Davies, "Roman Mines in Europe", 157, (Oxford, 1935).

cake was the result of a single smelting operation, then the furnace cannot have been more than about eighteen inches in diameter and twelve inches in depth. Its interior must have been a conical or hemispherical cavity, lined with a mixture of clay and charcoal ...... It was undoubtedly worked by an artificial blast of air, from a bellows or blowing machine of some kind, which was conveyed into the furnace by one or more blast pipes which rested on the edge of the cavity. The ore, which consisted chiefly of copper pyrites, would be prepared for smelting by expelling the greater part of its sulphur by calcining or 'burning' it in heaps piled up over faggots of wood. The calcined ore was then gradually charged into the furnace in alternate layers with charcoal, until sufficient had been added to produce, when smelted, one of these cakes of copper. When the whole was melted the last slag was removed and the molten copper loaded into a cavity in the ground near the furnace. The metal was certainly not tapped out of the furnace, as the operation of tapping copper is one of considerable difficulty, and would, moreover, have been impossible in the furnaces without greatly injuring if not destroying them".(1)

Commenting on the cakes of copper, Gowland writes that they "bear in their form and characters an unmistakable record of their history. They, as well as several others which have been found, are of the same shape, circular, with a slightly convex base and a rough flat top. The surface of the top is extremely irregular, being covered with vesicular-rounded bosses and having one large crater-like prominence near the centre. This peculiar structure is not due to the sluggish flow of the last portion of the metal, as has been stated by some writers, but has been produced in the following manner: During the gradual solidification of the cakes sulphurous acid gas has been freely evolved, and in escaping has thrown up the greater part of the surface of the copper into the rough vesicular bosses, and the portions last fluid into the large crater-like humps. This phenomenon is technically termed 'rising', and is seen daily in all copper works."

Tin

It is well known that tin was being mined in Cornwall in pre-Roman times. Herodotus mentions the "Cassiterides" or tin islands, and Posidonius and Diodorus in the early first century B.C. refer to Cornish tin. A trade route between Britain and the Mediterranean is definitely established from these sources. Strabo, writing about the time

(1) W. Gowland, Arch., 1899, LVI, 289.

of Christ's birth, besides mentioning the Cassiterides, speaks of the Phoenician trade with Cornwall. Later the sea route was used by the Carthaginians.

Just prior to the Roman occupation tin was used in coinage in Britain.(1) However, fairly conclusive evidence of tin working of the first century B.C. has been found on various sites - slag at Chun Castle and Penwith,(2) tin and high tin bronze at Kenidjack Castle,(3) at Redmoor near Luxilian tin slag and metallic tin with early La Tène fibula, and at Trevelgue Head Fort near St. Columb Minor a clay lined furnace pit with copper and tin slag.(4)

With the Roman occupation, even although Cornish tin was fairly well known - Caesar mentions it(5) - its exploitation dwindles considerably and exports seem to be a thing of the past. Modern writers assume that the conquest of Spain by Augustus, and consequent development of Spanish mining resources, together with the exploitation of the placer deposits in Galicia, supplied the wants of the Mediterranean.(6) Nevertheless, the Roman authorities seem to have maintained some interests in the Cornish deposits; some of the sites of La Tène date were occupied in Roman times, and objects of the early Empire have been found in proximity to the tin streams.(7) The most striking evidence was found at Tregear, near Bodmin - a fortified Roman enclosure housed potsherds and coins of the Flavian period. In the same area, at Boxarne, Roman objects of the first and second century were discovered.(8)

Extensive Roman development begins about 240 A.D. Milestones from Gordian III, Gallus, Volusian, Postumus, Licinius, Constantine have been discovered.(9) These coincide with the period of decline of the Spanish mines from 270 to 300 A.D. Hoards of coins in Cornwall, and discoveries of pewter and tin vessels not only in Cornwall but other parts of Britain, appear.(10) An example found among a

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(1) O. Davies, "Roman Mines in Europe", 146, (Oxford, 1935).
(2) Leeds, Arch., LXXVI, 205.
(3) Borlase, Arch., XLIX, 181.
(4) O. Davies, loc. cit..
(5) Caesar, "De Bello Gallico", V, 12.
(6) O. Davies, op. cit., 147.
(7) Borlase, "Observations on the Antiquities of Cornwall", and "Historical sketch of the Tin trade of Cornwall".
(8) V.C.H., Cornwall, 5; 4-5.
(9) I.A. Richmond, "Roman Britain", 156, (Pelican History of England, 2nd ed. 1963).
(10) V.C.H., Cornwall, 5; 21-26.
Pewter cup: Carew, Arch., XVI, 137.
Tin: Borlase, Arch. Jour., 1873, XXX, 325.

collection of tin and pewter ware at Appleshaw, Hampshire, was an ornamental oval dish originally nine inches long, with a tin content of 99.18%. "It consists of practically pure tin, which was doubtless first used in Britain without the addition of lead in the fabrication of vessels."(1) Finally, from Carnanton there is an ingot stamped "DDNN". This must have belonged to a period of co-regency in the fourth century.(2)

The extremely limited evidence of habitation seems to show that Roman settlement in Cornwall was confined to the establishment of a trading post.(3)

Gold

The earliest gold deposits known in the British Isles were in Wicklow, and these are considered to have been worked out by the beginning of the Iron Age.(4) Thus Strabo and Tacitus were referring to other mines when they mention British gold; the Irish product could hardly still be exported at this time when it is borne in mind that even in Ireland gold objects of the La Tène period are rare.(5)

It has been said that gold was obtained from alluvial deposits in rivers in Cornwall, and in Leadhills, Lanarkshire, Scotland;(6) it is significant that in modern times small quantities have been found on these sites, but whether the Romans actually exploited these placers is very uncertain. The ore-gold mine in Roman times in Britain is at Dolaucothy, Carmarthenshire, south-west Wales. Incidentally, the only modern gold mine in Great Britain is at Dolgelly, in North Wales: the gold is obtained from quartz veins as at Dolaucothy. The Roman origin of the Dolaucothy mines was doubted for many years, and has only been established recently. "Apart from the settlement evidence in the valley, the use of cross cuts and of an aqueduct, the graffiti on the gallery walls, the heavy iron hammer and the numerous mill-stones are all features which can be paralleled in Roman times. It is significant that the closest resemblances are to Dacia, where gold mining flourished in the middle of

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(1) Arch., 1897, LVI, 7.
(2) O. Davies, op. cit., 148..
(3) V.C.H., Cornwall, 1; 522.
(4) R.A.S. Macalister, "Archaeology of Ireland", 17.
(5) Tacitus, Agricola, 12; 6.
Strabo, Geography, IV, V; 2.
R.A.S. Macalister, op. cit., 148.
(6) Rutley, "Elements of Mineralogy," 252, (London, 1953).

the second century, a date not far removed from that given by the finds at Dolaucothy villa. Nor does it seem that the cross cuts slope the wrong way, and so could not be used for drainage, a piece of clumsiness that it might be difficult to ascribe to the Romans. The upper adit is now closed, but the lower is level so far as can be judged by the eye, and the water seems to flow slowly outwards. Along the left side it is paved with large roughly set slabs, to afford a dry walk. This is a variation of the combination of drainage and haulage adit found at Rio Tinto".(1) The hoard of gold ornaments found close to the workings are considered of second and third century date, and the deductions from the very limited evidence of pottery and a clay lamp found on the site, are that working before the end of the first century and continuing to the end of the second century, or later, was probable.(2)

The site is in the upper valley of the River Cothy, a tributary of the Towy; in Roman times it lay roughly between the forts at Llanio and Llandovery, near to the eastern edge of the military road between these two points which led to the legionary base at Caerleon along the valley of the River Usk. The visible surface features of the mining operations extend for a mile along the south-east side of the Cothy Valley. The most obvious remains are scattered heaps of waste material and the two large open cuts.

The Roman miners first of all attacked the rock, (veins of auriferous pyrites at an angle of 20°), working open cast to a depth of thirty feet. The workings were then continued underground; the entrances to some of these are still evident on the rock face. The two drainage adits were six feet high and were driven through one hundred and eighty feet of sterile rock. The workings descended to a considerable depth, one stope discovered was eighty feet below any known adit. One writer says that the workings were abandoned because the ore had become too poor to repay further expenditure.(3) The evidence for tools used is composed of iron gads and sledge hammers. The workings show signs, too, that fire setting was probably used to assist in driving. The propping and drainage of the mine have been discussed already. One of the cup-marked stone blocks used for crushing the ore can still be seen, it is named the "Carreg Pumpsaint" (cf. the block at the Gogofau mine, page 84). The ore was milled by rotary querns.

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(1) Arch. Cambrensis, 1936.
(2) Nash-Williams, "The Roman Gold Mines at Dolaucothy, Carmarthenshire", Bull. Board of Celtic Studies, 1950, <u>14</u>, Part 1, 80.
(3) O. Davies, "Roman Mines in Europe", 154, (Oxford, 1953).

Other discoveries were part of a stone mortar, some earthen pots and crucibles, part of what appears to be a wooden haulage sledge, and in particular a stone with the inscription PCXXV-P (EDES or PASSUS). Presumably this records a length of constructional work, done maybe in connection with the mine.

An aqueduct for washing gold dust and for general use in the mine was cut out of rock, tapping the river eight miles higher up the valley, and then it descended in a steady gradient along the south-east side to empty into settling tanks and a reservoir immediately above the main workings.

The apparent remains of a bath building are also situated close to the south-east bank of the river about three hundred and fifty yards south of Pumpsaint. They consist of two hypocausted rooms, with plain tessellated pavements. Objects of the first and second centuries are associated with this site. This bath house indicates the existence of a settlement; and the gold ornaments, indicating that goldsmiths were attached to the site, supports this. Perhaps it was not merely a coincidence that the regiment in the Llanio fort ten miles away, was the second cohort of Asturians, recruited originally from north-west Spain, one of the principal gold mining regions of the Empire.[1]

Davies considered that the Dolaucothy mine illustrates the most technically advanced methods of the Romans.[2] The extent of the evidence supporting a Roman date for the mine makes the theory of a mediaeval origin impossible; it is worth noting that the only mining operations in Britain under the Normans are "shallow grubbings with no scientific technique.[3]

Silver refining

The process of refining silver is based on the facts that silver does not oxidise, and that it can readily be alloyed with lead which does oxidise. The impure silver and some lead are melted together and the resulting alloy is then heated in a blast of air which oxidises the lead (and any other metallic impurities). Some of these oxides blow away, while the remainder are absorbed by the hearth on which the operation is performed; the silver is left behind as pure metal. If the hearth is made of calcium phosphate ("bone ash") the absorption is exceptionally efficient, particularly in the

(1) Nash-Williams, op. cit..
(2) O. Davies, op. cit., 155.
(3) Arch. Cambrensis, 1936.

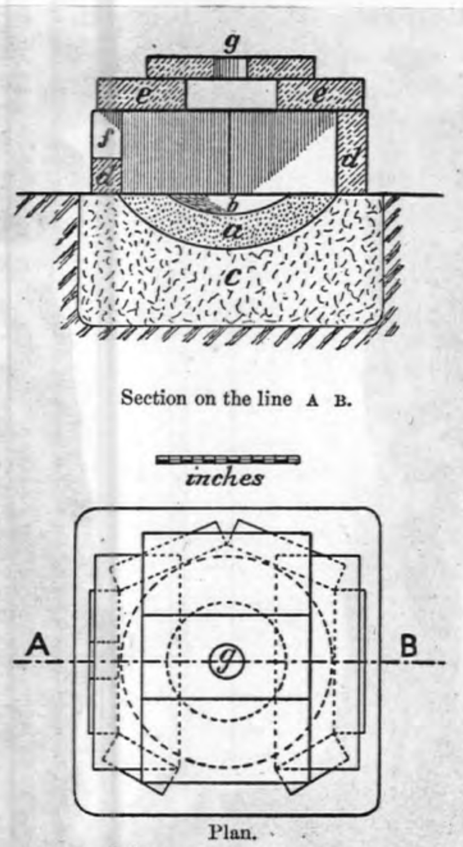

Fig. 74 Roman cupellation furnace.

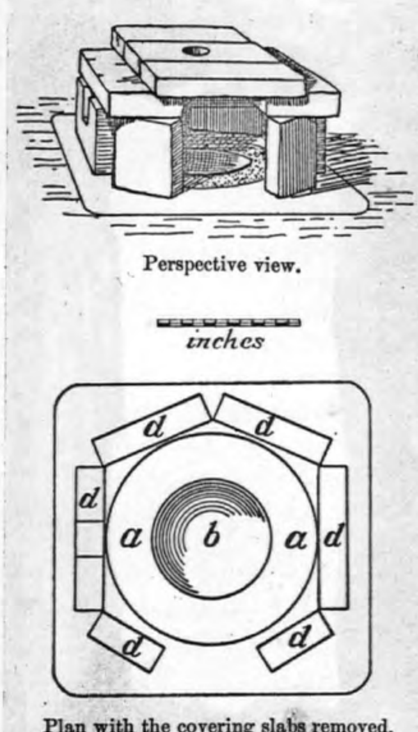

Fig. 75 Roman cupellation furnace.

case of lead oxide. This refining process, itself a cupellation, can be done on impure silver from any source, and it would follow the primary cupellation carried out in the case when the silver is being obtained as a by-product from lead smelting (see page 70).

It was thought that the Romans knew only of hearths of clayey marl - which have a limited absorptive capacity - for refining silver, until some metallic cakes found in two houses and a shop at Silchester in 1894 were analysed. It was then found(1) that the specimens were saturated with lead and copper oxides, and that they had a relatively high content of calcium phosphate. This at once suggested bone ash, and the presence of a small globule of silver embedded in one of the cakes showed that here, for the first time, was evidence that a bone ash hearth had been used in a cupellation process for refining silver. One of these hearths was so porous that part of the original alloy had sunk into it without first becoming oxidised. The alloy was argentiferous copper, very like that of the coins issued during the third century period of inflation, and in support of this the Silchester Collection in Reading Museum contains a few coins of Carausius (287-293) partly melted down.(2)

Gowland(3) in Figs. 74 & 75 has attempted on metallurgical grounds to conjecture how these cupellation or refining furnaces may have been constructed: The metal to be cupelled would be placed in cavity 'b' on charcoal resting on the bone ash hearth 'a' (renewed after each operation) which is supported by clay or marl 'c'; 'd' and 'e' are side walls and a cover, respectively, of clay slabs; 'f' is an aperture to take a pipe or tuyere from a bellows.

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(1) W. Gowland, Arch., 1900, LVII, 313.
(2) R.C. Boon, "Roman Silchester", 190, (London, 1957).
(3) W. Gowland, loc. cit..

MINING.

Mine Construction.

In winning most of their ore from deposits near the surface in this country, the Romans had no need of extensive underground mine workings. Thus coal was mined opencast, and no direct evidence exists of working underground. The evidence we have of shafts and adits in British mines is small, but there is no doubt that in certain instances they were found necessary to work a vein of ore out thoroughly. In ancient and Roman times shafts were sunk at close intervals, passages or caves leading off.(1) This was done in preference to sinking one or two shafts and making underground tunnels, which was difficult to accomplish and took a long time. In Spain, at Aljustrel, mining law decreed that five shafts had to be sunk in each concession issued to private contractors; perhaps to ensure a thorough exploitation of the area of ground.(2) Whether a legal reason existed for any types of mine construction adopted in Britain is unknown.

In mine construction, the ancient method of sinking shafts was as follows:(3) Using a pick, the workmen excavated vertically, cutting deeper on the side where the vein of ore was situated, and where, through their general knowledge, they knew the rock would break at the point of contact. Thus the striations on the side walls of the shaft became increasingly diagonal. The wall opposite the vein was not cut back at first, but instead as work progressed the miner removed about two inches of rock nearly to the floor of the shaft to prevent it contracting. This operation leaves evidence in the form of vertical tool marks on the wall in question. Beam holes were cut out as the shaft descended.

Archaeological experience has shown that ancient galleries were small and narrow, and the vein of ore was laid bare in the most convenient and quickest way. Thus, using tools, the rock was chipped up to the hanging, or foot wall, which would split easily. However, this method of

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(1) O. Davies, "Roman Mines in Europe", 19, (Oxford, 1935).
(2) H. Louis, "Some Aspects of Mining Laws under the Roman Empire", (Univ. of Durham Phil. Soc., 1921).
(3) O. Davies, op. cit., 21.

working meant very slow progress, and for driving a gallery the method known as "fire-setting" was widely recognized in ancient times.(1) Whether any sort of battering ram was ever employed in this country is not known. In fire-setting the rock was heated and then cooled rapidly with water; this caused the rock to split more easily when tools were used on it. Pliny mentions Roman miners using vinegar instead of water, as it was a better agent for splitting the rock.(2) One modern authority, commenting on a theory that the vinegar was possibly poured into holes cut into the rock, sealed up and then heated, the resultant explosion (caused by the violent evolution of carbon dioxide) fracturing the rock, says that the explosion would more certainly blow the seal out than break the rock.(3) Agricola mentions fire-setting, although he does not refer to the cooling of the rock by artificial methods.

In the iron mine at Lydney, in the Forest of Dean, the workings were cut through ferruginous marl, following joints in the dolomite.(4) A particular working found was a very narrow passage between eighteen and twenty-four inches wide, one of many similar workings situated on a hill.(5) In the Forest of Dean, the Romans first sank a large pit between twenty and thirty feet in diameter and then followed up the vein of ore which had thus been laid bare.(6) The iron workings in the hills of the Dowards, in Hertfordshire, have been described as follows: "The entrances through the caverns are still the objects of curiosity, and although now clogged up, they have been entered and a succession of chambers discovered and rude galleries running in more than one direction".(7) In the copper mine at Llanymynech, Shropshire, the miners lived in a cave from which ran galleries with ventilation shafts. This is an account of these workings and others at Clive, near Grinshill: "Some of the shafts and passages discovered were extremely sinuous, extending as much as two hundred yards. They were usually from a yard to

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(1) O. Davies, op. cit., 20-21.
(2) Pliny, "Natural History," xxxiii; 4,71; II, 49, 132.
(3) O. Davies, "Roman and Mediaeval Mining Technique", Trans. Inst. Mining & Met., 1933-4.
(4) O. Davies, op. cit., 153.
(5) R.E.M. Wheeler, "Excavations at Lydney", 1932, 18-22.
(6) R. Hunt, "British Mining", 28, (London, 1884).
(7) R. Hunt, op. cit., 28.

three yards wide, and occasionally developed into broad and lofty chambers. The long passages frequently terminated in small holes about the size to admit a man's arms, as if the strips of metal had been worked out. Twenty copper coins were found in these mines, ranging from the earliest emperors to a late period of Roman sway."(1) At Dolaucothy gold was mined opencast and then the workings were extended by long underground galleries. It is quite possible that in the Mendips lead was mined by underground galleries driven into the slopes of the hills; unfortunately, later mining in this rich ore-producing area has been so intensive that no definite evidence of Roman underground mining remains.

In the lead field of south-west Shropshire, in the Shelve district, the ore was mined both opencast and by means of adits. The workings have been vividly described: "Two of three veins had cropt out almost parallel to each other, and the Roman miners actually cut the mountain from top to bottom, into great ridges or grooves. We might suppose from the appearance that they began at the bottom, and then after they had followed the metal in one spot as far as they could, they commenced immediately above, and filled up the previous excavation with the waste from the new one. As we approach the top of the hill the remains of these excavations take the form of vast caverns, which have evidently gone to a great depth, but the entrance has been clogged up with fallen rock."(2)

It is obvious that fire-setting, with consequent smoke fumes, would be much more suitable for opencast mining rather than underground working.(3) One writer has pointed out that at the Roman mines at Laurium, in Attica, mining concessions were granted only for a specified period of time, and because the fumes from this method made the mines uninhabitable it was not used much. Whether this happened in Britain we cannot tell. Nevertheless, the use of fire-setting generally raised problems of ventilation. Sometimes, of course, the nature of the ground in the mining area allowed adits to be driven at different levels, and thus communicating

(1) R. Hunt, op.cit., 27.
(2) R. Hunt, op. cit., 27.
(3) O. Davies, "Roman & Mediaeval Mining Technique", 20.

with galleries helped to produce some draught[1]. Drainage adits helped in this fashion. Again, in a series of galleries fire-setting would assist ventilation, by creating a draught in one of the other galleries. Shafts could be sunk along the line of the galleries, and the method of sinking shafts in pairs, joining at the bottom, was used in ancient times. Pliny mentions "the flapping of cloths" to produce a draught.[2] But there is little doubt that the way work in mines was looked on, as obnoxious and dangerous, must have owed not a little to the generally poor ventilation of the workings.

Like ventilation, the drainage of an underground mine presented the Romans and all early miners with an awkward problem. However, in Britain the surficial character of mining compared with that of other Roman provinces did not create many difficulties. At the Dolaucothy gold mine the galleries were drained by cross adits, in the hillside. Here there are the remains of the only known drainage machine used by the Romans in this country: a wooden water wheel, which would be one of several employed in the low galleries of the mine. A water wheel revolved in a vertical plane, lifting water from one trough and discharging it into another. They sometimes worked singly, or in pairs revolving in opposite directions. Apart from the instance mentioned, drainage of British mines was by adits, or, more usually, by baling with a bucket, perhaps of leather (one made of copper was dredged from the Thames and was similar to examples in Spain),[3] or of metal.

