THE CHEMICAL COMPOSITIONS OF NINETEENTH-CENTURY COPPER-BASE ENGLISH JETONS

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THIS paper, in which jetons are defined in the general Continental sense to mean die-stamped small metal discs without intrinsic monetary value, spans a period of fundamental change in the English brass-making industry. Traditional calamine brass gave way to spelter brass and the Birmingham brass houses became pre-eminent. These changes are reflected by the jetons themselves which are best studied in three roughly equal periods. All specimens were analysed by the X-ray fluorescence technique using the methods and standards described previously.[1]

From c. 1790 to 1830

Three main alloys were popular during this period. Traditional calamine brass with a zinc content of 20 to 25 per cent was initially the preferred alloy, but this was to receive competition from brass made by Champion's granulated copper process with its higher zinc content of 30 to 33 per cent. Alongside these brasses were the gilding metals which had low zinc contents in the general range of 4 to 7 per cent and were normally used for making planchets that were subsequently to be silver plated.

BIRMINGHAM FIRMS

Thomas Halliday: floruit 1797–1845/49[2]

School counters of Princess Charlotte type probably struck shortly after her death in 1817.

1. *Obv.* Diad. bust left: signed below – H
   H.R.H. THE.PRINCESS.CHARLOTTE – below: BORN.JAN.7.1796.DIED.NOV.6.1817
   Rev. In a frame within ornamental cartouche: 5 INTEGERS
   (Hawkins 1975[3] no. 3005)
2. *Obv.* Diad. bust left: signed below – H
   H.R.H.THE.PRINCESS.CHARLOTTE
   Rev. Around rose: ONE.INTEGER: broad floral border
   (Hawkins 1975 no. 3004)

[1] M. Robinson and A. M. Pollard, 'Analysis of Burmese coins by X-ray fluorescence', *NCirc* (1983), 263–6 and 293–6; M. B. Mitchiner and A. Skinner, 'English tokens: *c.* 1200 to 1425', *BNJ* 53 (1983), 29–77; M. B. Mitchiner and A. Skinner, 'Contemporary forgeries of English silver coins and their chemical compositions: Henry III to William III', *NC* (1985), 209–36; M. B. Mitchiner, C. Mortimer and A. M. Pollard, 'The chemical compositions of English seventeenth-century base metal coins and tokens', *BNJ* 55 (1985), 144–63 and the references cited therein.

[2] R. N. P. Hawkins, 'Dictionary of Birmingham makers of metallic tickets, checks and counters during the middle and later part of the 19th century', *SCMB* (1960), 142 and 180. R. N. P. Hawkins published a series of articles on the makers of metallic tickets in this journal from 1960 until 1976. Subsequent references to this series are cited in the form Hawkins *SCMB* – plus date and page.

[3] R. N. P. Hawkins, 'School counters for marks of merit', in *Four studies of British metallic tickets and commercial checks of the 19th–20th centuries*. BANS Doris Stockwell Memorial Papers no. 2 (1975), pp. 1–31.

Kettle firm: floruit 1792–1830

Signed jetons and medalets span this period and are accompanied by a much larger number of closely related unsigned pieces, probably mainly produced by the same firm.[4]

'Napoleonic series of 1814–1815': a close-knit die-linked series.[5]

3. *Obv.* Napoleon seated backwards on a cow being led by walking horned devil who pulls a halter around Napoleon's neck: INSEPERABLE.FRIENDS – in ex: TO.ELBA
   Rev. around top: WE.CONQUER.TO.SET.FREE
   field: EMP./OF.RUSSIA/K.OF.PRUSSIA/MARQUIS/WELLINGTON/PRINCE/ SCHWARTZEN- /BERG
   bottom: MARCH.31.1814
   (Another jeton from the same obverse die has on the reverse the inscription in twelve lines 'The liberties of Europe rest by the united efforts of England and her august allies. The preliminaries of peace signed May 30, 1814)
4. *Obv.* Bare head left: ALEXANDER.EMP.OF.ALL.THE.RUSSIAS
   Rev. same die as previous jeton.
5. *Obv.* Armed horseman galloping left: CROWN.PRINCE.OF.ORANGE – HOLLANDS.GLORY
   Rev. In wreath: WATERLOO/JUNE.18.1815
   (Batty 1878, p. 508, no. 4964h)

'Monarchs and famous persons series of 1820–1830': an extensive series in which the present pieces probably emanate from the Kettle workshop. Another known manufacturer of related jetons was Ingram.

6. *Obv.* King's bust left: H.M.G.M.KING.GEORGE.III
   Rev. BORN.JUNE 4.1738.CROWNED.OCTR.25.1760.DIED.JANY.29.1820.IN.THE.60.YEAR. OF.HIS.REIGN.AND.IN.THE.82.YEAR.OF.HIS.AGE.
   (Batty 1878, p. 421, nos. 4137a–f: the same incorrect reverse occurs on a related issues signed KETTLE – author and Batty 4137s–t. George III acceeded when George II died on 25 Oct. 1760, but he was crowned on 22 Sept. 1761)
7. *Obv.* Bare headed bust left: FREDERICK.DUKE.OF.YORK
   Rev. Wreathed funerary urn on stand, inscribed: DIED/JANY.5th./1827
   around: BORN.AUGUST.16.1763 – THE.SOLDIERS.FRIEND
   (Batty 1878, p. 520 no. 5069c)
8. *Obv.* King's bare head left: GEORGE.IV.KING.OF.GREAT.BRITAIN
   Rev. Laureate funerary urn on stand, inscribed: BORN.1762 / DIED.1830
   above: BELOVED.&.LAMENTED
9. *Obv.* as previous jeton, different die
   Rev. In wreath: BORN/1762/DIED/JUNE 26/1830
   (Batty 1878, p. 436 no. 4236o)

Thomas Wells Ingram: floruit 1806–38[6]

His work includes a number of signed card counters closely related to the present unsigned specimen depicting Edmond Hoyle, the 'father of whist'. It was probably struck about 1830.