The use of a number of buckets, attached to a vertical cord, in drainage operations, cannot be proved for mining before the fifteenth century.[4]

For lighting underground galleries Romans and Greeks used oil lamps with one or more spouts, placed in niches cut in the side walls.[5] Pliny states that oil lamps were used for measuring the length of "shifts". There has been no evidence found in Britain of methods of lighting, and we can only assume that similar procedure was followed here.

In the narrow underground galleries of Britain, propping was rarely needed. However, the Dolaucothy workings have yielded evidence of the use of heavy timber framing - beams of ten feet in length - besides rock pillars for supporting the roofs of the galleries.

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(1) O. Davies, "Roman Mines in Europe," 23.
(2) Pliny, op.cit..
(3) G. Clement Whittick, "Roman Mining in Britain," Trans. Newcomen Soc., 1931-32, XII, 62.
(4) O. Davies, "Roman & Mediaeval Mining Technique." 21.
(5) G. Clement Whittick, op.cit..

Mine Working.

Tools for cutting and breaking rock were of iron and stone in ancient mines. Both Greeks and Romans used iron tools, and looking at the history of early mining as a whole there is little difference to be observed in the types of tools used in different mining countries at various times. Earth or soft rock could be cut with a pick. A typical example from the copper workings at Westbury Brook, Llanymynech, was little larger than a modern geological hammer with a single blade, slightly curved.(1) Evidence of a similar diminutive pick was found in the Lydney Park iron mine(2) where clear impressions of a pick were visible. At the iron mine at Lydney in the Forest of Dean it is also possible to see that a pick has been used from the curved striations on the walls(3). Early miners in other parts of the world used iron picks of varying types, either single or double ended, straight or curved(4). For heavier working the standard practice was to use a gad, which, driven by a hammer into a hole or fissure in the rock, would split it(5). Often the gad was of iron. A gad leaves marks forming a rough net-work pattern upon gallery walls. The gangue heaps produced by a gad are composed of small chips of rock, and quantities of dust. The hammers employed were of stone, with a groove around the middle and sometimes another across the back for the attachment of the wooden handle. Specimens have been discovered in the Shropshire-Hertfordshire lead field.(6) There are remains of early Roman hammers in the Ashmolean Museum, Oxford. Stone tools like picks or wedges were passing out of use in Roman times, although they seem to have been continually in use in Wales, for example mullers have been found on old tips in the Shropshire-Hertfordshire lead area, and in the Roman hill-forts of Cardigan and Montgomery, whilst rilled hammers were discovered in the settlements of Braich-y-Dinas and Ogof-Widdon.(7) It is reasonable to assume that wooden spades were used in Britain; they were used in mining until the close of the mediaeval period. A spoon type of spade, with handle and blade in one piece, from Charterhouse-on-Mendip, is considered Roman.(8) Agricola mentions the use of a two-piece spade, but with a handle fixed to the end of the blade, as in modern times.

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(1) O. Davies, "Roman Mines in Europe," 32.
(2) G. Scott-Garrett, "Roman Iron Mine in Lydney Park," Trans. Bristol & Glos. Arch. Soc., 1959, 78, 86-91.
(3) O. Davies, "Roman Mines in Europe," 32.
(4) G. Clement Whittick, op. cit..
(5) O. Davies, op. cit..
(6) O. Davies, op. cit..
(7) Cardigan & Montgomery: O. Davies, op. cit., 38.
Braich-y-Dinas: Hughes, Arch. Cambrensis, 1922, 346.
Ogof-Widdon: R.C.H.M., "Wales & Monmouth: Montgomery."
(8) Scarth, Proc. Bath Nat. Hist. & Antiq. Field Club, III, 334.

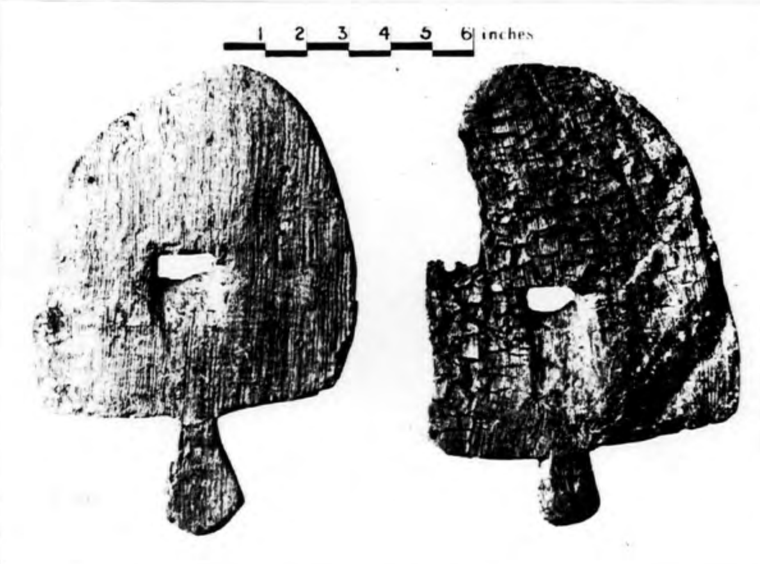

Fig.76

Fig. 77. Block of stone on which ore was ground. Gogofau mine.

Specimens of Roman shovels were found at the lead mines at Greenhow Hill, Yorkshire, at Shelve in Shropshire(1), and in the Mendips(2). Made from oak, they are about nine inches wide and vary from twelve to sixteen inches in length. Their shape is that of the spade silhouette in a pack of cards. Near the centre a hole was cut, sloping backwards to the projecting 'bead', said to be for the insertion of the handle. Fig.76 shows the Shelve specimens (now in Birmingham University Geological Museum); these have also been described as "spades", but we suggest that they may have been used as scrapers: the projecting piece is clearly a handle, and if this were gripped by the right hand while the left hand gripped another short handle projecting from where the hole is, an effective tool would result. It is perhaps significant that (considering the left-hand specimen in Fig. 76) it is the left side which shows the greatest wear, just what one might expect if the implement had been used as a scraper by a right-handed man. The right-hand specimen is the longer of the two, perhaps indicating less use and therefore a less well-defined region of wear (or did its left side break under scraping stress early in its life, so that it was discarded as a tool?).

The ore itself when mined was carried away in baskets, wooden trays or sacks.(3) Incidentally, a fifteenth century brass in Newland Church, in the Forest of Dean, shows the miner with a small hod strapped on his back. Whether any more advanced methods of transporting ore to the furnace were in use in Britain cannot be ascertained.

Treatment of Ores.

In Britain the situation of heaps of scorias show that the ores were treated close to the mines themselves. The first stage in the metallurgical operations was sorting by hand. After sorting the ore was crushed and was ground or pounded to a stage varying with each mineral. In the earliest days of mining, in prehistoric times, ore was pounded with rilled hammers, or mullers, either spherical or pear shaped on cup marked querns. This method of pounding was in use in Roman days, and at Dolaucothy there is a large stone block, deeply cup marked, used for reducing the ore(4). Fig. 77 shows a similar block, found near the ancient workings of the Gogofau

(1) V.C.H., Somerset, I, 337.
(2) G. Clement Whittick, op. cit..
(3) G. Clement Whittick, op. cit..
(4) Nash-Williams, "Roman Gold Mine at Dolcaucothy, Carmarthenshire," Bulletin of Board of Celtic Studies, 14, Part 1, November, 1950.

mine, Carmarthenshire[1]. Alternatively, the ore could be beaten in mortars, and Diodorous mentions that beaters of iron were used.[2] Mortars found at Wilderspool, near Warrington, measured from two to two and a half feet across the top, while the interior was approximately ten inches wide and seven inches deep, one side having been worn down by the beating process.[3]

Washing followed, and for this purpose the ore was sifted. Washing was a particularly effective process where gold mining was concerned, owing to the high specific gravity of the minerals.[4] The Furness Charters however show that it was also used for iron in a deposit of clay. At Dolaucothy wooden panning cradles were used for the washing operations.[5] How ore was washed in other parts of Britain is not known. In France and Europe in general, sloping "tables" of wood were used. An example from France was constructed from oak planks about thirteen feet long and three feet six inches in width. Water tanks had been built nearby.[6] In Strabo we find mention of sifting crushed ore through sieves, over water; the residue was removed and again beaten, the operation being repeated five times for good results.[7]

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(1) Illustration taken from a woodcut in a paper by Warrington W. Smyth, "Note on the Gogofau, or Ogofau mine, near Pumpsant, Caermarthenshire," Memoirs of the Geological Survey of Great Britain, I, 483.
(2) Diodorus Siculus, III, 13.
(3) Thomas May, Excavations at Wilderspool, 1899-1900.
(4) O. Davies, op. cit., 40-41.
(5) Nash-Williams, op. cit.
(6) G. Clement Whittick, op. cit..
(7) Strabo, Geography III, 2; 10.

COAL.

It is certain that coal was used for many purposes in Roman Britain, and that in some cases it was considered valuable enough to be carried substantial distances from its source to the place of use. In surveying the crafts of Roman Britain it is therefore desirable to include some of the evidence for the winning and utilisation of coal.

The most striking reference to British coal among ancient writers is found in the "Collectanea Rerum Memorabilium" of the third century writer Solinus. Writing about Bath, he describes the use of coal in the temple of Sulis: "The presiding deity of these springs is Minerva, in whose temple the perpetual fire never turns into white wood ash, but, when the flame dies down, into stony masses."(1) This has generally been recognized as a reference to coal from the Somerset deposits. Graham Webster states that coal and its qualities were not well known in the ancient world, but points out that in Latin writers the word "carbo" apparently was in use for both coal and charcoal, and whichever was actually meant is not always clear from the context.(2)

Almost certainly all the British coal was won from outcrops, or after outcrops had been followed below the surface of the ground so that shallow excavation would be necessary. There is no conclusive evidence of any underground mining of coal.(3) Nearly all the sites where coal has been found are situated on, or very close to, coalfields. There are, however, one or two interesting exceptions, and, taking these into account it is possible to single out four major areas where coal was in regular use by either military or civil consumers.

(i). Southern Scotland and the north of England. This region shows the most extensive use of coal, and so frequent are the discoveries of it in the military garrisons of northern Britain that it is safe to assume its mining was a standard feature of military work. Scottish, Tyne valley and Cumberland coal appears in the frontier forts. On the Antonine Wall it was used in at least four of the forts. For example, at Castlecary quantities of small coal, no piece

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(1) V.C.H., Somerset, 1; 220.
(2) Graham Webster, "A note on the Use of Coal in Roman Britain", Antiqs. Jour., 1955, XXXV, 199.
(3) See R.A. Peel, "Mining & Minerals in Roman Britain", 27-28, (Univ. of Durham, B.A. Dissertation, 1957).

larger than a cube of one inch, were found outside the granary walls.(1) At Bar Hill a layer of coal about six inches thick was found covering the bottom of a hole measuring five feet in length and six feet in breadth.(2)

Coal is a fairly common discovery in the forts on the line of Hadrian's Wall. At Housesteads part of the guard chamber at the East Gate had been walled up for use as a coal store, and a cart-load of nearly a ton was found there.(3) At Carvoran some large coal cinders were discovered in digging operations on the foundations of the fort;(4) at Castlesteads cinders were found in the ruins of the bath house.(5) A piece of coal was found during excavations on the Mucklebank wall turret in circumstances which showed it came from one of the nearby outcrops. More was found at Great Chesters.(6) A little north of the Wall a large quantity was found in the bath house of the Risingham fort,(7) and similar quantities were found south of the Wall at Papcastle,(8) and in the vicus, with iron slag, at Maryport.(9) Coal was found in the commandant's house at Rudchester, and also on the Corbridge and South Shields sites.(10).

In northern Britain the coalfields of Yorkshire and Lancashire were exploited also. At the fort in Templebrough near Rotherham a large quantity was found in the commandant's house. A store was found in the fort at Manchester, too.(11) The industrial site of Wilderspool, near Warrington, (according to Collingwood a disused fort), yielded much coal and Collingwood states that it was recognised as a type known as "Wigan Nuts" and must have been transported at least twelve miles to the site.(12) May mentions that cannel coal was discovered in association with ordinary coal here.(13) The evidence at Wilderspool shows that coal was in general use as fuel and regularly mined and transported there.

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(1) Proc. Soc. Antiqs. Scotland, 37, 313.
(2) Macdonald & Park, "Roman Forts on Bar Hill", 62.
(3) J. Collingwood Bruce, "Handbook to the Roman Wall" 124, (11th ed., 1957).
(4) Wallis, "History of Northumberland, 1, 119.
(5) Hutchinson, "History of Cumberland", 1, 114.
(6) Arch. Ael., XXIV, 16 & 48.
(7) I.A. Richmond, "Roman Britain", 159, (Pelican History of England, 2nd ed. 1963).
(8) Trans. Cumberland & Westmorland Arch. Soc., Series 2; 13, 40.
(9) Trans. Cumberland & Westmorland Arch. Soc., Series 1; 5, 248, 251.
(10) Rudchester: Arch. Ael., 1925, 108.
Corbridge: Arch. Ael., 1910, 267.
South Shields: Arch., XLVI, 170.
(11) T. May, "Excavations at the Roman Fort at Templebrough", 1922, 55. Mancunium: Reeder, "Roman Manchester", 151 - 159.
Whitaker, "History of Manchester", 50.
(12) T. May, "Excavations at Wilderspool", 1899 - 1900; 19-25.
(13) T. May, "Warrington's Roman Remains", 76 (Warrington, 1904).

(ii) The western edge of the Midlands: a line of settlements stretching roughly from about Chester in the north to near Gloucester in the south.

In the case of the coal found in association with iron smelting in Anglesey at Din Lligwy(1), and found at Heronbridge near Chester(2), the mineral must have come from the Flintshire field. Thus coal must have been carted about seventy-five miles to the iron smelting site. This field would provide coal for lead smelting at Pentre in Flintshire.(3) At Wroxeter coal found nearby was used for heating, maybe in bath furnaces.(4)

During excavations at Caerwent in Monmouthshire small cubes of coal were frequently discovered in some of the Roman houses.(5) Coal in this instance would be obtained from either the South Wales or Forest of Dean fields; similarly, that found in the iron smelting settlement at Weston under Penyard would be from either source.(6) A discovery of coal has been recorded at the villa at Ely, near Cardiff.(7)

(iii) South-western England: small settlements in Gloucestershire, Somerset, Wiltshire and Dorset.

The coal must have been obtained in these cases from the Somerset field, and the deduction made by Collingwood and Webster is that its distribution for the domestic use of inhabitants (there is no record of its industrial use) was organised on a commercial basis. As stated earlier, coal was used as fuel in the Temple of Minerva at Bath. In Wiltshire several sites have yielded coal - villas at Stanton St. Quentin and at Baydon on the Wiltshire-Berkshire border, villages at Stockton, Knook and Silbury Hill.(8) In Dorset coal has been discovered at the villa at Nuthills, near Calne.(9) At the villa of Spoonley, Gloucestershire, the coal found probably had as its field of origin the Forest of Dean.(10) Collingwood comments that: "It is clear that the Somerset coalfield, the chief one providing easily worked

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(1) R.G. Collingwood, "Economic Survey of Ancient Rome", iii 36-37.
(2) Graham Webster, op. cit., 6.
(3) Arch. Cambrensis, 1856; 306.
(4) J.P. Bushe-Fox, First Wroxeter Report 1912; 7.
(5) Arch., LVII, 316. (6) Jack, "Uriconum".
(7) Wheeler, "Prehistoric & Roman Wales", 267.
(8) Wiltshire Archaeological Magazine, XLV, 170.
(9) J.R.S., 1924, XIV, 237.
(10) Arch., LII, 651, 664.

deposits within the highly civilised half of Britain, was extensively worked and its produce consumed over a large area, even in the poor villages of the hardly Romanized peasantry, twenty or thirty miles away from the workings. This may possibly be connected with a progressive exhaustion of the natural woods on the chalk uplands, whose commencement can be traced as far back as the Bronze Age."(1)

(iv) The Fen district of East Anglia. The presence of coal on six sites in this district presents an unusual problem. There are no local outcrops; the nearest field is in the Midlands. Webster suggests that coal was used for corn drying purposes. He argues that coal was hardly likely to be wanted for domestic heating in view of the presence of peat; and bases his theory on the archaeological evidence for the rural prosperity of Britain in the fourth century, and the references by Zosimus, Ammianus Marcellinus and Eurapius, to shipments of wheat from Britain to the continent in the reign of Julian. At Wyboston coal has been found apparently in association with corn-drying.(2) Webster also points out that the river system comprised by the Car Dyke in Cambridgeshire, the River Witham, the Fossdyke and the River Trent would provide a waterway to York via the Humber and the Ouse, and help to support an alternative theory that the Fen district was an army granary for domestic supply. The Car Dyke, incidentally, is a site where coal has been found.

At Great Marches, Welney, a quantity of briquetage has been found(3) which was almost certainly, according to Webster, for use in brine evaporation.

As far as is known, there has never been any discovery of coal on sites in south-eastern England. Fuel for the local pottery industries and for domestic heating would be wood.

Webster has drawn a map which shows the coal outcrops and the sites where coal has been recorded in Roman Britain; this is reproduced on the following page.

(1) R.G. Collingwood, op. cit., iii, 37.
(2) Archaeological News Letter, 5; 110.
(3) Graham Webster, loc. cit., 203.

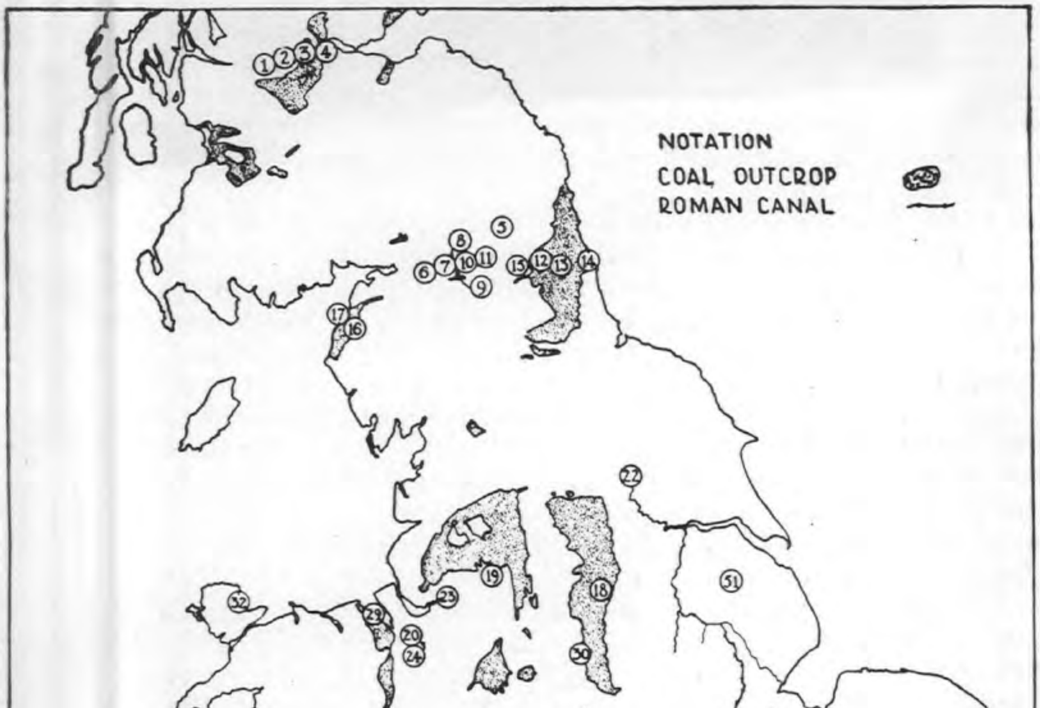


FIG. 78. Map showing coal outcrops and sites where coal has been recorded in Roman Britain. (*The numbers correspond to those in the schedule*)

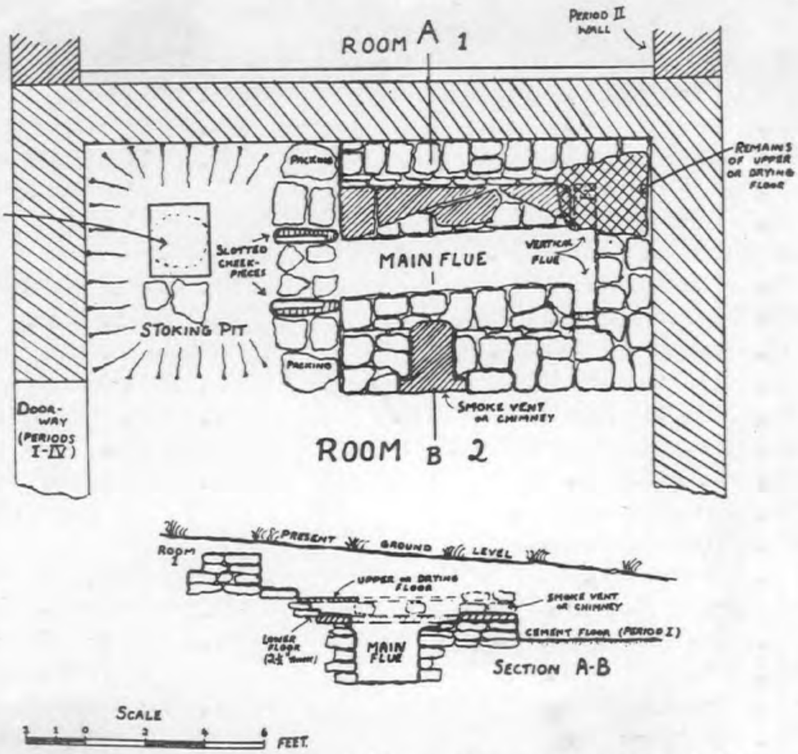
The map opposite is due to Webster(1). The Key to the sites is given below:

Military Sites:
Antonine Wall.
1. Bar Hill.
2. Croy Hill.
3. Castlecary.
4. Mumrills.
Between the Walls.
5. Risingham.
Hadrian's Wall.
6. Castlesteads.
7. Birdoswald.
8. Mucklebank Turret.
9. Great Chesters.
10. Carvoran.
11. Housesteads.
12. Rudchester.
13. Benwell.
Northern Forts..
14. South Shields.
15. Corbridge.
16. Papcastle.
17. Maryport.
18. Templeborough.
19. Manchester.
20. Chester.
Welsh Forts.
21. Brecon.
Civil Sites: (Towns, Settlements).
22. York.
23. Wilderspool.
24. Heronbridge, nr.Chester.
25. Wroxeter.
26. Ariconium.
27. Caerwent.
28. Bath.

Industrial Sites:
29. Flint.
30. Wirksworth.
31. Tiddington (nr. Stratford on Avon).
Countryside:
Wales.
32. Coed Newydd, Anglesey.
33. Ely, nr. Cardiff.
Gloucestershire.
34. Woodchester. (Lydney)
35. Gt. Witcombe Villa.
Somerset.
36. Clapton in Gordano. (Camerton) (Low Hamwell) (Chew Stoke)
Wiltshire.
37. Stanton St.Quintin.
38. Knook Castle. (Upton Lovell).
39. Nuthills Villa, nr. Bowood.
40. Rushall (Romano-British village).
41. Stockton.
42. Nr. Silbury Hill.
43. Baydon.
The Fens.
44. Holbeach.
45. Car Dyke.
46. Gt. Marshes, Welney,Norfolk.
47. Littleport (Cambs.).
48. Wyboston (Beds.).
Other Sites:
49. Water Newton, nr.Peterborough.
50. Foxcote, or Foscott, (Bucks).
51. Claxby Beck, Lincs. (Ancaster Lincs).

Note: Names in brackets are Addenda, not shown on map.

(1) Graham Webster, Antiqs. Jour., 1955, XXXV, 201.



T-shaped Corn-Drying Oven in Room 2, Roman Villa at Atworth, Wilts.

Fig.79

DOMESTIC CRAFTS

THE COUNTRYSIDE

Corn: Drying; Milling; Baking

A characteristic feature of late Romano-British agriculture was the corn-dryer. After the corn was harvested it was divided into two parts, one for seed and the other for consumption. That for consumption was parched in a heated corn-dryer to improve its keeping properties. The dryer could also be used for processing certain wheats, notably spelt, the chaff of which is difficult to remove by ordinary threshing unless first made brittle by heat. R.G. Goodchild points out(1) that most Romano-British corn-dryers are of fourth century date, and the ruthless manner in which they have been inserted into existing dwellings suggests a deliberate policy enforced by the central government. When the Romano-British villa at Yewden, Hambleden, Bucks., was excavated(2) no fewer than fourteen drying ovens were found, ranging from simple to quite elaborate types. Goodchild observes that the large variety on one site suggests something in the nature of an experimental station.

The essential feature of the corn-dryer was a double floor so that the heating furnace or flue was separated by an interspace from the floor on which the corn rested, thus avoiding the possibility of charring the grain. Fig. 79 shows one of two T-shaped corn-drying ovens found in the Roman villa at Atworth, Wiltshire. Fortunately this oven was very well-preserved; not only had the flue-walls survived to their full original height, but a certain amount of the superstructure still remained. It was this find which confirmed the belief that drying-ovens must have had a double floor. Previous ovens had been in too ruined a state to establish this point with certainty.

The term "T-shaped" refers to the shape of the flue in these ovens. The stem of the T constitutes the main flue, which is covered by the first floor. This floor stops short of the cross-piece of the T which thus forms a vertical flue communicating with the interspace between the first and second floors. The second or topmost floor, on which the grain rests, runs the whole length of the kiln, confining the smoke and fumes from the furnace to the interspace between the floors. A side vent, shown in Fig. 79 , allowed

(1) R.G. Goodchild, "T-shaped Corn-drying Ovens in Roman Britain", Antiqs. Jour., 1943, XXIII, 148.
(2) Arch., 1920-1, LXXI, 141.

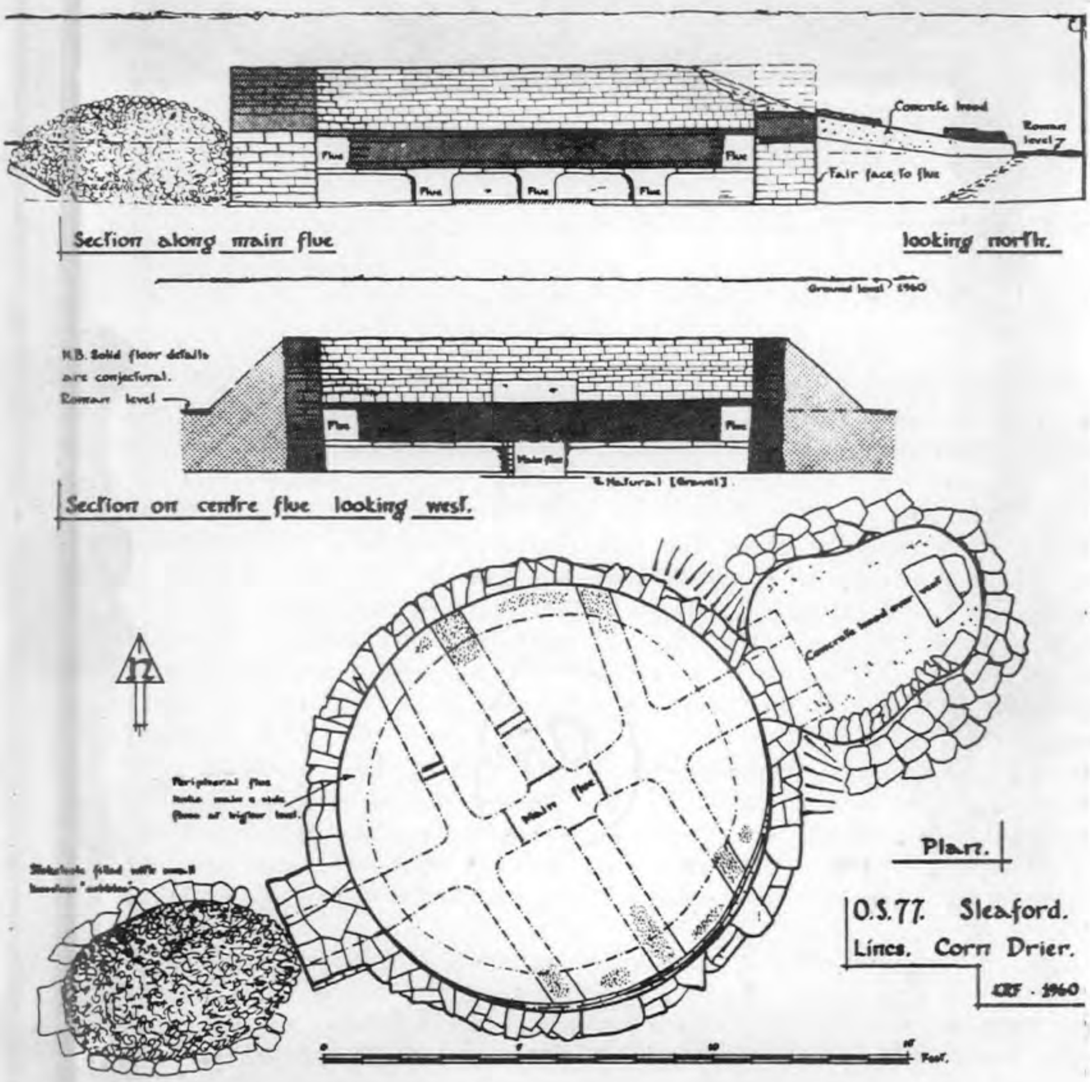


FIG. 80 OLD SLEAFORD : SECTIONS AND PLAN OF CORN-DRIER

Fig. 81. Section of a Roman hand-quern from stones found at Silchester. (⅛ linear.)

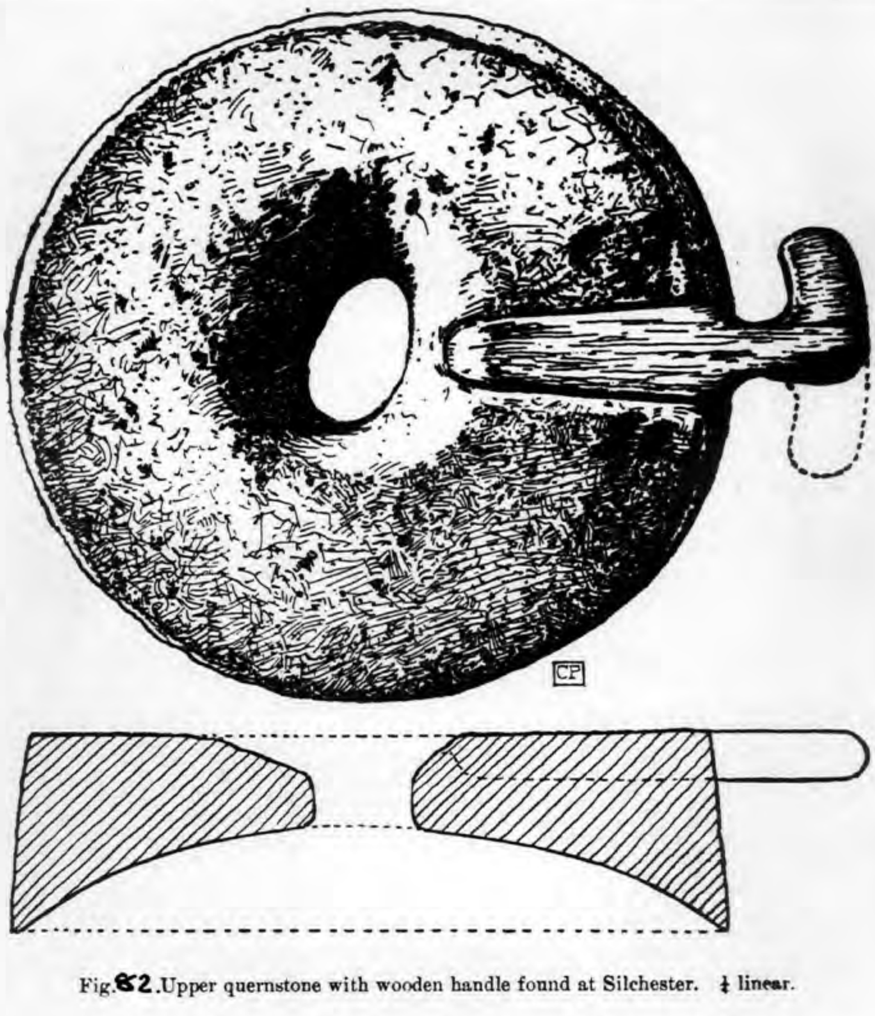


Fig. 82. Upper quernstone with wooden handle found at Silchester. ¼ linear.

Fig. 83. Baking bread and grinding corn. From a sarcophagus now in the Lateran Museum in Rome.

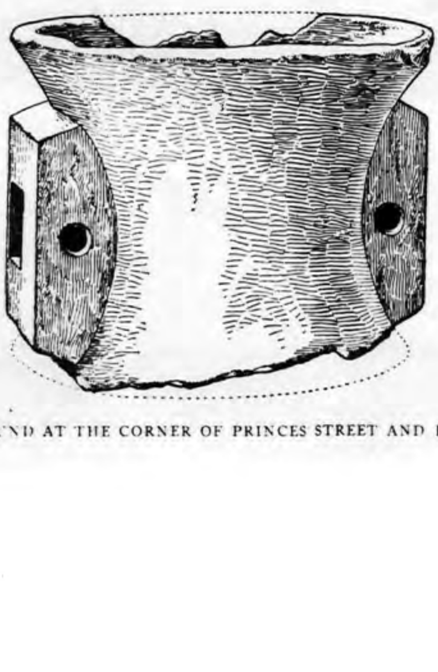


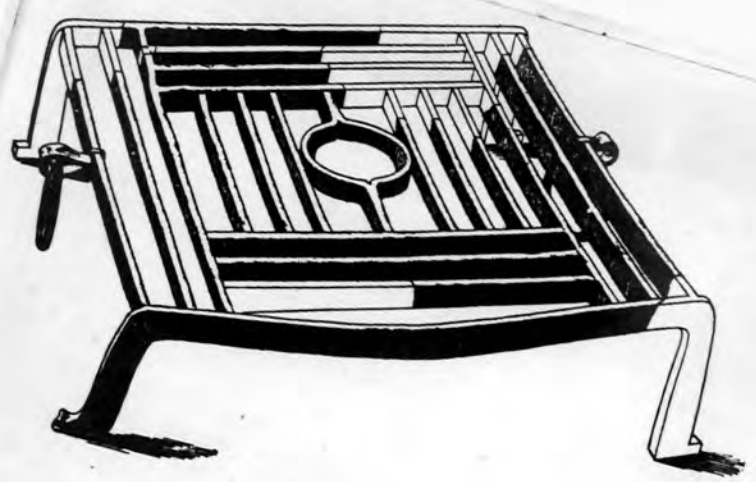
FIG. 84. MILLSTONE FOUND AT THE CORNER OF PRINCES STREET AND POULTRY, LONDON ($\frac{1}{12}$).

the smoke and hot air to escape from the interspace, probably to a chimney. At Atworth, the 6 in. gap between the two floors, with the hot air passing through it, would impart just sufficient heat to the upper floor to dry the corn without scorching it. Slots on each side of the main flue at the stoke-hole end, and recesses like door-jambs at the outer end of the smoke vent, suggest that dampers were originally present, to regulate the heat.

T-shaped corn-dryers are the commonest form, but circular types are known. Fig. 80 illustrates a circular corn-dryer found at Old Sleaford, Lincolnshire,(1) which had a more elaborate flue system. There were two opposing stoke-holds, one of which had been blocked, communicating with a main flue which opened into cross flues, three on either side. A peripheral flue, at a higher level, linked the main and cross flues.

The milling of corn was done in rotary querns, which had long superseded the saddle quern (in which the upper stone is pushed to and fro over the lower). The rotary querns varied in size from a small, hand variety, to large stones which would require two men to turn. Fig. 81 shows a section of a hand-quern, based on finds made at Silchester,(2) and Fig.82 illustrates a variant of this type(3) which when found still had most of its wooden handle intact. A very large upper millstone of fine white sandstone, 7½ in. thick, 2 ft. 4 in. diameter was found at Silchester in 1895, and two years later, in House No. 3 of Insula XVIII, two rows of three large, circular foundations were discovered(4) which the excavators thought might have been the sites of large querns, the establishment itself being possibly a mill-house. Querns of this size were turned by men, as the Lateran Museum sarcophagus shows (Fig. 83); here the upper stone is flat, but stones of hour-glass shape were common in Pompeii and in fact hour-glass stones of Niedermendig or Andernach lava, from the valley of the Rhine, were imported into Britain. In Fig.84 is seen an upper stone of this type, of Andernach lava, which was found in London at the corner of Princes Street and Poultry in 1928(5). This stone would be turned by levers inserted in the sockets at its waist. Its height is 23 in., top and bottom diameters 27 in., and the bore narrows to 8 in. at the waist.

(1) J.R.S., 1961, LI, 171.
(2) Arch., 1898, LVI, 117.
(3) Arch., 1899, LVI, 239-240.
(4) Arch., 1898, LVI, 113-115.
(5) Prof. Eric Birley, Antiqs. Jour., 1929, IX, 220-221.



Gridiron.

Fig.85

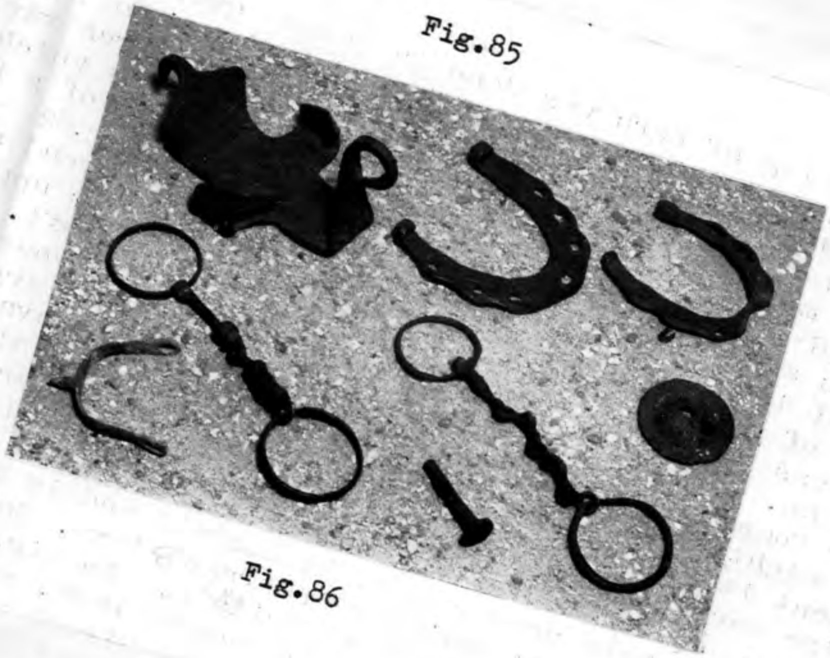


Fig.86

Farrier's tool found at Silchester (¼ linear).

Fig.87

Farrier's tool found in Pompeii (¼ linear).

Fig.88

No certain example of a Romano-British baking oven has come down to us, but Fig. 83 suggests what they may have looked like. Silchester has provided a gridiron, Fig. 85 .(1) This had an iron frame with an almost square top 17 in. by 18 in. The bars were riveted together, and the gridiron showed signs of having been warped over the fire on which it was used.

The Farrier

The size of Romano-British horse-shoes suggests that horses were smaller then than now. Examples of shoes in the Guildhall Museum are given in Fig. 86 ; the exact purpose of the solid type (top left), the so-called "hippo-sandal", is not known, but it is certain that they were attached to the hooves of horses.(2) Perhaps it protected the hoof if the horse were lame. Below the horse-shoes in Fig. 86 are two bits, with rings for attaching the reins, and at bottom left is a spur, with holes for the strap to buckle round the front of the foot.

The curious tool with a gouge blade, found at Silchester in 1900 (Fig. 87) was then known, by comparison with the horse and man on a similar object found in Pompeii (Fig. 88), to be a farrier's tool,(3) and it has since been identified as a 'buttrice', an instrument formerly used for trimming hooves.(4)

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(1) Arch., 1894, LIV, 153-4.
(2) R.G. Collingwood, "Archaeology of Roman Britain", 270, (London, 1930).
(3) Arch., 1901, LVII, 248.
(4) G.C. Boon, "Roman Silchester", 181, (London, 1957).

Fig.89

FURNITURE

The damp British climate is not conducive to the preservation of wood and textiles over the centuries. No wooden furniture made during the Roman occupation has survived, and only traces of textiles have come down to us. We have been more fortunate with articles of metal, stone and glass, and it is frequently possible to identify excavated objects in these substances with some domestic use; for example, metal locks, handles and small metal feet are sometimes recognisable as belonging to household articles. However for a general picture we have to depend on other sources, chief among which is the sculpture of the period. Altars, statues, and tombstones often depict domestic furniture, and comparison of these sculptures with actual pieces of furniture from Pompeii and Herculaneum, and with discoveries made in dry countries such as Egypt, has enabled archaeologists to describe the Roman domestic scene in Britain with some confidence. Scholarly surveys have been made by C.L. Ransom and by J. Liversidge,[1] and we shall draw on these for our present purpose, supplementing them with references to later discoveries.