10. *Obv.* Man seated left playing cards, with ace of spades in raised hand: another ace on table: above: HOYLE
    Rev. In wreath: KEEP / YOUR / TEMPER

Coin forgery

This class of plated forgery (normally shillings) is commonly encountered and probably emanates from Birmingham. A recent hoard has been published by Hawkins.[7]

11. George III halfcrown dated 1819
    (Mitchiner and Skinner 1985,[8] no. 48)

[4] For example, R. N. P. Hawkins, 'Minor products of British nineteenth-century diesinking', *BNJ* (1960), 174–89, appendix I: also numerous examples described by D.T. Batty, *Batty's descriptive catalogue of the copper coinage of Great Britain, Ireland, British Isles and colonies, local and private tokens, jettons etc*, (Manchester, 1868–98).

[5] In addition to further unpublished issues see also Batty (1877, p. 388 no. 3944) and, for mainly Continental pieces, R. Chalon, 'Numismatique de Waterloo', *RBN* (1878), 421–43.

[6] Hawkins, *BNJ* (1960), 177; *SCMB* (1960), 182 and (1970), 44; also Batty 1877, p. 399 no. 4002d.

[7] R. N. P. Hawkins, 'A hoard of uncirculated forged George III shillings', *SCMB* (1985), 237–8.

[8] M. B. Mitchiner and A. Skinner, 'Contemporary forgeries of English silver coins and their chemical compositions: Henry III to William III', *NC* (1985), 209–36.

LONDON FIRMS

Wyon: issued *c.*1790

12. *Obv.* Busts of king and queen right: GEORGIUS.III.ET.CHARLOTTE.REX.ET.REG.
Rev. Pair of outline hearts with crown above: PATRONS.OF.VIRTUE
(Brown,[9] 340; Fearon 1984,[10] 241.1; Batty 1884, p. 677 no. 2052)
Closely related jetons were signed by Wyon and dated 1790.

Anonymous: an East India Company recruiting ticket issued circa 1835

13. *Obv.* Armed mounted dragoon brandishing sword, galloping right: HORSE.ARTILLERY
Rev. Field: APPLY/AT.No.35/SOHO.SQUARE/LONDON
around: WANTED.FOR.THE.EAST.INDIES
(Bell 1975,[11], p. 5; Pridmore 1975,[12] p. 270 no. 398) See also Mitchiner 1979[13] no. 2106.

			Weight[14]	Cu	Zn	Sn	Pb	Ag	Ni	As	Sb	Fe	Ref.
	BIRMINGHAM												
1.	Halliday	*c.* 1817/18	13.20	77.2	22.0	–	0.18	0.08	–	0.35	–	–	713
2.	Halliday	*c.* 1817/18	6.36	76.6	22.1	0.24	0.79	0.07	–	0.49	0.17	0.20	714
3.	Kettle	1814	4.40	93.9	4.7	0.29	0.40	0.08	–	0.44	–	0.14	319
	(die-link 4)	silvered surface				0.39		0.46					
4.	Kettle (die-link 3)	1814	5.05	78.1	20.7	–	0.61	–	–	0.42	–	0.08	460
5.	Kettle (silvered)	1815	3.95	94.0	5.0	–	0.30	0.28	–	tr	–	0.09	461
6.	Kettle	1820	3.85	73.8	25.1	–	0.46	–	–	0.51	–	0.11	544
7.	Kettle	1827	5.48	73.1	26.4	–	0.13	–	–	tr	–	0.10	545
8.	Kettle	1830	5.45	69.1	30.4	–	0.09	0.13	–	–	–	0.15	546
9.	Kettle	1830	5.70	67.0	32.2	–	0.26	0.09	–	0.37	–	0.07	547
10.	Ingram firm	*c.* 1830	4.15	92.4	6.6	–	0.41	–	tr	0.21	0.11	0.09	323
11.	Coin forgery dated	1819	12.44	90.8	7.1	0.30	0.50	–	–	0.40	–	0.50	48
		silvered surface						3.4		(trace: Mercury)			
	LONDON												
12.	Wyon	*c.* 1790	2.60	78.5	20.1	0.43	0.23	–	–	0.52	0.18	–	712
13.	East India Company	*c.* 1835	..	76.2	22.5	–	0.53	0.09	–	0.27	0.13	0.11	X48

Traditional calamine brass

Brass continued to be made in England by the traditional calamine process with zinc content in the range 20 to 25 per cent until well into the nineteenth century. Among items emanating from official numismatic circles one may make mention of a Royal Mint sovereign weight dated 1821 with a zinc content of 20.4 per cent.[15] This quality of brass had a pedigree extending back through Nuremberg jetons,[16] English seventeenth-century

[9] L. A. Brown, *British Historical Medals, 1760–1960*. Vol. 1, *1760–1837* (London 1980).

[10] D. Fearon, *Catalogue of British Commemorative Medals: 1558 to the present day* (London, 1984).

[11] R. C. Bell, *Unofficial farthings, 1820–1870* (London, 1975).

[12] F. Pridmore, *The Coins of the British Commonwealth of Nations to the end of the reign of George VI, 1952. Part 4. India: vol. 1. The East India Company Presidency series, c.1642–1835* (London, 1975).

[13] M. B. Mitchiner, *Oriental coins and their values: III. Non-Islamic States and Western Colonies* (London, 1979).

[14] Weights are cited in grammes. Standard chemical symbols are used for metals: Cu, copper: Zn, zinc: Sn, tin: Pb, lead: Ag, silver: Ni, nickel: As, arsenic: Sb, antimony: Fe, iron.

[15] M. B. Mitchiner, C. Mortimer and A. M. Pollard, 'The chemical compositions of English seventeenth-century base metal coins and tokens', *BNJ* 55 (1985), see no. 75. For production data relating to early Tintern brass see M. B. Donald, *Elizabethan Monopolies: the history of the Company of Mineral and Battery Works, 1568–1604* (London, 1961).