Couches and Beds

The Romans referred to the couch for the dining-room as the 'lectus triclinaris' and that for the bedroom as the 'lectus cubicularis', but it is not certain whether there was any distinction between the two. It has generally been assumed that couches used for reclining during the day were also used as beds at night, but one authority[2] has suggested that couches used as beds were rare in most houses, and that a chest or a rectangle of masonry, suitably equipped with a mattress, cushions and covers, was often used for sleeping. A stone in the Grosvenor Museum at Chester certainly shows a child sleeping on a mattress apparently placed on a masonry base, but this arrangement seems to be the only one of its kind recorded in Britain. Usually couches are depicted in such circumstances that it is open to argument as to whether they are being used in the daytime or at night.

A well-preserved example is that shown on the tombstone of Victor the Moor, in South Shields Museum, Fig. 89 . The

(1) Caroline Louise Ransom, "Couches and Beds of the Greeks, Etruscans and Romans", (Chicago, 1905).
Joan Liversidge, "Furniture in Roman Britain", (London, 1955).

(2) P.M. Duval, "La Vie Quotidienne en Gaule pendant la paix romaine", (Paris, 1952).


D M
IVLIE VEVE PIENTISSI
ME VIXIT AN L AVREL
MERCVRIALIS FER FACI
VNDVM CVRAVIT VIVVS
SIBI ET SVIS FECIT

Fig.90

Fig.91

Fig.92

Fig.93

couch, or bed, here has an upright headboard and a smaller rest at the foot. The legs have evidently been turned on a lathe, and they stand on individual bases. A mattress with a cylindrical bolster or cushion is shown on top of the couch, and Victor is reclining on these, his left elbow being supported by the bolster. A similar couch, but not so clear in detail, is depicted on the tombstone of Julia Velva in the museum at York. There is a high, curved headboard and a lower foot-rest; the legs are straight and undecorated, and the mattress is exceptionally thick. A chair and a three-legged table are shown in front of the couch (Fig. 90).

In the two cases just mentioned the couches are without backs, but in fact the couches shown on Romano-British grave reliefs fall into two categories, those without backs, and those with backs. Miss Ransom[1] points out that the backless type has a long history, and the variety with turned legs and a carved head-rest was being used by the Greeks in the fifth century B.C., and possibly even earlier. The Grosvenor Museum at Chester provides several examples of couches with the high back continuous with the head- and foot-rests: one is shown on the tombstone of Curatia Dionysia, Fig. 91, and another is well portrayed on Stone No. 116 where the height and solidity of the back are emphasised by the head and shoulders of a small attendant just visible above and behind it. Two further examples, both very clearly sculpted, are the tombstones of Candida (Fig. 92) and Aelia Aeliana (Fig. 93) at York.[2] It must not be supposed that couches with backs were truly couches and that the backless variety were beds: Candida and Curatia Dionysia are shown in a reclining posture, and Liversidge[3] draws attention to a model of a backed couch (bearing the stamp Pistillus), from Bordeaux, and now in the museum at St. Germain-en-Laye, which is obviously a double bed with its two occupants well tucked up and their dog asleep at their feet.

Tables

In the case of couches and beds we can only conjecture that they were made in Britain; it is reasonably certain that the Romano-British joiner and carpenter in Britain would be as capable as his fellows on the Continent, but there is

(1) C.L. Ransom, op.cit., page 27.
(2) Figs. 90 & 92 are from the Yorks. Phil. Soc. Annual Report, 1922, Plates I & II.
(3) J. Liversidge, op.cit., page 11.

Fig.94

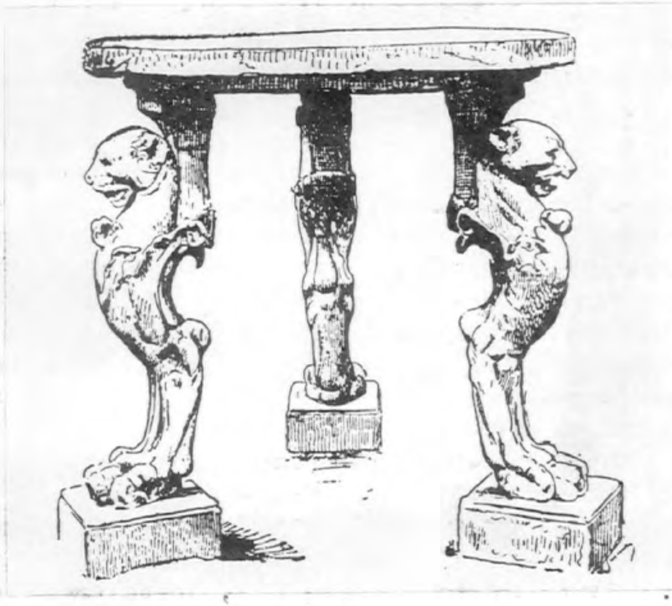

Fig.95

no proof that he made the 'lecti' delineated on the numerous grave reliefs which have come down to us. However, the position with regard to tables is altogether different. Britain is remarkably rich in fragments of Roman tables, and we can be absolutely certain that many of these came from Romano-British workshops. This is due to the fact that they are made of Kimmeridge shale, and the only source of this material so far known is that near Purbeck in Dorset, where there are two sites, Kimmeridge and Worthbarrow bays, and evidence for the working of the raw material, and its fashioning into various objects, since Neolithic times(1). Naturally, most of the pieces of Kimmeridge shale tables have been found in South-West Britain, and the Dorset County Museum at Dorchester has seven fragments on exhibition. The best of these is the shale table leg found in Colliton Park, Dorchester, in 1937(2) and shown in Fig. 94 . At the top of the leg the tenon (intended to fit into the mortise on the underside of the table) is clearly seen; below there is carved a conventional representation of an animal's head, and the leg terminates in a claw foot.

The type of table to which these legs belonged can be surmised with some certainty: the table frequently shown on Romano-British tombstones is a small round one with three curved legs (e.g., the tombstones of Julia Velva, Candida, Aelia Aeliana); this is believed to have been a Greek invention which became very popular in Hellenistic and Roman times.(3) The legs ended either in antelope's hooves or lion's claw-feet, and many known Roman tables also have the upper part of the legs decorated with heads of animals or birds. The parallel with the Dorset legs is irresistible, especially when one compares the Dorset remains with the legs on a marble table from Pompeii (Fig. 95).(4) There is also evidence that the tops of some of these tables were made in shale: Reading museum has a Kimmeridge shale fragment, originally part of a circular piece some 15 inches in diameter, found at Silchester. The top is flat and has a smoothly turned edge an inch thick, but the convincing

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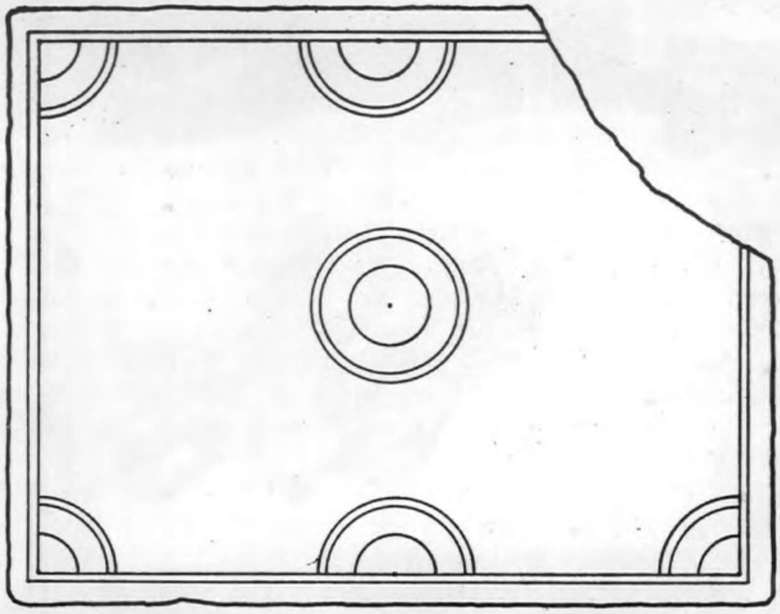
(1) Arch. Jour., 1937, XCIII, 212; Antiquity, 1950, XXIV, 25.
(2) Proc. Dorset Nat. Hist. & Arch. Soc., 1938, LIX, 9; J.R.S., 1938, XXVIII, Plate XXV.
(3) C.L. Ransom, loc.cit., page 87.
(4) Illustration from P. Gusman, "Pompeii the City, Its Life and Art", London, 1900.



ROCKBOURNE, HANTS : TOP OF STONE SIDE-TABLE (pl. XXIV, 2) FROM THE HOUSE IN WEST PARK (⅛)

Fig.96

evidence is on the underside, where there are traces of the mortises for the tenons of two legs. The Roman villa at Morton, near Brading, Isle of Wight, yielded a curved piece of shale, originally about 16 inches in diameter, lathe-turned, and with a footstand on the underside.(1)

The only shale objects so far found on the sites where Kimmeridge shale is quarried are armlets. Now at Silchester there were found two unfinished dishes in Kimmeridge shale, with the lathe chuck-holes still visible, showing that Kimmeridge shale was worked at Calleva(2). It is therefore possible that pieces of shale were transported from Dorset to other centres, where they were shaped, just as marble is quarried and then sculpted elsewhere. This could be an explanation of the wide distribution of shale articles. Thus Leicester Museum has part of a table leg which came from a Roman villa at Rothley in 1901; the Cambridge Museum of Archaeology and Ethnology has a small piece which came from Foscott in Buckinghamshire, and two were found at Caerleon(3). This widespread occurrence of single items inclines one to think that the shale tables were perhaps a luxury, ranking with the marble tables to which the wealthier members of the Roman society would be accustomed to in other parts of the Empire.

It is, of course, probable that most Romano-British tables were made of wood, but so far no traces of any such have been found in Britain. Stone has undoubtedly been used: fragments of a stone leg with a claw foot were found at York in 1884, and Fig. 96 shows the top and the decorated front edge of a stone side-table found at Rockbourne, Hampshire, in 1961.(4)

Chairs and Stools

For chairs, as with couches, we have to depend on sculptures for our impressions. From these it seems that the typical chair of Roman Britain had a solid, rounded back, made in one piece with the sides, and was set on a rectangular, or sometimes semi-circular, base. Julia Velva's tombstone shows a chair of this type; the back is shoulder-high, and

(1) J.E. & F.G.H. Price, "The Roman Buildings at Morton, near Brading", 1881, page 25.
(2) G.C. Boon, "Roman Silchester", 195, (London, 1957).
(3) (i) Arch. Cambrensis, 1932, LXXXVII, 98.
(ii) J.R.S., 1960, L, 213.
(4) J.R.S., 1962, LII, 185.

the chair is made of basketwork which the sculptor has been at pains to depict. A statue found at Birdoswald on Hadrian's Wall (now in the Tullie House Museum, Carlisle) shows a figure sitting in a similar wicker-work chair; the edges of a cushion are visible on the seat. A statue of Fortuna found at Lanchester, County Durham (now in Durham Cathedral Library) shows Fortuna seated in a chair which although weathered, still shows sufficient signs of a wicker-work pattern to identify it as a basket chair. The technique of wicker-work was known in Britain before the Roman conquest; the earliest examples come from the Glastonbury lake village. British baskets had reached Rome by Juvenal's day and had contributed the word 'bascauda' to the Latin tongue.[1]

The basket chair, however, was not necessarily universal; representations of chairs of more solid construction are found. For example, a statue of a Mother Goddess found at Housesteads (now in the Roman Museum at Newcastle) depicts the Goddess sitting on a straight-backed chair which has plain legs and perhaps side panels between front and back legs; there is no attempt on the part of the sculptor to show ornamentation or to represent wicker-work. In the Tullie House Museum at Carlisle the Murrell Hill tombstone shows a woman sitting on a chair having a high concave back and a cushioned seat, but again there are no indications of basket-work.

Coming now to stools, it is possible that footstools were used in Roman Britain: Candida's tombstone (Fig. 92) shows a boy attendant standing on a small, box-like object which could be a footstool. A more definite representation is to be seen on the relief of a goddess found at Netherby and now in the Tullie House Museum at Carlisle; here the seated figure is resting both feet on something which can only be a footstool because it is too shallow to be a casket or box of any sort.

As for stools proper, the Romans used what we would describe as a camp-stool, that is to say, a portable stool with folding legs and a seat of some flexible material, perhaps cloth or leather. Fortunately for the archaeologist some of the stools had metal rather than wooden legs, and two definite examples have survived in Roman Britain. The first to be discovered[2] was found along with Samian ware in a barrow on the Bartlow Hills on the Essex-Cambridgeshire border. The ware bore stamps dating from the earlier part

(1) A.L.F. Rivet, "Town and Country in Roman Britain", 125-126, (London, 1958).
(2) John Gage, Arch., 1836, XXVI.

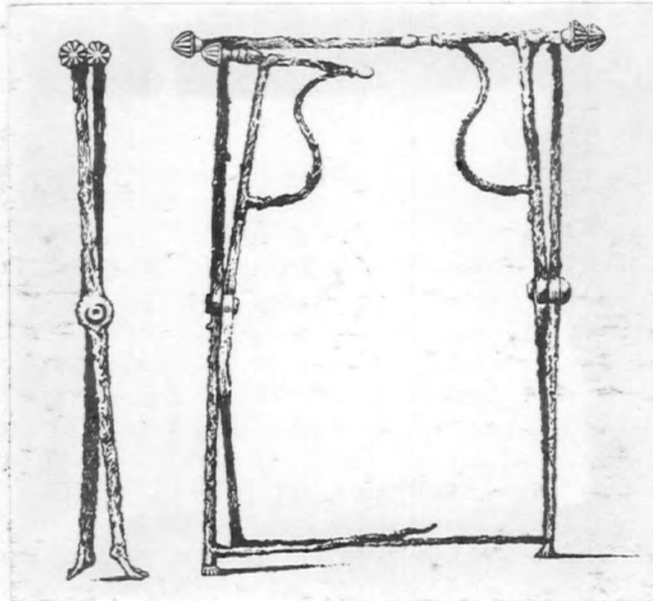


Fig.97

of the second century. This iron stool (Fig.97) had two pairs of legs pivoting about central bronze or bronze-capped pins. Fragments of the leather seat were still adhering to the seat bars. One of the bars extended right across the seat, as in a modern camp-stool, but the opposite bar was divided into two sections, each section being supported (as shown in Fig. 97) by an S-shaped bracket from the adjacent leg. The reason for this arrangement is obscure; it would seem to have the disadvantage of preventing the leather seat from extending across the full width of the stool; probably there were only two strips of leather, one from each half-bar, stretching back to the solid bar. The stool had bronze feet, and the ends of the seat bars were decorated with bronze caps.

A similar stool was found(1), unfortunately in a fragmentary state, at Holborough in Kent.

James Curle(2), excavating at Newstead, near Melrose, found five iron spindles each having a central disc ornamentation and adjacent smaller enlargements of the central rod. These were discovered with other metal objects, as if part of a smith's stock-in-trade. By comparison with another iron folding stool (in the Nijmegen Museum, Holland), having curved legs rather than the customary straight legs of a camp-stool, Curle concluded that his five spindles were intended for the stretchers between the legs of a curved-leg type of stool.

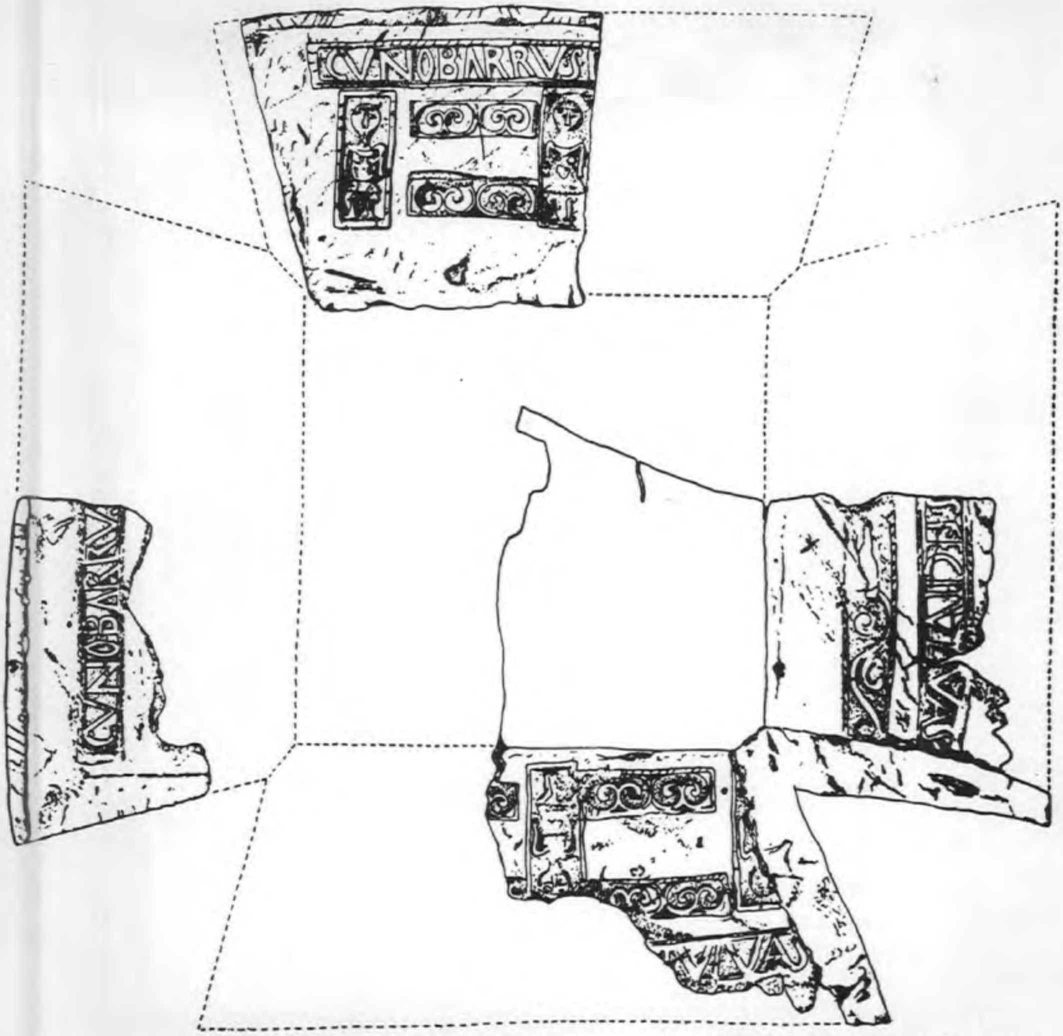
Chests and Caskets.

An essential item of furniture would be a strong-box or chest in which to keep money and the more valuable items of jewellery. During the excavation of a room at Silchester a slight subsidence was noticed in the tessellated floor, and it was found that underneath there was a cavity 6 ft. x 3 ft. 6 in. and 2 ft. deep, lined with flints on three sides, which contained the remains of a wooden chest standing on pieces of flanged tile to protect it from the damp earth.(3) The lid was strengthened with three iron bands terminating in hinges, and the lock-plate, key, and iron handle had also survived. The contents of the chest had been removed. Another iron-bound box was reported from the Roman villa at Brislington, Somerset.(4)

(1) R.F. Jessup, Arch. Cantiana, 1954, LXVIII.
(2) J. Curle, "A Roman Frontier Post and its People" Edinburgh, 1911.
(3) Arch., 1866, XL, 411.
(4) Barker, "Brislington", 15.


REGINA LIBERTA ET CONIVGE
ARATES PAL RENVS NATIONE
ATVALLAVNA AN XXX

Fig.98



(British and Lincoln Museums)

FIG. 99. CAISTOR: REMAINS OF LEAD CASKET. $\frac{1}{8}$

A smaller box found buried in the Romano-British village of Woodcuts, Dorset, contained a hoard of silver and bronze coins(1). Regina's tombstone at South Shields (Fig.98) shows Regina in the act of opening a small chest by her right side; the lock is plainly visible, and there is a crescent-shaped decoration, or perhaps a drop-handle, near the base of the chest just above the feet.

Three pieces of a remarkable leaden casket were found in a crumpled mass, weighing over 50 lb., at Caistor in 1863(2). These are shown in Fig. 99 , assembled to illustrate the construction of the casket.(3) Inscribed

CVNOBARRVS FECIT VIVAS

the casket was made of ¼" lead, so cut at the angles that the four sides could be bent up and their edges soldered into slots in four outsplayed corner posts of solid lead bar (one of these is in the British Museum) to form a casket 24 in. square at the base, about 30 in. square at the rim, and about 14 in. high. The corner posts would take the weight of a lid of similar construction, but no trace of a lid has survived. The sides of the casket are decorated with cast-in reliefs.

Possibly the good-luck wish was addressed to a bride, but in any case a casket of this size and weight was obviously intended to contain treasured possessions.

Lamps.

Romano-British houses were lit with candles and - if the owner could afford their upkeep - oil lamps. The latter observation is justified on the grounds that the oil would very likely be an edible oil and would have to be imported. When burning oil, therefore, one was actually burning food(4). Terracotta lamps made in Italy were exported all over the Roman world in the 1st. century A.D. and by the 2nd century lamp makers in Germany, Gaul and Britain were producing copies.