[16] M. B. Mitchiner, C. Mortimer and A. M. Pollard, 'Nuremberg and its jetons, circa 1475 to 1888: chemical compositions of the alloys', *NC* (1987), 114–55.

tokens and Charles I's farthings (brass wedges),[17] jetons of the Low Countries[18] and medieval pilgrim badges[19] to sundry Roman coins and badges.[20]

The seven calamine brass jetons (medalets) in this section are among the latest English artefacts to have been made in traditional calamine brass. With the fall in zinc prices consequent upon increased exploitation of zinc ores and more active refining[21] during the early nineteenth century spelter brass (i.e. metallic zinc directly alloyed with copper) undercut the price of calamine brass and the calamine process soon became obsolete.

Copper:	77.2, 76.6, 78.1, 73.8, 73.1, 78.5, 76.2 per cent	mean: 76.2 per cent	(SD.2.1)
Zinc:	22.0, 22.1, 20.7, 25.1, 26.4, 20.1, 22.5 per cent	mean: 22.7 per cent	(SD.2.3)

(The sum of copper plus zinc is close to 99 per cent in all cases.)

Brass made by the granulated copper process

Although the granulated copper process for raising the zinc content of calamine brass had been used on the Continent since 1560,[22] the credit for using this process on a commercial scale in England belongs to Nehemiah Champion[23] who obtained a patent in 1723. Using this process the zinc content of the resulting brass can be raised to a maximum value of 34 per cent.[24]

Only two of the present specimens belong in this category:

Copper:	69.1, 67.0 per cent	mean: 68.1 per cent	(SD.1.5)
Zinc:	30.4, 32.2 per cent	mean: 31.3 per cent	(SD.1.3)

Gilding brasses

The name gilding brass (gilding metal) is a general term for a group of low-zinc brasses[25] that have been popular since the eighteenth century. In earlier times low-zinc brasses, more often known by the name latten,[26] had been made by alloying down calamine brass. Due to volatalisation the zinc content was difficult to control and somewhat variable.[27] The gilding metals were made by directly alloying metallic zinc with copper and had a more

[17] Mitchiner, Mortimer and Pollard, 'English seventeenth century base metal coins and tokens'.

[18] M. B. Mitchiner, C. Mortimer and A. M. Pollard, 'The alloys of Continental copper-base jetons (Nuremberg and medieval France excepted)'. To be published.

[19] M. B. Mitchiner, *Medieval Pilgrim and Secular Badges* (London, 1986).

[20] Badges to be published. For coins see P. T. Craddock, 'The composition of copper alloys used by the Greek, Roman and Etruscan civilisations; 3. The origins and early use of brass', *Journal of Archaeological Sciences* 5 (1978), 1–16: P. T. Craddock, A. M. Burnett and K. Preston, 'Hellenistic copper base coinage and the origins of brass', in *Scientific Studies in Numismatics*, edited by W. A. Oddy. BM. Occasional paper no. 18 (1980): E. R. Caley, *Orichalcum and related ancient alloys* (NNM. no. 150 of the ANS. New York, 1964): C. F. Carter and C. E. King, 'Chemical compositions of copper-based Roman coins. IV. Tiberius to Nero, AD 34–66', in *Metallurgy in Numismatics, I* (RNS. London, 1980), 157–67.

[21] Factories were opened in Carinthia (1799), Ruhberg (1799/1800) and Liege (1809). English import tariffs were lowered in 1830. See T. E. Lones, *Zinc and its alloys* (London, 1919): H. Hamilton, *The English brass and copper industries to 1800*, 2nd edn, (London, 1967).

[22] This date is based on scientific instruments and jetons analysed by us at the Research Laboratory for Archaeology in Oxford. See A. M. Pollard, 'An investigation of the brass used in mediaeval and later scientific instruments', paper presented to UKIC meeting 'The preservation of historical scientific material', Geological Museum, 14 Nov. 1983 (proceedings to be published): Mitchiner, Mortimer and Pollard, 'Continental jetons'. See also H. K. Cameron, 'Technical aspects of mediaeval monumental brasses', *Archaeological Journal* 131 (1974), 215–37.

[23] Patent no. 454. See Hamilton, *English brass and copper industries to 1800*: also J. Day, *Bristol Brass: a History of the Industry* (Newton Abbot, 1973).

[24] See Craddock, *Origins and early use of brass*.

[25] For the physico-chemical properties of gilding brasses see E. G. West, *Copper and its alloys* (Chichester, 1982).

[26] As written, for instance, in the inscriptions of many medieval French jetons. Discussed in M. B. Mitchiner and A. M. Pollard, 'Reckoning counters: patterns of evolution in their chemical composition', British Museum and Royal Numismatic Society symposium on the use of scientific techniques for studying the coinage of Europe and the Mediterranean World, AD 500–1500, British Museum, London 6–7 April 1984 (proceedings to be published). See also Mitchiner, Mortimer and Pollard, 'Continental jetons'.

[27] See analytical results in the papers just cited.

reproducible composition. Tombac and pinchbeck, were two early European forms[28] and paktong was a much earlier Chinese version. Metallic zinc had been imported from the Orient by the English and Dutch East India Companies since the seventeenth century[29] and the metal was later refined in Europe. In England William Champion obtained his patent for refining zinc in 1738,[30] but the metal remained expensive and could only be used commercially during ensuing decades for such low-zinc alloys as gilding metals. In 1781 Emerson took out a patent[31] for making higher zinc spelter brass by direct mixing. Although in 1786 Watson praised his alloy as 'the purest and finest brasses in the world', it proved too expensive and Emerson was bankrupted in 1803.