Fig. 100 shows a number of lamps discovered in London (Guildhall Museum). The candlestick in the middle of the

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(1) Pitt Rivers, "Excavations in Cranborne Chase", 1887, I, 61.
(2) Gentleman's Magazine, 1866; 38.
(3) C.F.C. Hawkes, "Lincoln: The Roman Occupation", Arch. Jour., 1946, CIII, 16.
(4) Donald M. Bailey, "Greek and Roman Pottery Lamps", 10-11, (British Museum, 1963).

Fig.100

Lamp. ¼

Fig.101

top row is of clay; to its left and right are lamps of bronze, at the bottom are three of clay (two of the 'enclosed' type, and one of the older 'open' style). The pointed instrument below the bronze hen was a pricker for adjusting the wicks.

Practical test shows that the oil in these pottery lamps oozes from the wick-hole faster than the flame can consume it, and runs down the outside of the lamp. This probably explains the number of lamp holders found in Britain, because wastage of the relatively expensive oil would have to be avoided.(1) Fig. 101 shows a metal lamp stand or lamp holder, some 10 inches high, found at Silchester.(2) The 'container' is riveted to the stem which is about ½ inch in diameter.

Two seal-boxes from Corbridge were found to contain wax which, when analysed, proved to be a paraffin wax probably "of local origin, since oily exudations, containing solid paraffins, are of frequent occurrence in coal pits and have been described under various names, such as ozokerite, urpethite, middletonite."(3) Provided that this wax was available in sufficient quantity it could also have been used to make candles, in which case candles in the north of Roman Britain may have been of reasonable quality because the paraffin wax was certainly good of its kind.

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(1) Donald M. Bailey, op. cit., 9-10.
(2) Arch., 1894, LIV, 153.
(3) J.A. Smythe, "Roman Objects of Copper and Iron from the North of England", Proc. Univ. Durham Phil. Soc., IX, 400-1.

Fig.102

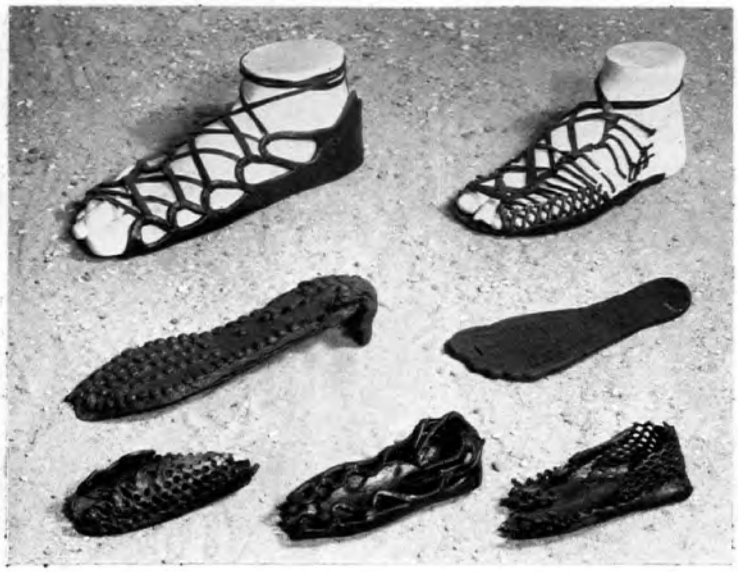


Fig.103

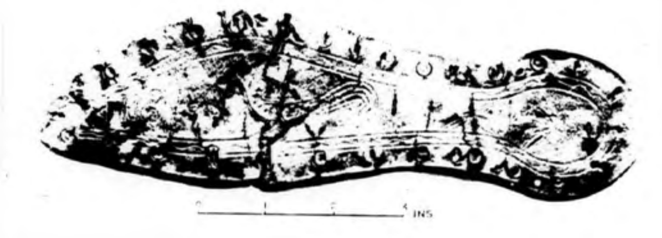


Fig.104

LEATHERWORKING

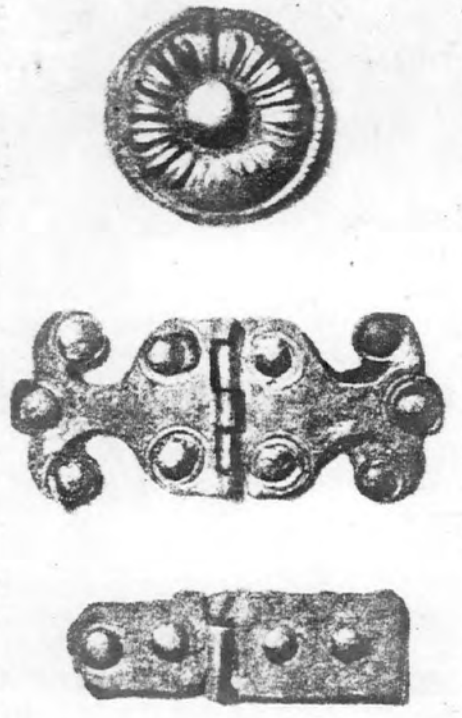
Tanning

Evidence of a tannery was found at Silchester in the form of an enormous deposit of ox-jaws in Insula VI(1) covering an area 50 ft. by 25 ft. to a depth of about 14 inches. It was calculated that the deposit represented 2,500 oxen. As no other bones were found in the vicinity, this 'hoard' is now thought to be a definite indication of tanning: the hides, with heads still attached, would be steeped and then the skulls would be removed when the condition of the hides permitted, the hides subsequently passing to the tan-pit. No trace of a tan-pit was recorded, however.

Leather articles

Leather would be an important material in Roman times, because apart from the needs of the British population, the army would require substantial supplies. Remarkably, considering the perishable nature of leather, quite a number of leather finds have been recorded; these usually occur in the bottom of wells or pits, where the sludge evidently has a preservative effect. During the excavations on the site of the Temple of Mithras in London in 1954 a thin piece of leather some 4 inches long was discovered, embossed with a design which showed traces of gilding(2) The Bartlow stool (Fig. 97 , opposite page 99) when found still had vestiges of the leather seat adhering to it. A well in the City of London yielded a pair of leather trunk drawers (Fig. 102).(3) So many shoes and scraps of leather have been found in the ground near the Bank of England as to suggest that shoemakers had shops there; some of these finds are now in the Guildhall Museum and are illustrated in Fig. 103 , which shows a collection of sandals and (mid-left) the studded sole of a boot. Most shoes, even those for children, are heavily hobnailed. The inner sole of a sandal 10 inches long, again from the Bank of England site, is depicted in Fig. 104 ; it is decorated with an incised design of a cock, a St. Andrew's cross, and a plant(4). Amongst finds outside of London may be mentioned sandals and shoes found when clearing a flint-lined well at Thatcham, Berkshire,

(1) Arch., 1906, LX, 165.
(2) Daily Telegraph, Oct. 2. 1954.
(3) J.R.S., 1955, LV, Plate LI Fig. 3.
(4) J.R.S., 1934, XXIV, Plate XIV, and page 211.



[1/1]

Fig.105

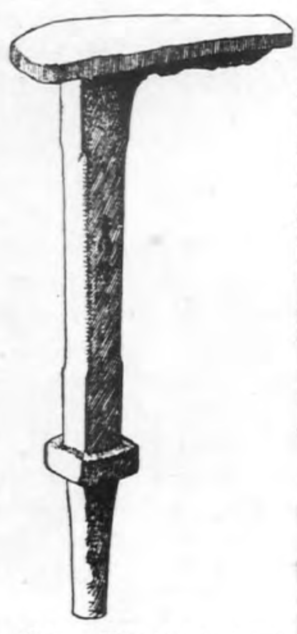


Fig. Shoemaker's Anvil.
¼.

Fig.106

in 1929[1] and more recently, sandals and a number of well-preserved shoes (late second century) for adults and children discovered on a kiln site at Cantley, near Doncaster, in 1959[2].

Silchester has produced an example of ornamental metal work associated with leather. This find was a brass rosette and ornamental hinges (Fig. 105), of a "rich golden colour", which had been attached to leather work, traces of which were still visible.[3] Silchester has also furnished us with a shoemaker's anvil (Fig. 106).[4]

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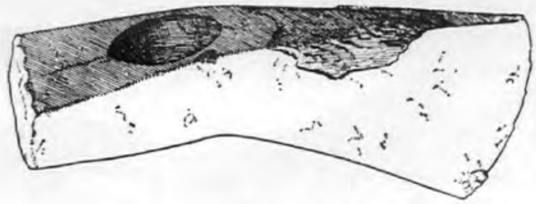
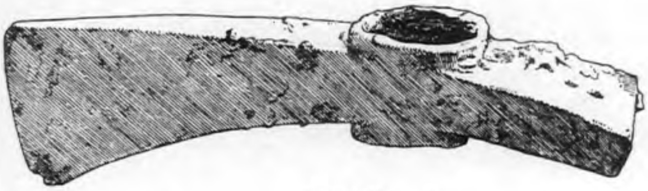
(1) J.R.S., 1929, XIX, 180.
(2) J.R.S., 1960, L, 221.
(3) Arch., 1901, LVII, 244-5.
(4) Arch., 1894, LIV, 142.

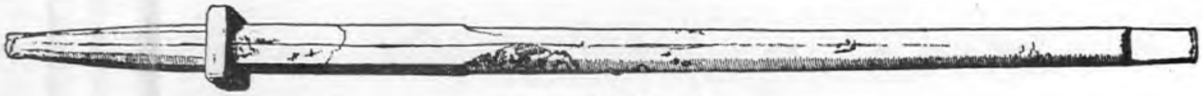
Axe-head. $\frac{1}{3}$.



Upper View.



Axe-head. $\frac{1}{3}$.



Axle (?). $\frac{1}{6}$.

Pair of Tongs. $\frac{1}{6}$.

Anvil. $\frac{1}{6}$.

Fig. 107

METALWORKING.

In this section it is proposed to highlight some of the more interesting aspects of Roman technique in metal-working without going into a detailed description of all the numerous examples of metalwork which have come to light in the various hoards of metal objects.(1)

Iron.

The raw material for the Romano-British blacksmith was blooms of iron made as described on page 56. These would be re-heated and probably beaten into bar form, the bar being a convenient starting point for much of the smith's work. Under the repeated hammering which the iron would receive in its metallurgical progress from the bloomery through the smith's hearth, the resulting products from the forge would all be wrought iron. It is possible that in some cases a carburised bloom would be received - if a furnace such as that at Colsterworth were operated as suggested on page 60 - and then the final products might approximate to a good mild steel, but there is little doubt that the majority of the articles turned out by the blacksmith would, at their best, be wrought iron.

Stripped of their outer layer of rust, such wrought iron finds reveal the history of their manufacture. Thus an axe was made by taking a bar of wrought iron, bending it double, and welding it into a strip; the strip was then bent in half, a mandrel inserted between to make the haft-hole or eye, and the iron welded together into a solid mass. Recent metallographic examination of one of the Silchester axes (from the 1890 hoard) showed, contrary to expectation, that it had not been hardened at the edge by quenching and tempering, but only by the hammering necessary to produce the requisite thinness. The axe-head is of a medium-carbon steel; the carbon was included from the smith's hearth during the repeated forgings of the metal from which the tool was made.(2)

Typical axe-heads from the 1890 Silchester hoard(3) are shown in Fig. 107 together with a blacksmith's anvil and tongs. The "axle" is over 3 ft. in length and illustrates how straight such a piece could be made, from two flat bars welded together;

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(1) A concise survey of weapons, tools & utensils is given by R.G.Collingwood in Chapter XVI of his "Archaeology of Roman Britain", (London, 1930).

(2) H.H.Coghlan, "Notes on Prehistoric & Early Iron in the Old World", 148 (Pitt-Rivers Museum Occasional Papers on Technology, 1956).

(3) Arch., 1894, LIV, 139.

Fig. 108

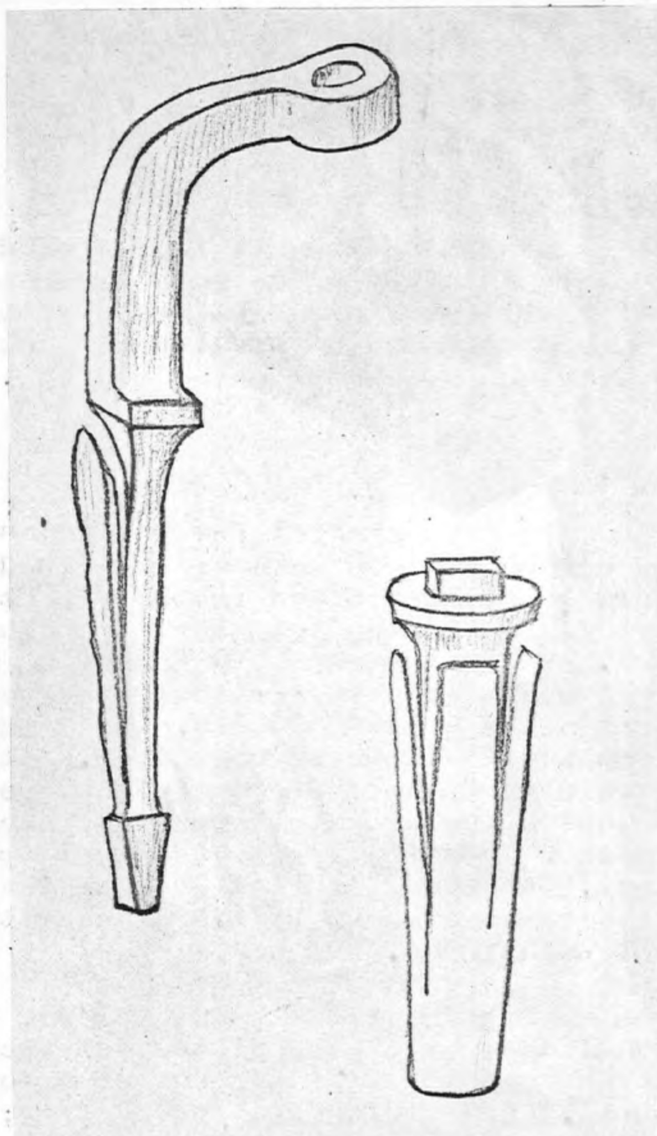
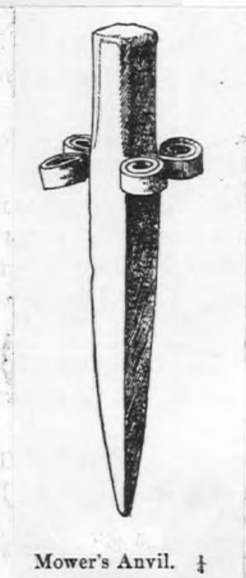


Fig. 109



Mower's Anvil. ¼

the collar near the left-hand end is 2 inches square.

Provided that an axe is sharp enough to cut, it is not a serious disadvantage if the metal is not hardened; a hard edge could be seriously damaged on striking a stone or other obstacle, whereas a roughened soft edge can readily be dressed on a whetstone. Scythes which, because of their length, might bend due to the comparative softness of the metal, were made with a stout rim to stiffen them. Nicks in the blade, caused by striking obstacles, were beaten out on mowers' anvils. Fig.108 shows, at 29, a scythe, with a blade about 5 ft. 4 in. long, from the Great Chesterford hoard, together with a mowers anvil from Silchester; the pieces projecting from the anvil prevent its being driven too far into the ground.

After metallurgical examination of some iron objects from the Wall, Smythe reported that "Sockets for various tools and weapons are made by bending the flanged end of the object, and the wooden shaft is secured by nails through the socket. A roadman's pick gave evidence that its socket was drifted and also that a broken point had been mended by welding on a piece of metal about 2 inches in size". Large masses of chain mail from Chesterholm were proved to be made of "a very mild steel".[1]

The Romans achieved a degree of standardisation in their craft products. Fig.109 shows two barbed bolts, traced from a Plate in Artis' book of engravings[2]. The larger of the two might be described as a hinge-bolt, because something is obviously intended to pivot in the hole. An identical hinge-bolt, but with its full complement of four barbs, was found at Silchester[3]. These bolts are evidently intended to be fixed into holes in masonry by running lead or cement into the hole, the barbs then serving to prevent the bolts being pulled out. A further example of uniformity is illustrated in Fig.110 where locks from Great Chesterford (drawn to a smaller scale) are clearly of the same pattern as the Silchester padlock.

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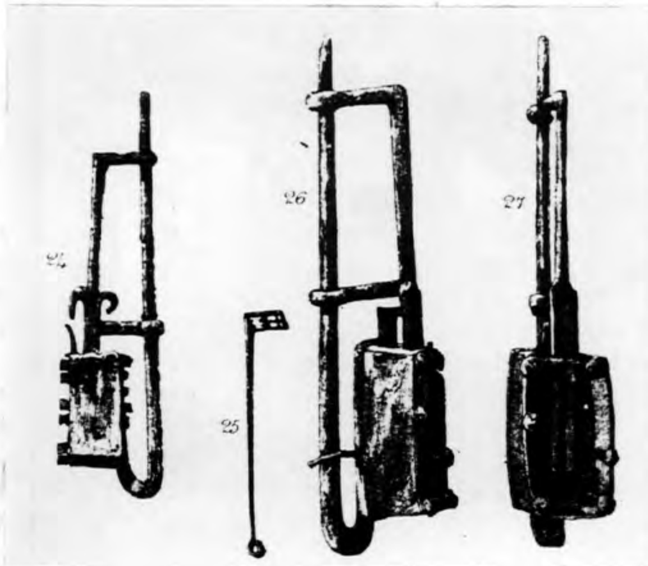
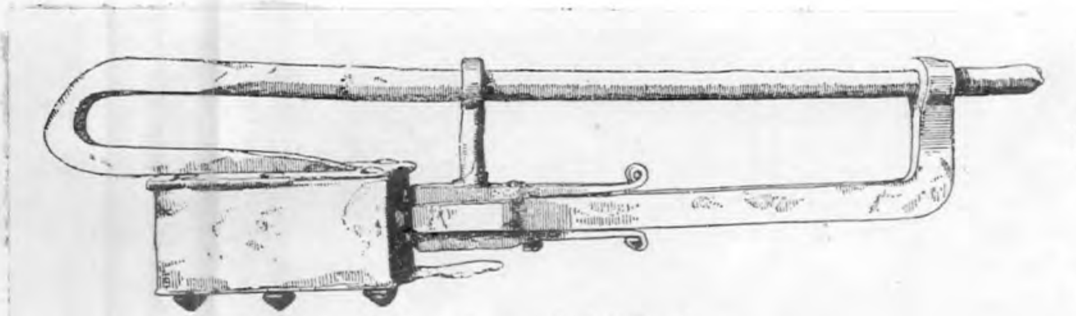
(1) J.A. Smythe, "Roman Objects of Copper & Iron from the North of England", Proc. Univ. Durham Phil. Soc., IX, 398.
(2) E.T. Artis, "The Durobrivae of Antoninus Identified and Illustrated", (London, 1828); Artis says that the bolts were found in the Parish of Castor and Sutton.
(3) See Fig. 27, Item 7, in G.C. Boon, "Roman Silchester", (London, 1957).





Large padlock (¼ linear).

Fig. 110 Great Chesterford padlocks compared with Silchester padlock.

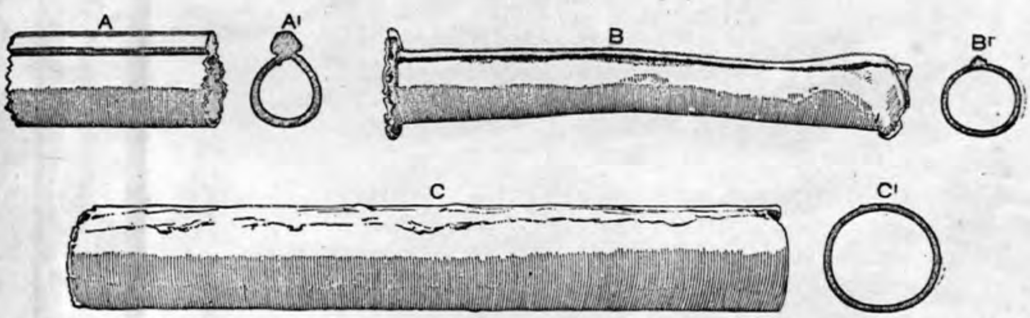


Fig 111. Examples illustrating the three methods employed by the Romans for making the joints in the manufacture of pipes. (⅙ linear.)

A A'. First method. A piece of a water-pipe dug up in Chester.

B B'. Second method. A flanged pipe from Silchester.

C C'. Third method. One of the pipes of the force-pump discovered at Silchester in 1895.

Lead.

W. Gowland investigated the methods used by the Romans in Britain for making joints in leadwork(1), as shown by the different techniques they employed in joining the edges of a strip of lead to make pipes. He found that three distinct methods were used:

1. Autogenous soldering, or "lead burning",
2. Burning the edges together with an alloy consisting of lead plus a little tin.
3. Soldering with soft solder, i.e. with a high tin solder.