Three of the present jetons, plus the coin forgery, are made of gilding metal and three of these are silver-plated. Several further jetons in the Kettle series have the appearance of gilding metal and are also silvered.[32] The composition is:

Copper:	93.9,	94.0,	92.4,	90.8 per cent mean: 92.8 per cent (SD.1.5)
Zinc:	4.7,	5.0,	6.6,	7.1 per cent mean: 5.9 per cent (SD.1.2)
Plating:	Ag + Sn	(not analysed)	(not plated)	Ag,tr.Hg

The plating suggests that the Kettle firm was using a tin-containing silver wash. A similar situation has been observed in the case of some Nuremberg jetons[33] (other, generally earlier, jetons only had a tin wash[34]). The coin forgery suggests silver plating by the mercury amalgam technique, a process also suggested in the case of some medieval English coin forgeries[35] and some other Nuremberg jetons.[36]

From c.1830 to 1870

The increased scale of European zinc production in the early nineteenth century,[37] combined with the easing of English import tariffs in 1830, made metallic zinc both cheaper and more plentiful. This turned the tide in favour of spelter brass and the phasing out of the calamine process. Cheadle (*c.* 1830) and Bristol (*c.* 1840) converted to the spelter process. The last recorded use of a calamine furnace in South Wales was in 1858[38] and in Birmingham the last calamine brass-house closed in 1866.[39]

In the field of English jetons and related cheap small copper-base artefacts the period of transition from calamine brass to spelter brass was marked by a distinct preference for the use of low-zinc recipes. This does not imply any decline in the use of high-zinc alloys for other purposes; but it does suggest that during this transitional phase considerations of cost may have made the low-zinc brasses a better economic proposition in the field of cheap stamped metal discs. Be that as it may, there can be no doubt that by around 1870 the cost of spelter brass had fallen low enough to permit the mass production of 'spade guinea' jetons and related artefacts at little expense. These will be considered in the next section.

[28] Described in 1786 by R. Watson, *Chemical essays IV* (London, 1786).

[29] High zinc brasses which have a zinc content greater than 34 per cent attest the use of at least some metallic zinc in the brass-making process. This was first documented by Glauber in *De Prosperitate Germaniae* (Amsterdam, 1656). Our analytical results attest the process from 1650 onwards, and have been discussed in Mitchiner, Mortimer and Pollard, 'English seventeenth-century base metal coins and tokens'.

[30] Patent no. 564. R.F. Tylecote, *A History of Metallurgy* (London, 1976), p. 132; also J. Day, *Bristol Brass*.

[31] Patent no. 1297.

[32] Author's collection (MBM); not analysed; some signed by Kettle.

[33] Mitchiner, Mortimer and Pollard, 'Nuremberg jetons'.

[34] M. B. Mitchiner and A. M. Pollard, 'Tin-plated 16th century Nuremberg reckoning counters from the River Thames', *NCirc* (1983), 152–53.

[35] Mitchiner and Skinner, 'Contemporary forgeries of English silver coins'.

[36] Mitchiner, Mortimer and Pollard, 'Nuremberg jetons'.

[37] Noted above; see also Lones (1919).

[38] Hamilton, *English brass and copper industries to 1800*.

[39] W. C. Aitken, 'Brass and brass manufacture' in *The resources, products and industrial history of Birmingham and the Midland hardware district*, edited by S. Timmins (London, 1866), pp. 225–381.

BIRMINGHAM FIRMS

Coronation medalets

These may have been made by either the Kettle or the Ingram firm, both of which had issued related signed pieces during the 1820s

14. *Obv.* King's bare head right: WILLIAM.IV.KING.OF.GREAT.BRITAIN.
in small letters above head: CROWNED.SEP.8.1831
Rev. Queen's bust right: HER.MOST.GRACIOUS.MAJESTY.QUEEN.ADELAIDE
(Batty 1878, p. 516 no. 5053h)
15. *Obv.* Queen's diad. bust left: HER.MOST.GRACIOUS.MAJESTY.VICTORIA
Rev. Crown: above: BORN.MAY.24.1819
below: CROWNED / JUNE.28.1838
(Batty 1878, p. 501 no. 4911y)

Card counters

16. *Obv.* Garter arms with half length lion and unicorn supporters: slightly faulty inscriptions: HONI.SOIT.QUI.MAL.P.Y and DIEU.ET.MON.DROT
Rev. Field: KEEP.YOUR / TEMPER
around: BE.MODERATE.IN.YOUR.STAKES
Issued during the 1840s or the early 1850s. For allied issues see Batty 1884 (p. 671 no. 1964) dated 1847, and Batty 1884 (p. 671 no. 1967) dated 1859: also Hawkins *BNJ* (1960), 178, for a note written in 1851, and Hawkins *NC* (1959) no. 59, dated 1846; Hawkins *SCMB* (1960), 95, dated 1848 and 1853.
17. *Obv.* Victoria's young head left: VICTORIA.REGINA
Rev. Fan of three playing cards: Jack of diamonds accosted by six of spades and five of clubs.
(Batty 1884, p. 670 no. 1949: and see also Hawkins *NC* (1959), no. 5.)
18. *Obv.* Victoria's young head left: VICTORIA.QUEEN.OF.GREAT.BRITAIN
Rev. same punch for the cards design, but struck on a smaller flan
(Batty 1884, p. 670 no. 1953)
These two issues can be dated to the 1850s, partly by succession from the 'Keep your temper' issues, and partly by comparison with related (and sometimes obverse die-linked) 'To Hanover' counters.

'To Hanover' counters: issued 1837 to *c.*1883

19. *Obv.* Victoria's young head left: VICTORIA.REGINA
Rev. Duke of Cumberland on horseback, with three-headed dragon below:
above: TO.HANOVER – in ex. 1837 (traditional date)
(cf. Hawkins, *NC* (1959), nos 1–4; issued 1837 – *c.* 1840s)
20. standard designs: H.M.G.M.QUEEN.VICTORIA: dated in reverse exergue 1854
(Not listed by Hawkins: but cf. no. 24 dated 1859)
21. standard designs: VICTORIA.QUEEN.OF.GREAT.BRIT: dated below head 1862
(Hawkins, *NC* (1959), no. 51)
22. standard designs: H.M.G.M.QUEEN.VICTORIA: dated below head 1867
(cf. Hawkins, *NC* (1959), nos 63–64)
23. same issue

Prince of Wales half sovereign counters: issued 1842 to 1870s

24. *Obv.* Victoria's young head left: VICTORIA.QUEEN.OF.GREAT.BRIT:
Rev: Three plumes in crown: all in garter inscribed: HONI.SOIT.QUI.MAL.Y.PENSE
(Magnay 1980[40] type 1: issued 1842–late 1840s)
25. *Obv.* Victoria's young head left: VICTORIA.QUEEN.OF.GREAT.BRITAIN: dated below head 1850
Rev. Three plumes in crown: garter not inscribed: all crowned:
margin: THE.PRINCE.OF.WALES.MODEL.HALF.SOVRN.
(Magnay 1980, type 6)
26. same designs, but dated 1854

[40] D. E. Magnay, 'The Prince of Wales models', *NCirc* (1980), 261–64.

Model coins of Joseph Moore

27. Bi-metallic model penny issued *c.*1847; with nickel-brass centre and copper rim.
Obv. Centre: Victoria's young head left: VICTORIA.REG:
Rim: ONE.PENNY – MODEL
Rev. Centre: 1
Rim: ONE.PENNY – MODEL
(Magnay 1975,[41] Hawkins, *BNJ* (1960) and *SCMB* (1960), 229–30: Yarwood 1957:[42] Batty 1892, pp. 1156–69, nos 6568–6779)

			Weight	Cu	Zn	Sn	Pb	Ag	Ni	As	Sb	Fe	Ref
	BIRMINGHAM												
14.	Kettle/Ingram	1831	5.10	84.3	14.9	–	0.43	tr	–	–	–	0.09	548
15.	Kettle	1838	3.62	68.2	30.8	–	0.44	–	tr	tr	tr	–	715
16.	Card counter	*c.* 1840s	2.28	83.8	15.4	–	0.21	–	–	0.36	–	0.07	474
17.	Card counter	*c.* 1850s	2.90	85.9	13.2	–	0.24	–	0.10	0.21	–	0.20	725
18.	Card counter	*c.* 1850s	2.19	84.1	14.7	–	0.20	–	0.15	0.44	0.14	–	726
19.	'To Hanover'	*c.* 1840s	3.31	84.4	14.6	–	0.33	–	0.10	–	tr	0.17	716
20.	'To Hanover'	1854	4.10	80.9	18.2	–	0.26	–	tr	0.20	0.22	–	718
21.	'To Hanover'	1862	5.68	88.5	10.5	0.24	0.20	0.05		tr	tr	–	717
22.	'To Hanover'	1867	4.30	86.2	12.8	0.34	0.17	–	0.20	–	–	–	719
23.	'To Hanover'	1867	4.48	87.3	12.0	–	tr	–	tr	0.44	–	–	720
24.	'Prince of Wales'	*c.* 1840s	2.93	89.3	9.7	–	0.08	tr	0.36	tr	–	0.32	722
25.	'Prince of Wales'	1850	2.20	84.5	13.6	0.24	0.55	–	tr	0.53	0.16	0.25	723
26.	'Prince of Wales'	1854	1.50	66.0	33.6	–	0.41	–	–	–	–	–	724
27.	Joseph Moore:	*c.* 1847 Rim	4.00	99.8	–	–	0.10	0.11	–	–	–	–	658
		Centre[43]		'65'	'26'				'8.5'				

Gilding brass

The preferred alloy was a form of gilding brass with a zinc content within the range 10 to 15 per cent. In colour these pieces range from brownish to yellowish and on this basis Hawkins described 'To Hanover' counters as being made of either copper or brass. But, in practice, one appears to be looking at a fairly narrow range of recipes that falls within the general category of gilding brasses.

Considered in the context of the mid nineteenth-century English technology it is likely that all these gilding brasses were made by the direct alloying of metallic zinc with metallic copper – the spelter process. Their mean composition is:-

Copper: 84.3, 83.8, 85.9, 84.1, 84.4, 88.5, 86.2, 87.3, 89.3, 84.5 per cent
mean: 85.8 per cent (SD. 2.0)

Zinc: 14.9, 15.4, 13.2, 14.7, 14.6, 10.5, 12.8, 12.0, 9.7, 13.6 per cent
mean: 13.1 per cent (SD. 2.0)

(The sum of copper plus zinc is very close to 99 per cent in all cases.)

Standard brasses

Only two jetons are made of good quality brass and a third specimen might just qualify. Jetons of 1838 and 1854 have a zinc content of 30.8 per cent and 33.6 per cent respectively. The former is probably made of calamine brass, continuing the traditional practices of the Kettle and the Ingram firms. The brass of the 1854 half sovereign counter might have been made by either the calamine or the spelter process. The alloy composition does not permit

[41] D. E. Magnay, 'The models of Joseph Moore', *NCirc* (1985), 378–79.

[42] S. R. Yarwood, 'Model coins', *SCMB* (1957), 342–45.

[43] The composition cannot be cited with precision because the nickel content is above the range of available standards.

differentiation between the two processes and historical information about the technical traditions of the manufacturing firm is lacking. The third specimen is a 'To Hanover' counter made in 1854 with a zinc content of 18.2 per cent. In the context of kindred counters its metal can probably be considered as spelter brass with a zinc content that is higher than was usual for this kind of artefact.