Fig. 111 shows the objects examined by Gowland. AA' is a lead pipe from Chester (shown again in cross-section, in Fig. 112); microscopical and chemical examination showed no difference between the lead of the joint, and that of the pipe, hence the edges must have been burned together with lead only. The joint in the Silchester pipe, BB', by chemical analysis, contained 4.52% tin whereas the pipe itself showed only a trace of tin, indicating that the joint had been made by lead burning but using a low-tin lead alloy instead of pure lead. CC' was the pipe found in the Silchester force pump (page 19). Here the joint contained 25.42% tin, corresponding to plumber's soft solder, revealing for the first time that the Romans made and used soft solder.

The piece of pipe from the force pump body was remarkable in that, contrary to Roman lead in general, it contained tin, to the extent of 1.1%. Gowland argues(2) that as tin would be more costly than lead, tin would not be present in a lead pipe unless deliberately added, and "the effect of the addition of even small quantities of tin to lead on its physical properties is to increase its hardness, strength and durability", precisely the features which a force pump pipe should possess, and furnishing "another example .... of the intimate knowledge possessed by the Romans of the properties of metals and their alloys".(3)

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(1) W.Gowland, "The Early Metallurgy of Silver & Lead", Arch., 1901, LVII, 412-417.

(2) Arch., 1901, LVII, 416.

(3) Some caution is necessary here, because the excavation report (Arch., 1896, LV, 233) makes it clear that the pipes found in the pump body were not the originals, because they did not have the side branches which the originals must have had (to make the whole function as a force pump). As the report says, "Either, then, new pipes of a different pattern have been substituted for the older, or others for another use have replaced the originals." However, this does not affect the soft solder part of Gowland's investigation, provided that the new pipes were actually Roman, which there is no obvious reason to doubt

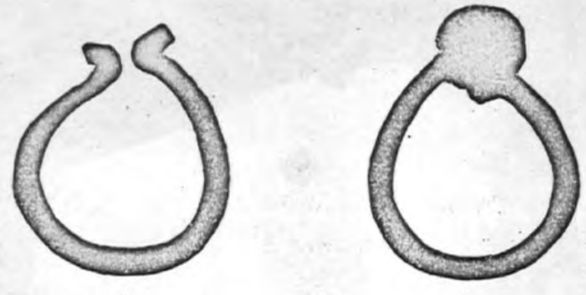
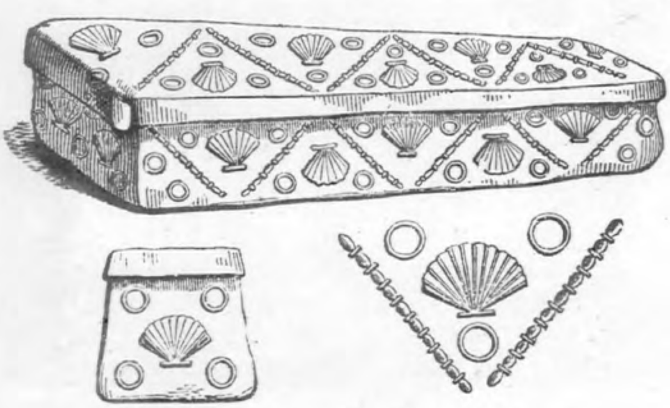


Fig. 112. The pipe from Chester (fig. 15, A A[1].) ($\frac{1}{2}$ linear.)

A. Tranverse section of sheet of lead as bent before the joint was made.

B. Tranverse section after the joint was made.



Roman leaden coffin. Colchester Museum

Fig. 113

The Romans made extensive use of lead, and Britain was no exception to this practice. A large proportion of the lead went into lead cisterns for storing water; into lead pipes for distributing water; and into the heavy plates used for making public baths. The great bath at Bath was lined with sheets of lead about 10 ft. long, nearly 5/8 inch. in thickness, and weighing 37 lb. per square foot(1). A water channel at Bath, in cross section 21 in. by 7 in., was made of lead nearly 1 inch thick.(2)

When inhumation superseded cremation, lead coffins became common, and French archaeologists are agreed that British lead was used for this purpose even in Normandy(3). Fig.113 shows a lead coffin discovered at Colchester. Gowland remarks that these coffins are generally made out of a single rectangular sheet of lead, by cutting out pieces from the corners so that the ends and sides could be bent up to form a box.(4) The vertical edges were usually joined by soldering rather than by lead burning.

The Romans appear to have been aware of the poisonous nature of minium (red-lead), for Pliny states that preventive measures were adopted by workers in minium: "Qui minium in officinis poliunt faciem laxis vesicis inligant, ne in respirando pernicialam pulverem trahant et tamen ut per illas spectent"(5) - "They who prepare minium in workshops tie up their faces in loose bags lest in respiring they inhale the pernicious dust, yet so that they may see through them".

Other Metals.

Reference has already been made (page 103) to the brass rosette and hinges found in association with leatherwork at Silchester. Gowland, who made several contributions to the study of early metallurgy, was impressed by the rich golden colour and the extreme thinness of these pieces, and he made a chemical analysis of the metal of the rosette and a stud from one of the hinges. His figures were:

	Rosette.	Stud.
Copper	80.42%.	82.31%.
Zinc	18.77	17.11
Lead	0.09.	0.08.
Iron	0.62.	0.45.

(1) Arch., 1901, LVII, 408.
(2) Cox, Arch., Jour., 1895; 25.
(3) Cox, loc. cit..
(4) W. Gowland, Arch., 1901, LVII, 419.
(5) Lib. xxxiii. cap. vii. sect. 39, Sillig's ed.

showing that rosette and stud are of practically the same alloy. Gowland says[1] "Now, of all the copper-zinc alloys, those which contain 15 to 20% of zinc possess the greatest ductility. This Roman brass is therefore one of the most ductile of the whole series of brasses. It is, besides, identical in composition with Tournay's alloy (copper 82.5%, zinc 17.5%), which, on account of this property and its rich colour, is used for the manufacture of all French jewellery made from thin sheets in imitation of gold. Hence the brass of which the rosettes are made is notably of the composition which is best fitted for making such ornaments, and is that which would be employed at the present day. Another example is thus added to those already furnished .... of the advanced stage the Romans had reached in their knowledge of metals and alloys and of their applications to suitable uses."

The metal zinc was unknown to the Romans, but a zinc ore, calamine (zinc carbonate), was familiar to them, and they made brass from calamine and copper by heating granules of copper with a ground mixture of calamine and charcoal. The charcoal reduced the calamine to zinc which then alloyed with the copper to produce brass. According to Gowland this ancient process was followed until comparatively recent times.

Specimens of brass recovered from the neighbourhood of Hadrian's Wall, and examined by Smythe[2], were found to fall into three groups if the analyses were recalculated in terms of copper and zinc only.[3]

Copper	87%	89%	94%
Zinc	13	11	6

which may imply distribution of standard brass from one centre of manufacture. Brass was "the favoured material for the making of pins and small appliances like tweezers, where springiness is required. A good deal of wire, evidently used in making these articles, consists also of brass.[4]

Bronze, of course, was well-known and it was extensively employed for making cooking utensils, weapons and jewellery. Reporting on specimens of bronze, Smythe says "In these the percentage of tin ranges from 2.5 to 12.2% and it is of interest to observe that in ancient Peruvian bronzes the range is from 2 to 13% and in Egyptian 2 to 16%[5]. Amongst the

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(1) Arch., 1901, LVII, 245-6.
(2) J.A. Smythe, "Roman Objects of Copper & Iron from the North of England", Proc. Univ. Durham. Phil. Soc., IX, 386.
(3) For convenience, Smythe's results are here quoted in round figures.
(4) J.A. Smythe, loc.cit..
(5) J.A. Smythe, op.cit., 385.

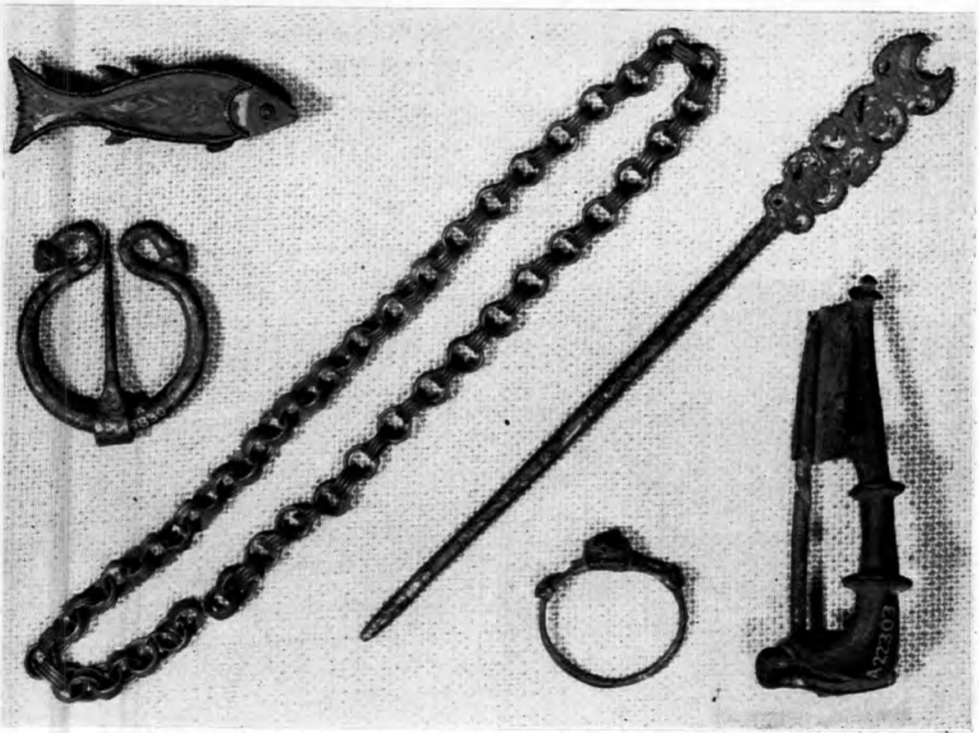

Fig.114

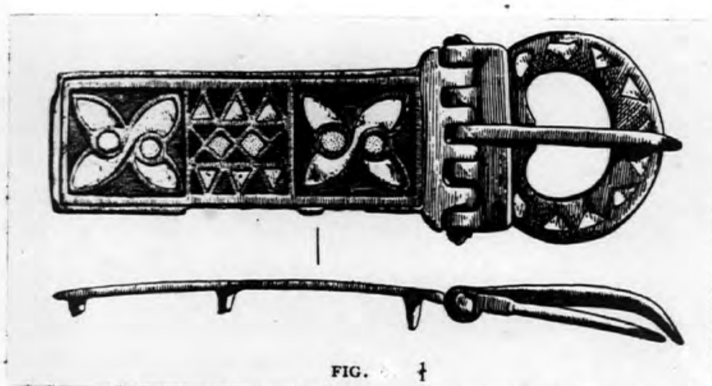

Fig.115

furnaces at Wilderspool described by May(1) were two of the reverberatory type, and associated with one of these were five fragments of crucibles. Enough of one crucible remained to indicate that it was 3/8 inch thick, about 2¾ ins. across the rim and 1¾ inch deep. Adhering to some of the pieces was corroded metal which on analysis corresponded to a bronze of composition: copper 88.74%, tin 9.73%, and zinc 1.53%. It was therefore a specimen of the alloy from which sestertii were made, and May suggests that it may have been used to make the fibulae and similar articles found in the vicinity. May concluded that the neighbouring houses were jewellers' work-shops. Crucibles, droplets of bronze, and a mould for a ring were found at Calleva.(2)

Any collection of Romano-British jewellery is certain to contain a large number of brooches, simply because brooches were then used instead of buttons. The ancestor of all brooches was the safety-pin, and Collingwood reminds us that "long before our period begins, the original safety-pin had developed in various ways and differentiated itself into various forms", and "by the time the Romans conquered Britain, the conquerors on the one hand, and the conquered on the other, were using brooches of many different kinds. Spring pins and hinge pins, bow brooches and plate brooches, simple patterns and elaborate patterns - all these were already in use".(3) Collingwood describes 118 types; he says that "Traces of the workshops in which these brooches were made have been found at Brough-under-Stainmore and Kirkby Thore in Westmorland, and at Traprain Law in Haddingtonshire" (East Lothian).(4) Here in Fig.114 we illustrate three brooches in the Guildhall Museum: the fish (top left) is enamelled green and white, below it is one of four known forms of penannular brooch; at bottom right is a 'trumpet' brooch of which there are many varieties (the remaining items in Fig.114 are a bracelet, a hair-pin and a finger-ring). In Fig.115 is an enammeled belt-end and buckle found at Caerleon.(5) A bronze brooch with green and blue enamel is shown in Fig.116, together with another brooch which has a sliding ring, and a bronze cap, probably for a staff; this cap is a good example of bronze-casting. All the pieces in Fig.116 were found at Silchester.(6) Speaking about the casting of bronze, Smythe says "Repetition work is indicated by the identity of two rather intricate ornamental castings in bronze, found at Corbridge and Housesteads," and "an ornamental stylus handle of bronze still contained a core of baked clay."(7)

(1) Thomas May, "Warrington's Roman Remains", 76, (Warrington 1904)
(2) G.C. Boon, "Roman Silchester", 182, (London, 1957).
(3) R.G. Collingwood, "Archaeology of Roman Britain", Chap. XV, 243-4, (London, 1930).
(4) R.G. Collingwood, op.cit., 253.
(5) Arch. Cambrensis, XCV, 101.
(6) Arch., 1898, LVI, 124.
(7) J.A. Smythe, op.cit., 391.

Bronze Brooch, with green and blue enamel, found at Silchester, 1897. 1/1

Bronze socketed Staff-head (?) found at Silchester, 1897. 1/1

Bronze Brooch, with sliding ring, found at Silchester, 1897. 1/1

Fig.116

Fig.117.

Examination of certain small finds disclosed some points about working methods: "Hinge pins of bronze seal boxes are made of iron; those which secure the spring of fibula-pins are of iron, brass, or bronze and, in the last case the metal is usually wrought, whilst that of the brooch itself may be cast. In one case, an iron rivet seemed to be set in a bronze sleeve. A section cut through an ornamental stud in a fibula showed that the fibula had been drilled to take the inset, the evidence being the dragging out of the cores of the cast metal of the fibula, roughly tangential to the edge of the hole."

Silchester has provided a small leaf cut out of thick gold foil,(1) probably intended for a piece of jewellery never finished, and at Verulamium in 1960 there were found a dozen tiny crucibles, some still containing traces of gold.(2) Silver plating, that is to say, silver sheathing, was not unknown in Roman Britain, as the plated heddle mentioned on page 113 proves. Ornamental silver spoons and solid silver objects like the beautiful silver dish known as the Corbridge Lanx were imported.(3) What evidence there is of native silversmith's work appears to be confined to ornamental - sometimes inscribed - silver plates used in temple ritual.(4) An interesting find at Shapwick Heath, Somerset, was a wooden tankard 57/16th inches high, with a bronze casing. The wooden base is decorated with lathe-turned circles (Fig. 117)(5).

Pewter does not appear in Romano-British civilisation until late in the period of occupation, when the rising standards of living among villa inhabitants of the fourth century probably created a demand for metal ware of pleasing appearance but without the costliness of silver.(6) Pewter is an alloy of lead and tin, and its appearance in the economy coincides with the revival of Cornish tin production. A hoard of pewter vessels was discovered at Appleshaw, near Andover,(7) and eight ingots were brought out of the Thames near Battersea.(8)

Evidence of British manufacture of metal dishes and bowls, perhaps by metal-beating rather than casting, is supplied by a remarkable series of stone moulds from Lansdown, near Bath. The moulds display not only the shape of the vessels themselves, but details such as handles, medallions and other ornamentation.(9)

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(1) Arch., 1899, LVI, 241 (2) J.R.S., 1961, LI, 180.
(3) F. Haverfield, J.R.S., 1914, IV, 1.
(4) R.G. Collingwood, "Economic Survey of Ancient Rome", iii, 99.
(5) J.R.S., 1940, XXX, 175.
(6) R.G. Collingwood, loc. cit., 98.
(7) Arch., 1897, LVI, 7. (8) Ephemeris Epigraphica, IX, 1263.
(9) I.A. Richmond, "Roman Britain", 175. (Pelican History of England, 2nd ed., 1963).

Fig.118

Jet.

Although not a metal, it is convenient to include jet here because of its association with jewellery and ornamentation. Jet is a black, coal-like substance, of dense texture but easily cut, capable of taking a high polish. Its use for ornamental purposes is known since Neolithic times, but there is no evidence of continuity between native and Roman working of jet.(1) Whitby, in Yorkshire, is the source of British jet; for generations there have been undersea outcrops which, eroded by wave-action, provided beach deposits of the material. This source has failed only within recent years, so the Romans would undoubtedly collect their supplies from the beaches without mining. Excavations in 1873 for the railway station at York, some 45 miles from Whitby, revealed blocks of jet in the rough and some pieces partly worked for pins. On the same site there was an inhumation cemetery, the third to fourth century graves of which have yielded many examples of jet jewellery, now in the Yorkshire Museum at York. It is therefore probable that somewhere on the site of the present railway station there was a workshop producing articles made from Whitby jet. Workshop rejects from this site show how jet hairpins were made: A roughly-squared block 2 to 3 inches long was pared to a cylindrical or polygonal shape, according to the kind of head required, and the shaft was then turned on a lathe and sharpened and polished. The heads were sometimes made spherical, or ovoid, or faceted, the latter by cutting the corners of a cubical head.

Jet beads for necklaces or bracelets are very numerous, and some have been cut with admirable skill to form intricate interlocking pieces. Pendants were also made, some in the form of portrait medallions; one of these from the Yorkshire Museum is shown in Fig. 118. Bangles, anklets, hair-rings and finger-rings are known, but it is worthy of note that the circular wasters, known as "coal money", which are a feature of the Kimmeridge shale industry, are conspicuously absent at York. Perhaps jet, being the more valuable material, was treated more economically, and any remnant discs were reworked into smaller objects such as beads.

At York three jet spindles, 7.4 inches long, half-an-inch in diameter, were found. As these are too long and thick for pins, it is thought that they may have been distaffs. Fragments of jet distaffs were found at Silchester.(2), and jet jewellery is found throughout Britain. This raises the

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(1) R.C.H.M., "Ebvracvm: Roman York", I, (London, 1962).
(2) G.C. Boon, "Roman Silchester", 194, (London, 1957).

question whether these products were made at York and thence traded across the country, or whether - as appears to have been the case with Kimmeridge shale - the raw material was sent to be worked at other centres. Of even greater interest is the origin of the jet objects found on the Continent, for example, in the Rhineland, because jet occurs in Spain and Southern France. Solinus, the third-century schoolmaster, recognised British jet as being of better quality,(1) and it is not unlikely that the Rhineland jet specimens were made from British jet, because the material is very similar, and it is known that the Rhine was in direct communication with eastern Britain.(2)

It might be mentioned that the York graves have also supplied ivory in the form of the ribs of a fan and a parasol, but whether these were fashioned at York from pieces of ivory, or were imported ready-made, it is as yet impossible to say.

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(1) Collectanea rerum memorabilium, 22, 11.
(2) R.C.H.M., "Ebvracvm: Roman York", I (London, 1962).

TEXTILES.

Spinning and Weaving.

Eighty-nine weaving combs, mainly made from antlers of the red deer, found in the Glastonbury lake village show that there was a flourishing production of textiles long before the Roman occupation.(1) In the Roman era British woollen goods had a reputation throughout the Empire; this is shown by Diocletian's price-fixing edict of A.D.301, in which they are the only British product mentioned. The edict was carved in stone at several imperial centres of administration, and the complete text is still being pieced together from fragments found in many places. A waterproof cloak, the "birrus Britannicus", said to be made from goat's wool, has been known for some time, but a fragment of the edict recently found in North Africa has revealed the "tapete Britannicum", a sort of plaid blanket,(2) perhaps also used as a rug or as a horse-cloth.

The Notitia Dignitatum, or list of government appointments, mentions an imperial weaving mill at Venta (which is believed to be Venta Belgarum, i.e., Winchester); the cloth would almost certainly be for the Roman army. The weaving would be done on hand-looms which would be mainly of wooden construction, unlikely to survive to the present day, although what are considered to be loom-weights - stones with a hole through them or a groove around them, or the equivalent in fired clay - are sometimes found. A remarkable survival, almost certainly Roman, is the small "heddle" found at South Shields.(3) This is made of bone, partly sheathed in silver, and in appearance is like a miniature five-barred gate stood on end, measuring about 3 1/8 x 1 ¾ inches. The bars are perforated with a single hole in the centre, each to take a thread of the warp, and the function of the heddle - as with all heddles - is alternately to raise and lower the threads of the warp when weaving, so that the shuttle containing the weft thread can pass alternately below and above the warp threads. A heddle as small as the South Shields find could only be used for weaving narrow bands such as tapes or garters, nevertheless it is but a reduced version of the full-scale wooden heddles which must have been used in the weaving of cloth.

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(1) Arthur Bulleid & H. St. George Gray, "The Glastonbury Lake Village", I, 266, (Glastonbury Antiquarian Soc., 1911).
(2) G. Caputo and R. Goodchild, "Diocletian's Price-edict at Ptolemais (Cyrenaica)", J.R.S., 1955, XLV, 106.
(3) R.C. Bosanquet, "A bone Weaving-frame from South Shields in the Black Gate Museum", Arch. Ael., 1948, XXVI, 89.

FIGURE 119. *Girl spinning with a spindle and distaff. From a Greek wine-jug, fifth century B.C.*

Fig. 120

Fig. 121

On all Romano-British domestic sites there is evidence of hand-spinning. Hand-spinning was the method of forming yarn. In this process the combed and cleaned wool or flax is impaled on a distaff held in the left hand or under the arm. A length of fibres is drawn from the mass, twisted by hand, and wound on to the spindle which is then kept twirling to draw off, and twist, more yarn. The spindle is weighted with a "whorl" which acts as a small fly-wheel, and so helps to maintain the rotary movement (see Figs. 119&120). The evidence for hand-spinning is the many spindle whorls - in stone, lead, glass, baked clay - which are unearthed, along with spindles in bone or wood. Fig. 121 illustrates some implements (in the Guildhall Museum) for the making of clothing or nets. From left to right they are: a bronze needle for net-making; spindle of bone; spindle of wood with a glass whorl; group of five whorls; bronze hook; three needles. That spindle whorls were treasured possessions is shown by the trouble taken at times to decorate them[1], and by the fact that they are sometimes found buried with the people who had used them.

Several thin bronze plates, about one inch square, with five teeth filed along one edge, were found at Silchester, and are considered to have been used either for carding wool (drawing out the fibres lengthwise), or as weaving-combs to press down the weft.[2] There have been actual finds of textiles: Silchester furnished a shred of linen, and the Roman fort at Huntcliff a piece of brown cloth.[3] The most outstanding discovery, however, was made in 1850 by two men digging peat on Grewelthorpe Moor in Yorkshire, who came upon the body of a man - "from his dress evidently a Roman" - which the peat had almost completely preserved. "The robes were quite perfect when found, the toga of a green colour, while some portions of the dress were of a scarlet hue; the stockings were of yellow cloth, and the sandals of a finely artistic shape".[4]

Finishing: Fulling and Cropping.

"Finishing" is the treatment of the cloth after weaving. The most important part of finishing is "fulling"

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(1) For example, the early harbour site at Gloucester yielded a first-century spindle whorl of the local blue-lias stone, decorated with incised hatched triangles and segments of circles (J.R.S., 1943, XXXIII, Plate I).
(2) G.C. Boon, "Roman Silchester", 195, (London, 1957).
(3) J.R.S., 1912, II, 215.
(4) Audrey S. Henshall, "Textiles & Weaving Appliances in Prehistoric Britain," Proc. Prehistoric Soc., 1950, XVI, 140, quoting from "The Ripon Millenary Record", 1892. A stocking and a sandal are in the Yorkshire Museum at York.

FIGURE 122 · (Above) *Cloth shears*; (below) *fulling. From a Gallo-Roman tomb at Sens.*

which cleans, felts and thickens the cloth. The ancient fuller carried out this process by treading the cloth in a vat containing a detergent solution. Soap was not known to the Greeks, or to the Romans(1) who used Fullers' earth ("creta fullonica", a hydrated aluminium silicate) and an alkali, the former to absorb grease and the latter to form soluble compounds with it. A commonly used alkali was human urine which through staleness had become ammoniacal, but lye made from plant ashes or from natron (soda) was sometimes employed. The lower part of Fig. 122shows a fuller at work. The fullers were also the laundrymen of ancient times, cleansing garments which had already been worn.

G.E. Fox described(2) probable fulleries at Chedworth Villa, Gloucestershire; Titsey, Surrey; and Darenth in Kent. The identity of the Titsey and Darenth finds has not so far been questioned, but modern opinion about Chedworth is that in the fourth century the original bath house was converted into hot rooms with large cold plunges, and it is this scheme which has been mistaken for a fullery.(3) The principal evidence at Titsey is firstly, a large tank, 9 ft. wide, over 21 ft. long and 2 ft. deep, paved with tiles, and with a central gutter running longitudinally. A thin, transverse dwarf wall of brick divides the tank into two sections, the gutter passing through the wall. This tank was thought by Fox to be for cleaning purposes because it is too large for private baths and too shallow for a cold bath. The second important piece of evidence is a large and complicated hypocaust system which could perhaps have been for heating hollow drying-tables on which the treated materials would be laid out to dry.

The plant at Darenth is smaller. There is a shallow trough, probably the treading place of the 'fullonica', in which the larger articles to be fulled could be trodden in the detergent before being pulled up the sloping sides of the trough for beating and scrubbing. Another shallow tank and a large tank complete the washing facilities, and in one of the blocks of buildings there is a "larger number of heated chambers than any Roman building erected for habitation in this country is known to have had". It is thus possible at Darenth to identify the places for fulling and drying.

After fulling the cloth had, of course, to be washed with clean water, either in a vat or in a stream, and at the same time it was beaten with sticks to increase the closeness of texture. Subsequently it was stretched in the open air to

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(1) Singer, Holmyard, Hall & Williams, "A History of Technology", 2, 215, 355, (Oxford, 1956).
(2) G.E. Fox, "Notes on some probable traces of Roman Fulling in Britain", Arch., 1905, LIX, 207.
(3) "Chedworth", (National Trust Guide, 1962).

Figure 123. *Raising cloth before cropping. From the Clothiers' window at Semur-en-Auxois. c 1460.*

Figure 124. *Shearing (or cropping) cloth. From the Clothiers' window at Semur-en-Auxois.*

Figure 125. ***Roman napping-shears from Chesterford, Essex. c 4·5 ft long.***

Fig. 126. Furnaces in a dyer's workshop at Pompeii.

dry on frames or "tenters". Lines of post-holes observed at Silchester may have been for tenters.(1)

The dried fabric can then be treated in two ways according to whether a soft, fluffy finish, or a hard, close nap is required. For a soft finish the fibre ends are raised by a severe form of brushing, using - as Pliny describes - hedgehog skins, or sometimes a tough kind of thistle. In Europe and particularly in southern England teazels were cultivated for the purpose, and the mediaeval cloth finisher depicted in Fig.123 is obviously using a 'brush' made of teazel heads.

For a hard nap, the raised fibres were clipped off, as close to the cloth as possible, by "cropping shears". The large shears from Great Chesterford, shown as Item 30 in Fig.108 opposite page 105, and again in Fig.125, are thought to be cropping shears from a woollen mill. The upper part of Fig.122 shows a Roman using cropping shears, but the manner of use is more clearly illustrated in Fig. 124 where the mediaeval worker has his left wrist through a stirrup-grip on one blade of the shears; he operates the blades with the fingers of the same hand, whilst with his right hand he steadies the shears against his body. By having the cloth stretched over a frame or on a bench, and repeatedly brushing and cropping, Roman and mediaeval finishers would achieve a firm nap.

Finishing: Dyeing.

Bleaching and dyeing are crafts of great antiquity. Linen cloth as woven was a grey-brown colour and had to be bleached, either in the sun for several weeks, or artificially by sulphur fumes. A Pompeian mural shows a hemispherical wire frame, like the hoop of a skirt, for cloth to be laid over and exposed to the fumes from a pot of burning sulphur placed inside the frame.

In the nineteenth century it was thought that a Romano-British dyeworks had been discovered at Silchester: Fox, excavating in Insulae IX, X and XI, came across buildings which were not houses but apparently workshops of some sort. The chief feature was the remains of a number of circular furnaces. No superstructures remained, but "only one or two courses of tiles surrounding a tile hearth". Comparison of these with furnaces in a dyer's workshop at Pompeii (Fig. 126) led Fox to say (2) that had the Pompeian furnaces "been reduced to the

(1) J. Thompson, "The Book of Silchester", 2, 406, (London,1924).
(2) G.E. Fox, Arch., 1895, LIV, 439 et seq..

condition of those at Silchester, they would have presented identically the same appearance. Not only that, they agree almost to an inch in dimensions. If, therefore, such a close likeness is to be relied upon, it may with reason be considered that the furnaces at Silchester and those in the house in Pompeii were built for the same purpose", that is, for dyeing.

This evidence is altogether too slender. Boon points out(1) that the "dyer's furnaces" could have provided hot water for brewing, and that the building containing the furnaces resembles a villa at Roncinnes (Belgium) which is thought(2) to have been used as a brewery. Alternatively, as Boon himself suggests, the furnaces may just have been the hearths of ordinary baking ovens.

The latter suggestion, in fact, is supported by Fox's own report where (page 459) he reveals that a number of querns were dug up on the site, leading him at first to think that bakeries were involved and that the circular hearths were those of ovens. What is even more difficult to understand is that Fox also mentions (page 460) the discovery "of several cakes of metallic substance in Insulae IX and XI", but for some inexplicable reason he does not appear to have had these examined before issuing his report(3) One is therefore forced to the conclusion that the Silchester dye-works is not proven,(4) which means that, so far, we have no certain evidence of a Romano-British dyer's establishment.

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(1) G.C. Boon, "Roman Silchester", 193, (London, 1957), quoting a suggestion made to him by Dr. Applebaum.

(2) Annales de la Soc. Arch. de Namur, XXI, 198.

(3) It seems hardly likely that these were the specimens analysed by W. Gowland in 1900 (Gowland, "Remains of a Roman Silver Refinery at Silchester", Arch., 1900, LVII, 313), because although the find-year, 1894, is the same, Gowland says that Fox and Hope gave him "fragments of refractory material found in 1894", whereas Fox speaks of "<u>cakes</u> of <u>metallic</u> substance".

(4) This observation in no way impugns the honesty of Fox as an excavator. He has at least <u>stated</u> all the evidence, but his keenness to find an Italian parallel for his discovery apparently tempted him to reject out of hand alternative and (on the evidence) equally probable explanations.

Fig.127.(1/5)

Fig.128

WOODWORKING

Fig. 127 shows a group of Romano-British carpenter's tools in the Guildhall Museum, London. From left to right we have: a saw, an axe and hammer combined; two boring bits with squared ends for gripping in a brace; a chisel; a whetstone; a kind of gimlet; a modelling tool; a mason's chisel and a branding-iron for marking CVC on wood.

Fig. 128 is a carpenter's plane from Silchester. Two adzes, some chisels and gouges, and a nicked file for saw-sharpening, all from Silchester,[1] are illustrated in Fig.129. At first sight these tools look remarkably modern, particularly the plane which could almost be a copy of a modern all-metal jack plane.[2] This modern appearance, however, is not astonishing when it is remembered that we are considering <u>hand</u> implements which have been made and used from time immemorial. There is obviously a limit to the evolution of an implement as far as suitability of shape for purpose is concerned, and by the time of the Romans, hand tools must have attained something like perfection of form. In appearance, therefore, Roman chisels, planes and the like might be expected to resemble their modern successors; the only scope for improvement in the intervening years has been in the quality of the materials used to make the tools: for example, tempered steel blades instead of the wrought iron which was the best metal available in Roman times.

At least two Roman ladders are on record, both found in wells and both remarkable in having their rungs spaced rather more widely than would be considered correct today. One found at Silchester in 1900 had rungs 14 inches apart,[3] and the other from the City of London[4] had rungs spaced at 20 inches. The London ladder was 15 ft. long, but the Silchester specimen had been broken, apparently when the well had fallen in, and only the buried length was found. From the depth of the well, the ladder could have been 24 ft. long. The sides were of fir and the rungs of oak; this may be an instance of careful choice: fir for its long, straight grain, and oak for its hard wearing properties. The oaken rungs were 1 inch thick and 2 inches deep, projecting 2 inches beyond the sides where they were secured by wooden wedges. The London ladder was entirely of oak. These ladders are substantial reminders of Romano-British woodwork, but in the

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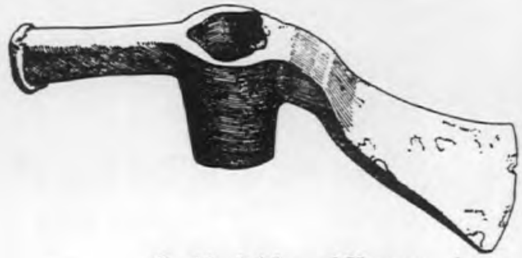
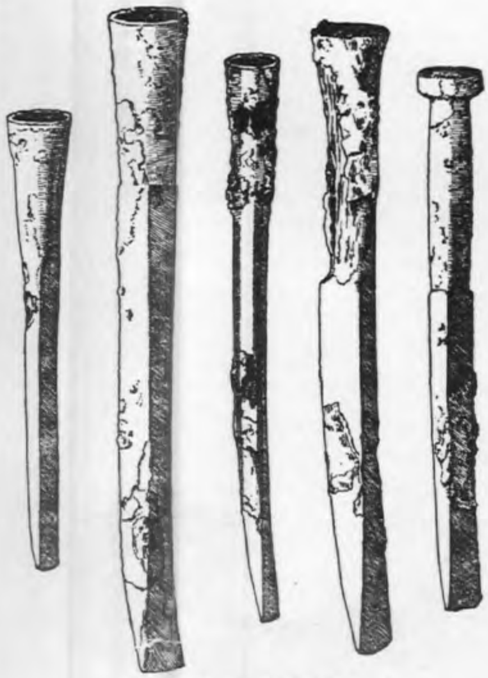
(1) Arch., LIV, 139.
(2) Actually, the Silchester plane is only of wood clad with metal.
(3) Arch., 1901, LVII, 244.
(4) J.R.S., 1955, LV, 138-9.

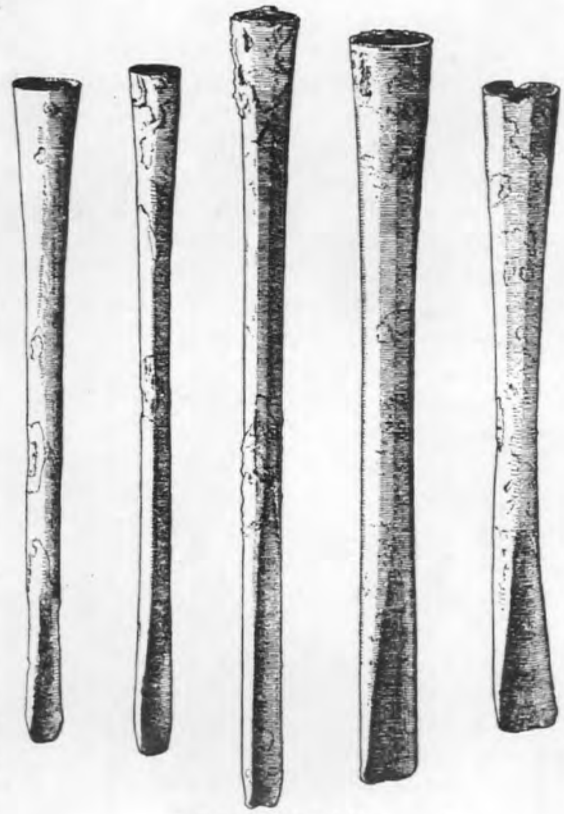
Adze. ¼.



Combined Adze and Hammer. ¼.



Group of Chisels. ½



Group of Socketed Gouges. ⅓.

¼.

Fig.129

main we have only vestiges remaining, for example, at Verulamium some evidence of oak plank flooring was found in 1960,[1] and sockets for shelf brackets, with traces of shelving were found in the cellar of a shop in 1930.[2]. At Lullingstone in Kent the imprint in mortar, of the timbers of a staircase was observed.[3]

Three bronze foot-rules have been found. The first came from Caerleon[4] and is illustrated in Fig. 130. In common with the others it is hinged to fold. It has a stay at the back, turning on a pivot and engaging with two studs (just visible on the drawing) on the opposite limb, to keep the rule rigid when opened. Another 'regula' was found at Warrington, and as described by May[5] it seems to have been very similar to the Caerleon rule, with the same pivoting latch on one limb to slip under the heads of two studs on the other. Graduations, however, were visible on the Warrington rule: slight indentations for the inches, with a double mark for the quarter foot. The third specimen, of which only one limb remained, came from Silchester;[6] three of the faces of the limb were graduated, one in 'unciae' (twelfths of a Roman foot), the second in 'digiti' (sixteenths), and the third in quarters of a foot, 'palmi'.

The turning of wood on a lathe, or its equivalent, is a process of considerable antiquity, even in Britain where Glastonbury has yielded a massive lathe-turned wheel-hub of oak, some 8 inches in diameter and over 12 inches long.[7] Wood turning, naturally, was practised in Roman Britain, as shown by the legs of the couch or bed on Victor the Moor's tombstone (Fig. 89 , opposite page 94), and by the base of the tankard depicted in Fig. 117 opposite page 110 .

Spades, shovels and scrapers were made of wood, reinforced with iron only at the edges. As there was no scarcity of iron in Britain this practice was probably due

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(1) J.R.S., 1961, LI, 180.
(2) J.R.S., 1931, XXI, 228, Plate XVIII.
(3) J.R.S., 1951, XLI, 137; Plate XI.
(4) Arch. Jour., 1851, VIII, 160.
(5) Thomas May, "Warrington's Roman Remains", 80, (Warrington, 1904).
(6) G.C. Boon, "Roman Silchester", 196, (London, 1957).
(7) Arthur Bulleid & H. St. George Gray, "The Glastonbury Lake Village", Vol. 1, 336, (Glastonbury Antiquarian Society, 1911).

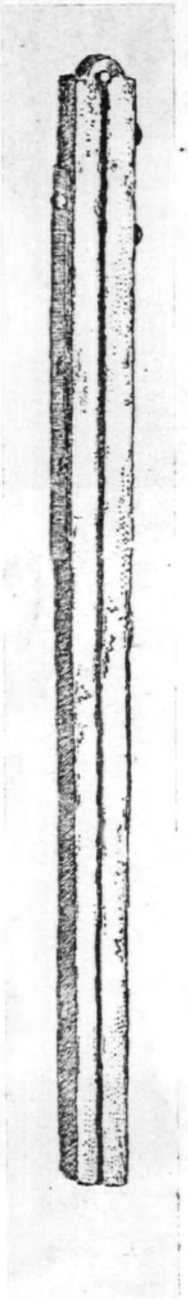
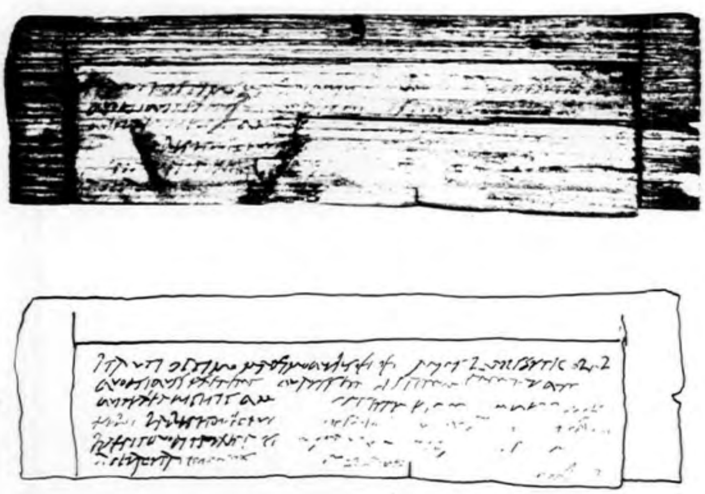


Fig.130

Fig. 131



CHEW STOKE, SOMERSET: WRITING TABLET OF LARCH INSCRIBED IN INK, FOUND IN THE WELL OF A ROMAN HOUSE.

Fig. 132

CITY OF LONDON: ROMAN WRITING-TABLET, A LETTER WRITTEN APPARENTLY AT ROCHESTER (DUROBRIVAE), NOW IN THE GUILDHALL MUSEUM.

Fig. 133

to the difficulty of making metal blades stiff enough to withstand the leverage applied in normal use.

Another and probably much less extensive use of wood was for writing-tablets. These wooden tablets (see Fig. 131 , Guildhall Museum) were coated with wax for writing upon with a pointed stylus. In the top right of Fig. 131 are two metal styli and one of bone; the blunt end in each case may have been for rubbing out. To the left of Fig. 131 is a baked clay inkwell, and below it, one of bronze. The pen between the two inkwells, for writing on papyrus or parchment, is spoon-shaped at one end for stirring the ink. There are examples of direct writing in ink on wood, as opposed to scratching a waxed wooden tablet, and two specimens of this procedure have recently come to light. One (Fig. 132) was found at a depth of 25 ft. in the well of a Roman villa at Chew Stoke in Somerset; the wood has been identified as larch, not generally thought to have been indigenous in Britain in Roman times. What is left of this tablet measures 6.6 by 2 inches; another 'leaf' found at the same time was of silver fir, measuring 6.5 by 3.8 inches, but it bore no writing.(1) The second example (Fig. 133) was pieced together from seventeen pieces of wood found in a timber-lined pit in Queen Street, in the City of London. The assembled pieces corresponded to a long, thin strip about 10.75 by 2 inches.(2)

Interesting survivals of wood, evidence of the trees existing in Roman Britain, are first, the contents of the well of a villa at Langton, Yorkshire, which included alder, ash, cherry, sweet chestnut, elder, oak, sycamore, willow, heather, hazel nuts and walnuts,(3) and second, an excavation at Brough-by-Bainbridge which showed that the early rampart incorporated a lacing course of birch branches.(4)

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(1) Eric G. Turner, "A Roman Writing Tablet from Somerset", J.R.S., 1956, XLVI, 115.
(2) Eric G. Turner & Otto Skutsch, "A Roman Writing Tablet from London", J.R.S., 1960, L, 108.
(3) J.R.S., 1932, XXII, 203; with these specimens was found a coin of Constantine I, A.D. 335-7.
(4) J.R.S., 1952, XLII, 91 and Plate XI.