Copper

The copper rim of Joseph Moore's model penny has a higher purity than contemporary English copper coinage. The difference is due to the significant arsenic content of the coinage,[44] and the lack of arsenic in the present piece. The high copper purity of Joseph Moore's model penny is more closely comparable with earlier (non-arsenic) copper jetons struck in the Low Countries.[45] But, Joseph Moore's specimen was probably made of copper refined in this country, though lacking the arsenic associated with coinage. The South Wales copper refining industry grew up on the smelting of oxide-sulphide copper ores mined in Cornwall and the end product was a characteristic arsenical copper.[46] English copper and bronze coinage retained its arsenical nature until the eve of the First World War,[47] but in the meantime South Wales had been processing copper ores from many new sources[48] and producing refined copper free of arsenic. Present analytical results suggest that non-arsenical copper was first produced during the mid nineteenth-century transitional period and that it continued to be the norm thereafter. The continued appearance of arsenic in copper and bronze coinage was probably intentional. A small amount of arsenic hardens the copper[49] and the addition of 0.5 per cent arsenic to refined copper has been recommended:[50] the intention in the present case was presumably to enhance the durability of the coinage.

Nickel-brass

Nickel-bearing copper ores occur naturally in Germany and Austria,[51] but were not exploited as a natural alloy until the nineteenth century. Before that time these had been shunned as low grade copper sources. From the 1820s some of this natural German alloy was marketed and commonly acquired the name 'German silver'.[52] Nickel itself was not to be produced in commercial quantities as a refined metal until around 1870.[53] Joseph Moore's use of a natural nickel-brass alloy was not an isolated occurrence. Ralph Neal's market tallies, one of which is considered in the next section, probably provide another example and likewise certain Belgian coins struck after 1832.[54] In the Orient a comparable alloy, paktong, had been in use for several centuries, including use for coins struck in the medieval Sumatran kingdom of Srivijaya.[55]

[44] For examples see both Mitchiner, Mortimer and Pollard, 'English seventeenth-century base metal coins and tokens' and also R. Chadwick, 'Copper 1: Alloy to pure metal', *Historical Metallurgy*, 19 (1985), 8–11. Copper is still refined by physico-chemical processes to a purity of 98.5 to 99.8 per cent. The electrolytic process for producing a higher purity was patented by Elkington (1865–70): for discussion see West, *Copper and its alloys*.

[45] Mitchiner, Mortimer and Pollard, 'Continental jetons'.

[46] See penultimate references: also Tylecote, *History of Metallurgy*: R. F. Tylecote, H. A. Ghaznavi and P. J. Boydell, 'Partition of trace elements between the ores, fluxes, slags and metal during the smelting of copper', *Journal of Archaeological Sciences* 4 (1977), 305–33: R. F. Tylecote, 'Summary of results of experimental work on early copper smelting, in *Aspects of Early Metallurgy*, edited by W. A. Oddy, BM. Occasional paper no. 17 (1980), pp. 5–12.

[47] Chadwick, 'Copper 1'.

[48] Tylecote, *History of Metallurgy* and also Chadwick, 'Copper 1'.

[49] West, *Copper and its alloys*, p. 93.

[50] West, *Copper and its alloys*: also Chadwick, 'Copper 1', p. 8.

[51] J. A. Phillips and H. Louis, *A treatise on ore deposits*, 2nd edn (London, 1896).

[52] Tylecote, *History of Metallurgy*, p. 149. See also West, *Copper and its alloys*, pp. 120–22: S. Temple, 'Copper 2: Brasses, bronzes and nickel silvers', *Historical Metallurgy* 19 (1985), 12–16.

[53] Tylecote, *History of Metallurgy*, p. 149. For German production during the 1890s see Phillips and Louis, *Treatise on ore deposits*.

[54] C. L. Krause and C. Mishler, *Standard Catalogue of World Coins* (1981), pp. 142–43.

[55] M. B. Mitchiner and A. M. Pollard, 'Early South East Asian Currency Systems' (submitted for publication).

After c.1870

By this time the spelter process of brass making had fully replaced the calamine process. Constraints placed on the zinc content of brass by the calamine technique were now removed and various recipes were tried in order to decide the optimal compositions for brasses destined for particular uses. Transition from malleable alpha brasses with a zinc content of not more than 37 per cent to brittle beta brasses with high zinc contents was found to place a practical maximum level of 40 per cent zinc (duplex brass) on any brasses that were to be used for making small die-stamped artefacts.[56] The jetons described below show compositions ranging from the 90/10 recipe of gilding brasses up to the 60/40 recipe just discussed.

BIRMINGHAM FIRMS

Card counters

28. *Obv.* Fan composed of three playing cards: Ace of diamonds accosted by four of diamonds and five of diamonds
Rev. Plain field with a narrow raised rim.
(Batty 1884, p. 669 no. 1919)
29. *Obv.* Fan composed of three playing cards: King of clubs accosted by eight of diamonds and three of clubs
Rev. Plain
(Heart shaped) A number of related counters were published by Batty in 1884 and another of the author's specimens is dated 1871.
30. *Obv.* English arms in garter with lion and unicorn supporters: surmounted by lion on crown: correct inscriptions – HONI.SOIT.QUI.MAL.Y.PENS and DIEU.ET.MON.DROIT
Rev. Shield of Paris with correct inscription: FLUCTUAT.NEC.MERGITUR: all in wreath

Late 'To Hanover' counters

31. Half-size issue bearing standard designs and VICTORIA.REGINA legend: but, with a two-headed dragon (cf. Hawkins, *NC* (1959); the two-headed dragon and small size are late features; see also Batty 1884, p. 658 no. 1713, dated 1867).