APPENDIX I.

Some Notes on Terra Sigillata

Designation

By long usage, the term 'Samian' has come to mean any red-gloss ware found in Europe, whether from the island of Samos or not. True Samian ware, R.J. Charleston says,[1] "is distinguished by a cinnamon-coloured or pinkish-yellow body full of particles of mica, and by an orange-red gloss, which absorbs water". It has been found on sites in Greece, South Russia, Syria, Palestine, and plentifully on Samos itself.

Much so-called Samian ware has been decorated with figures in relief either by shaping the pieces inside fired bowl-shaped clay moulds bearing the design in intaglio, or by applying previously moulded designs or figures to the ware. The nature of the decoration - figures in cameo or relief - has led Continental writers to use the term 'Terra Sigillata', 'figured clay', to denote this type of ware. This description is preferable to 'Samian', because in the vast majority of examples the ware has been made in Italy or in one of the western Roman provinces, but if taken literally it excludes - as Oswald and Pryce point out[2] - red-gloss ware which is

(i) Plain
(ii) Decorated 'en barbotine' (i.e. by trailed slip)
(iii) Rouletted
(iv) Incised
(v) Painted with a pattern.

Perhaps the safest designation, and one having the widest application, would be "red-gloss ware", provided that the gloss or lustre has been produced in the manner described below; "red-glazed ware" would be

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1. R.J. Charleston, "Roman Pottery", (London, 1955).

2. Felix Oswald & T. Davies Pryce, "An Introduction to the Study of Terra Sigillata", (London, 1920).

inadmissible because the uniquely luminous surface is not due to a glaze, in the strictly ceramic sense of the word.

Nature of the lustre

By "red-gloss ware" (or Terra Sigillata", if the term is applied to cover not only figured ware but the Oswald and Pryce variants mentioned earlier) is meant antique pottery of Greek or Roman origin which is distinguished by a particularly beautiful lustre and a red-brown colour. Archaeologists have long been interested in ascertaining how this surface effect was produced; it could not be a glaze, or an engobe (a sintered coating of mixed minerals) because the thickness of the red-gloss 'skin' - 5 to 15 microns, in most of the measured specimens - is much less than that of glazes or engobes. In older literature there was speculation about a varnish or a laquer, or even a glass coating, and it is only in the last 25 years or so that the problem has been properly attacked from the ceramic side and solved, chiefly by German workers.

The first fundamental approach was by C. Neumann(1) who suggested that the gloss was the result of applying clay washings to provide a glaze-forming flux, but subsequent investigators failed to reproduce the surface lustre despite the use of a large variety of clays. Eventually T. Schumann(2) showed that the required effect could be obtained by applying clay suspensions, provided that only particles smaller than 1 micron are used. His method was to stir up a clay/water mixture, add a suspending agent (ammonia, alkali, etc.), allow the coarser particles to settle, and then use only the supernatant liquid, containing the finest particles, at a predetermined specific gravity of about 1.1. If in this procedure a ferruginous clay is used, thus giving ferric oxide when fired in an oxidising atmosphere, the result is the red-gloss of the Roman Terra Sigillata.

In 1953 Oberlies and Koppen(3), employing both the ordinary and the electron mic_roscopes, and X-ray diffraction methods, examined fragments of Greek and Roman lustre ware. They confirmed Schumann's findings, and they were able to reproduce the red-gloss themselves by applying a wash of very fine clay particles to laboratory-made ware. They demonstrated that the lustre is due to reflection of light from ultra-fine,

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(1) C. Neumann, Sprechsaal für Glas, Keramik, Email, 1932 page 253.
(2) T. Schumann, Berichte der Deutschen Keramischen Gesellschaft, 1942, 23, 108-126.
(3) F. Oberlies & N.Koppen, Berichte der Deutschen Keramischen Gesellschaft, 1953, 30, 102-110.

Bild 2. Nr. 801 „Arretin. Sig.". Lackabdruck. Vergr. 7500×

Bild 3). Nr. 854 „Südgall. Sig.". Lackabdruck. Vergr. 7500×*

Bild 4. Nr. 689 „Ostgall. Sig.". Lackabdruck. Vergr. 7500×

Fig. 134

Bild 8. Nr. 3 Griechische Vase, roter Grund. Lackabdruck. Vergr. 7500×

Fig. 135

Bild 10. Römische Terra Sig. Nr. 801. Vergr. 200×

Fig. 136

lamina-shaped clay particles. Some of their electron micrographs are reproduced in Fig. 134 which shows that the lamina-shaped clay minerals impart a surface texture which, to the electron microscope, is rough although to the naked eye it appears exceptionally smooth and luminous. Reading from top to bottom in Fig. 134 the wares represented are Arretine, South Gaulish, and East Gaulish; these micrographs show a progressive change in appearance, arising from differences between the local clays employed. Oberlies and Koppen stress the fact that all smooth sintered surfaces show a marked decrease in lustre ('smooth' in this context means as viewed by the electron microscope.

Particularly interesting is Fig. 135, also taken from Oberlies and Koppen's paper; this depicts a crack in the surface layer of a Grecian vase, a region where in the course of time the exceptionally thin glossy skin has split open, revealing the much more coarsely-formed body underneath. The extreme thinness of the lustre of red-gloss ware is illustrated by Fig. 136 which is a section through the surface of a Roman vase fragment. Here the glossy skin, represented by the upper dark layer, is only about 20 microns thick.

The electron micrographs in Figs. 134, 135, and 136 are slightly reduced as compared with the originals in Oberlies and Koppen's paper, and as reproduced here the corresponding magnifications are approximately x 4,400, x 6,800 and x 150.

Oberlies and Koppen concluded that suspensions made from clays of the illite and kaolinite type gave the highest gloss.

Many Greek painted vases have glossy black painting on a red-gloss body, i.e., black-gloss and red-gloss lustres can appear on the same vase. Oberlies and Koppen believe that the Greeks painted the black decoration thickly, and fired the ware first under reducing conditions, giving an all-black body, and then completed the firing under oxidising conditions. At first, therefore, the iron oxide was reduced to black Fe_3O_4, and subsequently, in the oxidising fire, it was re-oxidised to Fe_2O_3 but only where the coating was thin. The thick painted decoration remained black because it was relatively impervious to the oxygen available in the second (oxidising) stage of the firing. In this way the Greeks obtained iron in two states of oxidation, and therefore in two colours, on the same vase.

Classification of Forms

The numerous shapes or 'forms' of Terra Sigillata have been listed. The first systematic study was made by Hans Dragendorff. W. Ludowici followed with a study of Rheinzabern Sigillata, potters' stamps and pottery of the Hadrian-Antonine period; Joseph Déchelette dealt with Gaulish pottery, and H.B. Walters made a valuable compilation of forms in the British Museum. These four authorities are regarded as the principal classifiers of Terra Sigillata, and their works are:-

Hans Dragendorff, "Terra Sigillata", Bonner Jahrbucher, XCVI, 18-155, and XCVII 54-163 (Bonn 1895-6)

Hans Dragendorff, (ed. C. Watzinger) "Arretinische Reliefkeramik", (Reutlingen, 1948).

W. Ludowici, (Munich, 1901-12):

i. "Stempelnamen röm. Töpfer von meinen Ausgrabungen in Rheinzabern", 1901-4.

ii. Ditto, 1901-5.

iii. Urnengräber röm. Töpfer in Rheinzabern",1905-8.

iv. "Röm. Ziegelgräber", 1908-12.

J. Déchelette, "Les vases céramiques ornés de la Gaule romaine," (Paris, 1904).

H.B. Walters, "Catalogue of Roman Pottery in the Department of Antiquities in the British Museum", (London,1908).

Mention should also be made of an excellent survey which is particularly useful in linking Continental production with finds in Britain:

Felix Oswald & T. Davies Pryce, "An Introduction to the Study of Terra Sigillata", (London, 1920).

Felix Oswald compiled two valuable indexes relating to Terra Sigillata:

"Index of Potters' Stamps on Terra Sigillata", (The Author, East Bridgford, 1931).

"Index of Figure Types on Terra Sigillata," (Univ. of Liverpool, Inst. of Archaeology 1936-7).

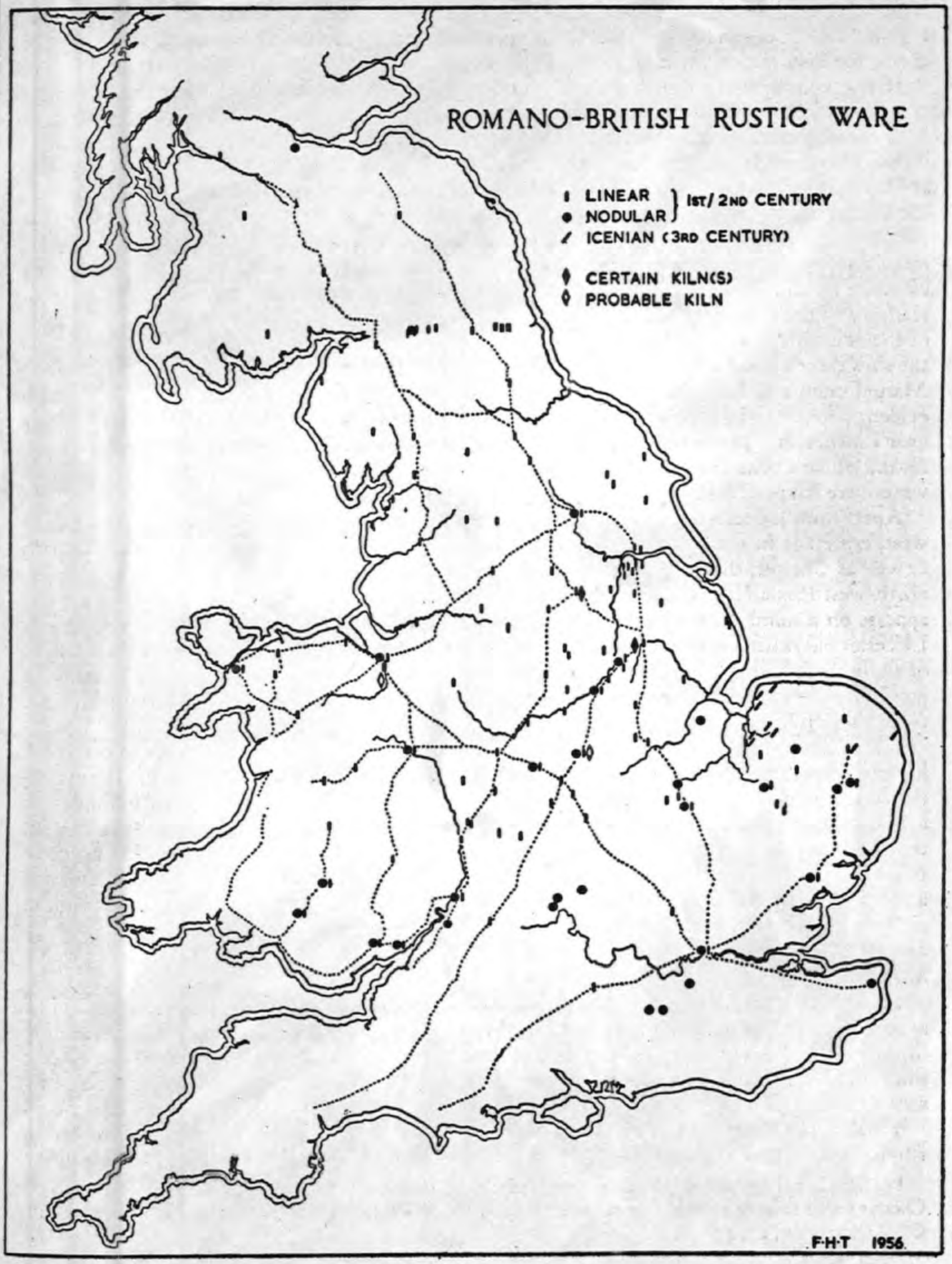

FIG. 137. Map showing distribution of Romano-British rustic ware. ***Addendum***: **kiln site at Lea, nr. Gainsborough, Lincs.**

Jar of dark-coated grey clay with raised slip-decoration ('rustic ware'). Found at York. North British; second half of 1st century A.D. *Ht.* $6\frac{1}{2}$ *in.*

Fig.138

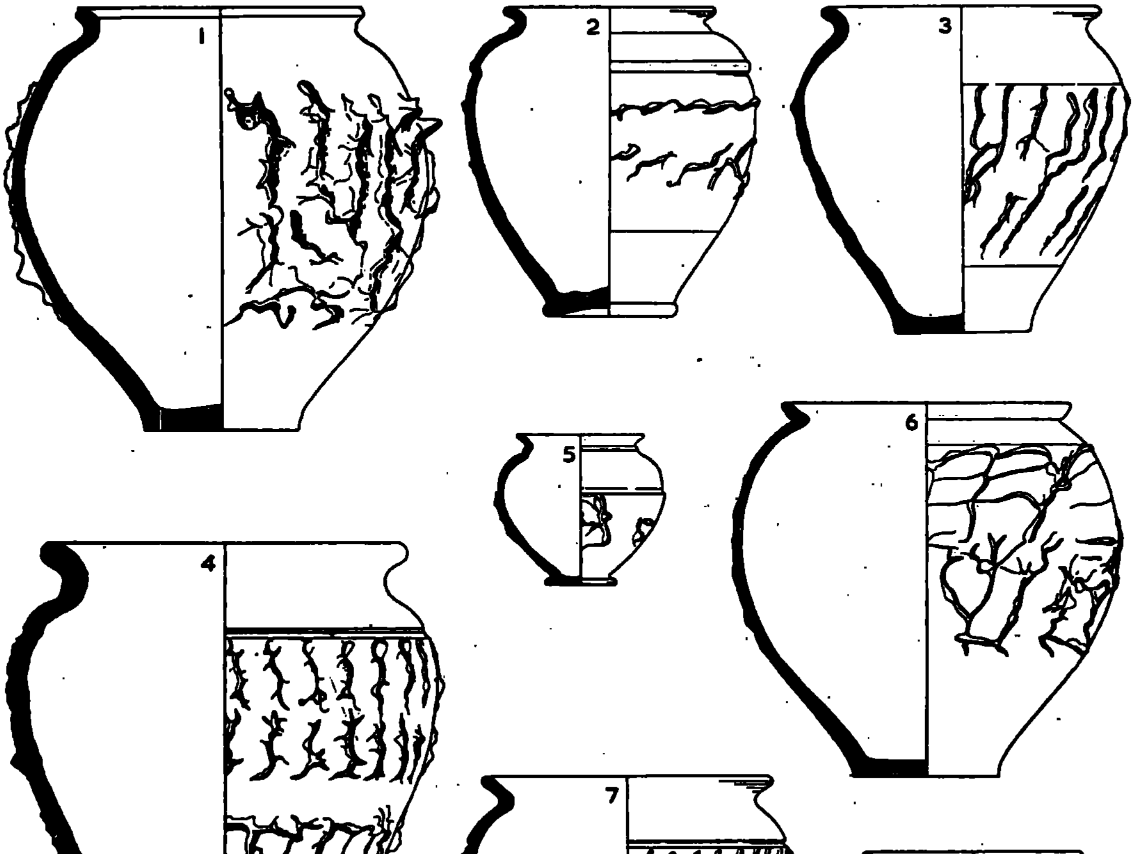

FIG. 139 Examples of Romano-British rustic ware (¼).

Appendix II

Romano-British Rustic Ware

A type of decorated ware which should be mentioned because of its remarkably wide distribution (see Fig. 137)(1) is the so-called 'Rustic' ware. The decoration, or rustication, is a relief effect obtained by applying slip (almost invariably of the same colour as the body of the ware) to the piece when the latter has reached the leather-hard stage. The slip is applied either as blobs or as lines which immediately afterwards are drawn up by the finger (or a suitable tool) into points or ridges respectively. No attempt is made to obtain smoothness, and therefore the result is either rough, pointed blobs or jagged, ridged lines, giving a not unpleasing appearance aptly named 'rustic'. Fig. 138 shows a typical specimen, in the Yorkshire Museum at York.

F.H. Thompson(1) classifies this ware into three varieties according to the nature of the decoration:

1. Nodular (pointed blobs)
2. Linear (ridged lines)
3. Icenian (oblique, ridged lines confined to the shoulder of the pot)

The term 'Icenian' was suggested by Prof. D. Atkinson(2) to describe the third variety, which appears to be confined to a number of sites in Norfolk. Icenian ware belongs essentially to the third century, and it followed a gap in the production of the nodular and linear types which ran from about mid-first century into the second century. The three types are easily identified in Fig. 139.

F.H. Thompson suggests(3) that Rustic ware sprang from the Rhineland by reason of the strong military connection between Roman Britain and Germany, but R.J. Charleston reminds us that "Although probably inspired by early first-century imported wares with applied blobs or ridges of clay, the character of these Rustic pots is utterly different. They have a spontaneous quality which (their precise shapes apart) should appeal to those who admire the immediacy of effect and the personal touch of some Japanese pottery."(4)

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(1) F.H. Thompson, Antiqs. Jour., 1958, XXXVIII, 15; the present account is based on his Appendix, page 24 et. seq..
(2) Norfolk Archaeology, XXVII, 219.
(3) Loc. cit., page 32.
(4) R.J. Charleston, "Roman Pottery", 34 (London, 1955).

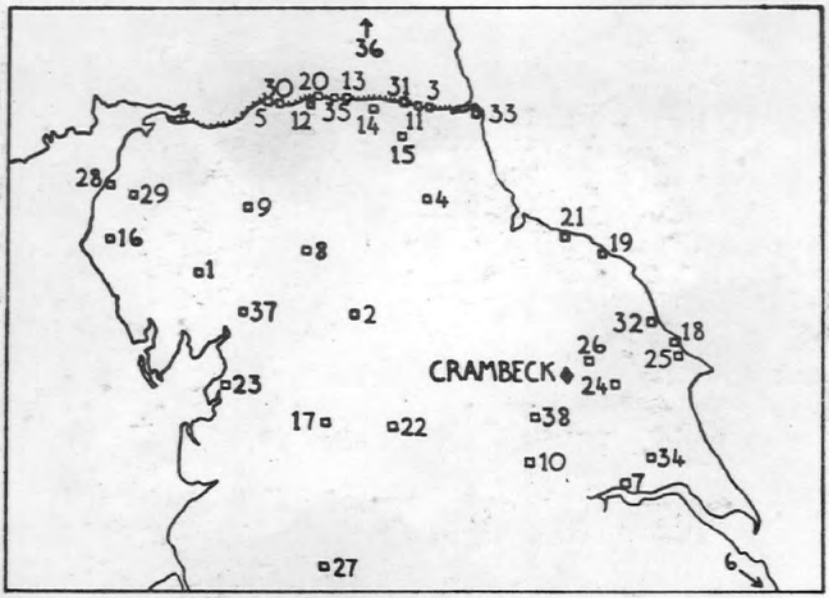

FIG. 47. Sketch-map showing distribution of Crambeck Ware

Appendix III

The Distribution of Crambeck Ware.

There are seven types of Crambeck ware which occur in deposits later than the Picts War of A.D. 367; this fact, coupled with the lack of late coin-evidence from many sites in northern England, makes the distribution of Crambeck ware a valuable guide to chronology. Below is given the key to the distribution map of Fig. 47. For complete details, of course, reference must be made to the original paper.(1)

1. Ambleside.
2. Bainbridge.
3. Benwell.
4. Binchester.
5. Birdoswald.
6. Brancaster.
7. Brough on Humber.
8. Brough under Stainmore.
9. Brougham.
10. Cawood.
11. Chapel House.
12. Chesterholm.
13. Chesters.
14. Corstopitum.
15. Ebchester.
16. Ehenside Tarn.
17. Elslack.
18. Filey.
19. Goldsborough.
20. Housesteads.
21. Huntcliff.
22. Ilkley.
23. Lancaster.
24. Langton Villa.
25. Long Whins.
26. Malton.
27. Manchester.
28. Maryport.
29. Papcastle.
30. Poltross Burn.
31. Rudchester.
32. Scarborough.
33. South Shields.
34. Throlam.
35. Tower Tye.
36. Traprain Law.
37. Watercrook.
38. York.

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(1) "A Pair of Fourth-century Romano-British Pottery Kilns near Crambeck (Philip Corder), with a note on the Distribution of Crambeck Ware (Margaret Birley)", Antiqs. Jour., 1937, XVII, 392.