'Spade guinea' counters: issues of *c.*1870 to 1885

Obv. Diad. bust of George III: GEORGIUS.III.DEI.GRATIA
Rev. Crowned shield as on spade guineas, with fictitious legend and date (as cited below)
32. IN.MEMORY.OF.THE.GOOD.OLD.DAYS – 1768
(Batty 1878, p. 416 no. 4135s–v: Hawkins, *BNJ*, 1963)[57]
33. similar: dated 1788
34. similar: dated 1797
35. C.P.E.V.E.R.E.L.L.E.L.A.T.E.M.C.A.R.R.O.L.L.M.A.K.E.R – 1788
(Batty 1876, p. 261 no. 2435e and 1878 p. 469 no. 4561a: Hawkins, *BNJ* (1963), no. 1)
Charles Peverelle, late M. Carroll, maker, Birmingham: he took over the firm in 1866.
36. C.H.A.R.L.E.S.P.E.V.E.R.E.L.L.E.M.A.K.E.R.B.I.R – 1788
(Hawkins, *BNJ* (1963), no. 4: 'Charles Peverelle maker, Bir')
37. C.H.A.R.L.E.S.P.E.V.E.R.E.L.L.E.M.A.K.E.R.B.I.R.M – 1788
(Half size: Batty 1880, p. 595 nos. 930–34: Hawkins, *BNJ* (1963), nos 101–103)
38. G.Y.I.ET.F.G.REX.SUF.ST.D.S.T.M.S.ET. – 1701
(Hawkins, *BNJ* (1963), nos 9–13)
39. same issue
'George Yorke Iliffe and Frederick Gardner (Rex) of Suffolk Street, die-sinkers, toolmakers, stampers, etc'. Iliffe and Gardner were in partnership from 1878 until 1881.

[56] Discussed by West, *Copper and its alloys*; see particularly fig. 39, p. 103.

[57] R. N. P. Hawkins, 'Catalogue of the advertisement imitations of 'Spade' guineas and their halves', *BNJ* 32 (1963), 174–219.

40. N.C.R.ET.CO.D.G.L.T.REX.F.D.B.I.R.M - 1790
(Hawkins, *BNJ* (1963), nos 29–32)
41. same issue and legend, but half size
(Hawkins, *BNJ* (1963), nos 109–113: Batty 1880, p. 595 no. 924) Probably Nathaniel Cracknall Reading, who commenced business in 1873/75.
42. J.W.REX.F.D.M.C.M.D.S.T.M.S.P.E.T.C – 1790
(Hawkins, *BNJ* (1963), no. 34)
43. same issue, but with modified shield
(Hawkins, *BNJ* (1963), no. 33)
'John Wood (Rex fidei defensor), machine chain maker, die-sinker, toolmaker, stamper, piercer, etc'. His business was first cited in 1876 and last cited in 1900. His issues citing Joseph Rollason as partner were published by Batty in 1878 (p. 475 no. 4601a) and 1884 (p. 678 no. 2065).
44. W.C.B.ET.CO.D.G.I.REX.F.D.B.I.R.M – 1790
(Hawkins, *BNJ* (1963), no. 48)

'Spade guinea' counters: late issues

45. Crowned shield inscribed: WAVERLEY/NILE/PICKWICK/OWL/HINDOO/PENS
margin: MACNIVEN.&.CAMERONS.PENS.ARE.THE.BEST
inside margin: THEY.COME.AS.A.BOON – AND.BLESSING.TO.MEN
(cf. Hawkins, *BNJ* (1963), nos 21–28: issued 1873–1901: for a slightly earlier issue see Batty 1878, p. 456 nos 4427–28)
46. PLAY.WITH."INTERNATIONAL SERIES".GAMES
(Hawkins, *BNJ* (1963), nos 64–65: issued *c*.1920–39)

LONDON FIRMS

Market tallies of Ralph Neal

Ralph Neal signed his products and commonly included his address. From 1866 until 1895 he worked at 19 Percival Street, London EC and then moved to 49–50 Percival Street until the outbreak of war. Although he subsequently retained that address, the tallies catalogued below all appear to belong to the period before 1914 and issues struck for some stall-holders cite both the pre- and post-1895 addresses (see Hawkins, *SCMB* (1968), 170–171 and (1974), 77–79).

47. Struck for 'KB' of Billingsgate market: late 1890s

Obv.	Field:	15/BILLINGSGATE/2S./K B
	small letters:	R.NEAL.49 & 50 – PERCIVAL.ST.EC
Rev.	Field:	2 S.
	small letters:	R.NEAL – 19 PERCIVAL.ST.EC

48. Struck for John Gunn of Borough market: 1895–*c*.1914

Obv.	Field:	plain: in small letters around: R.NEAL.49 & 50 – PERCIVAL.ST.EC
	margin:	JOHN.W.GUNN – BORO,LONDON
Rev.	Field:	2/6
	small letters:	NEAL – 49 & 50.PERCIVAL.ST.EC

49. Struck for P.C. Hegerty of Borough market: late 1890s

Obv.	Field:	P.C. HEGERTY/& CO/BORO/MKT
	small letters:	R.NEAL.49 & 50 – PERCIVAL.ST.EC
Rev.	Field:	5/S. at sides: FIVE – SHILLINGS
	small letters:	R.NEAL – PERCIVAL.ST.EC

50. *Obv*. as previous, probably the same die

Rev.	Field:	10 S. at top and bottom: TEN – SHILLINGS
	small letters:	R.NEAL – MAKER

Some obverse die-linked tallies of other denominations cite Neal's earlier address at 19 Percival Street (e.g. 2/6).[58] Tallies struck for Hegerty, Gunn and other customers were often made of different metals for different values.[59]

[58] Author's collection.

[59] Most commonly copper, zinc, brass and nickel-brass. About the time of the First World War aluminium and galvanised iron were alternatively used.

Market tally of Hubbard and Walker

Made by Hubbard and Walker (fl. 1883–1921) for Matthew Proctor of Covent Garden market (Hawkins, *SCMB* (1968), p. 129).

51. *Obv.* Field: ONE/SHILLING
margin: M.M.PROCTOR.COVENT.GARDEN
Rev. Field: M.P.P.
small letters: HUBBARD – AND/WALKER

			Weight	Cu	Zn	Sn	Pb	Ag	Ni	As	Sb	Fe	Ref
	BIRMINGHAM												
28.	Card counter	*c.*1870s	2.05	62.1	37.2	–	0.59	–	tr	–	tr	–	727
29.	Card counter	*c.*1870s	2.50	60.1	39.5	–	0.29	–	–	–	–	–	728
30.	Card counter	*c.*1870s/80s	"	59.9	39.2	–	0.35	–	0.10	–	–	0.08	389
31.	'To Hanover'	*c.*1870s	1.72	67.1	32.4	–	0.26	–	–	tr	–	–	721
	'Spade guinea' counters:	*c.*1870–85											
32.	Anonymous		2.22	83.2	15.8	–	0.22	–	–	0.21	0.17	0.11	X33
33.	Anonymous		1.93	64.7	33.8	0.34	0.67	–	–	–	0.10	0.15	X34
34.	Anonymous		3.99	63.1	35.7	–	0.54	0.10	–	–	–	0.14	X35
35.	C. Peverelle		4.00	89.2	9.8	–	0.22	–	0.10	–	tr	–	729
36.	C. Peverelle		2.21	69.2	29.8	–	0.36	–	0.35	–	tr	–	731
37.	C. Peverelle		2.25	88.7	10.0	0.47	0.19	–	tr	tr	0.14	tr	730
38.	Iliffe and Gardner		3.32	83.4	16.1	–	0.10	0.05	0.15	0.07	0.09	0.22	583
39.	Iliffe and Gardner		3.50	82.0	17.5	–	0.17	–	–	–	–	tr	732
40.	Nathaniel Reading		3.50	62.1	37.2	–	0.76	–	–	–	–	–	733
41.	Nathaniel Reading		1.87	63.2	36.1	–	0.37	–	tr	–	–	0.23	734
42.	John Wood		2.70	61.9	37.6	–	0.38	–	tr	–	–	–	735
43.	John Wood		2.22	66.4	33.0	–	0.58	–	–	–	–	0.09	Z
44.	WCB		3.70	62.5	36.8	–	0.20	0.17	–	0.06	0.07	0.14	584
	Late 'Spade guinea' counters												
45.	Macniven and Cameron:	*c.*1873/1901	4.05	62.5	36.8	–	0.55	tr	–	–	tr	–	736
46.	International Games:	*c.*1920/39	4.50	65.9	33.4	–	0.36	–	–	–	–	0.11	630
	LONDON												
47.	R. Neal for KB	late 1890s	"	66.4	32.6	–	0.31	–	0.06	0.18	–	0.21	X49
48.	R. Neal for J. Gunn	1895/1914	5.90	65.2	33.3	–	0.42	–	0.31	tr	–	0.61	737
49.	R. Neal for P. Hegerty	late 1890s	6.58	62.6	36.7	–	0.35	–	–	–	0.14	tr	738
50.	R. Neal for P. Hegerty	late 1890s	6.75	'65'	'22'	–	tr	–	'12'	–	tr	tr	659
51.	Hubbard & Walker	1883/1901	"	65.9	33.2	0.24	0.35	–	–	–	–	0.16	X50

Gilding brasses

Until the late 1870s there still appears to have been limited use of gilding brasses in the manufacture of jetons. All types of 'spade guinea' counters in this low-zinc alloy are known to have been produced by about 1880, either because they had already been published by Batty (nos 32, 35, 37), or else because the issuing partnership had been dissolved by that date (nos 38, 39).

Jetons made in this quality of brass show zinc contents in the same order as those of the previous period (10 to 15 per cent), with an emphasis on the higher end of this scale. This

quality of brass, being superior in corrosion resistance to plain copper, remains popular during the present century for such uses as bullet envelopes, plaques and name-plates;[60] but it appears to have passed out of fashion in the field of jetons about 1880.

Commercial brass: 70/30 brass

This recipe was to become one of the most popular standards for general purpose brasses. During the First World War it was standardised by the British government as Cartridge Brass with a tolerance of 68 to 72 per cent copper (32–28 per cent zinc).[61] Among present jetons one sees the emergence of the 70/30 recipe during the 1870s. It is a quality of spelter brass that bears comparison with the better grades of calamine brass that had been used earlier in the nineteenth century both in England and at Nuremberg.[62]

60/40 brass

The 60/40 quality of brass first made its commercial appearance as 'Munz metal'[63] during the 1830s for use in the sheathing of ships. But it proved too susceptible to corrosion and was soon replaced in this field by the more resistant Naval brass.[64] In the field of jetons this high zinc brass enjoyed some popularity during the last quarter of the nineteenth century, but so far as one can judge from the fairly small number of observations the 60/40 quality of brass failed in competition against the generally more popular standard commercial brass (70/30 quality).

Conclusion

During the course of the nineteenth century English brass making passed through a fundamental metamorphosis when the calamine process gave way to the spelter process. This period of change is reflected in the chemical compositions of jetons and is divisible into three main phases. During the first third of the century traditional calamine brass appears to have retained its dominant role, with spelter brass only being used for low quality alloy of gilding metal quality. The middle third of the century was a period of transition during which good quality brass found little use in the field of jetons, probably because the calamine process was falling into disuse and the new spelter brass was still too expensive for such mundane items as jetons. These now tended to be made of low grade gilding brasses. During the last third of the century the production of spelter brass had expanded and the product had become cheaper, with the result that good quality spelter brass now came into general use for the manufacture of jetons.

[60] Discussed by Temple, 'Copper 2'.

[61] Temple, 'Copper 2'; see also West, Copper and its alloys.

[62] See above; Mitchiner, Mortimer and Pollard, 'Nuremberg jetons'.

[63] Temple, 'Copper 2'.

[64] Copper 62 per cent, zinc 37 per cent, tin 1 per cent (nominally). See West, *Copper and its alloys*; Temple, 'Copper 2'.