William Cary and His Association with William Hyde Wollaston

THE MARKETING OF MALLEABLE PLATINUM IN BRITAIN FROM 1805 TO 1824

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A comparison of entries in notebooks kept by William Hyde Wollaston with the records of an account that he maintained in the bank of Thomas Coutts & Co, London, serves to establish that approximately three quarters of Wollaston's output of malleable platinum was disposed of through the London scientific instrument maker, William Cary. This article reviews the relationship between these two men, the nature of their business association and their incomes from the sale of platinum.

The fact that William Cary (1759–1825) became responsible for the marketing of much of the malleable platinum produced by William Hyde Wollaston (1766–1828) only became evident some thirty years ago, following the discovery of Wollaston's notebooks in Cambridge and the realisation that Wollaston had had an account with the London bankers, Thomas Coutts and Co (1). It may seem odd that Cary, who specialised in the manufacture of optical and mathematical instruments, should have taken on that role but the explanation may well be that Cary had become well known to the Wollaston family at least ten years before W. H. Wollaston produced his first specimens of malleable platinum.

In 1788 the Revd. Francis Wollaston, father of William Hyde, sought to have a transit circle made to his own design for determining the altitudes of celestial bodies as they cross the meridian. He tried to persuade Jesse Ramsden, at that time regarded as the foremost maker of scientific instruments, to undertake the construction but Ramsden was too busy with other commitments; the same was true of Edward Troughton, another highly respected instrument maker. Three years later the name of William Cary was recommended to Francis Wollaston as one fully qualified to undertake the work (2). Cary had served an apprenticeship under Ramsden, and by 1786 had set up in business in the Strand, London, as a mathematical instrument maker (3). He agreed to make the transit circle—the first of its kind to be produced in England—and subsequently he set it up in the private observatory which Francis Wollaston had established at his home in Chislehurst, Kent.

The beauty of workmanship of this transit circle was attested to by Brewster (4), and in a paper read to the Royal Society on the day that William Hyde was himself elected to Fellowship, his father paid the following tribute to Cary's professional qualities:

> Observers know best what it is they want; and an instrument-maker who will condescend to listen to them, is a treasure. In this, as well as other respects, it is but justice to Mr. CARY to say, that he has answered the character which was given of him. He has shewn himself, during the whole time, very diligent and attentive; comprehending readily my directions; giving freely his opinion, and his reasons for dissent, if he disapproved of what was proposed; yet being willing to follow mine, if I still continued in the same mind; improving upon some of my hints; and executing in a masterly way every part of it (2).

Of William Hyde's career around this

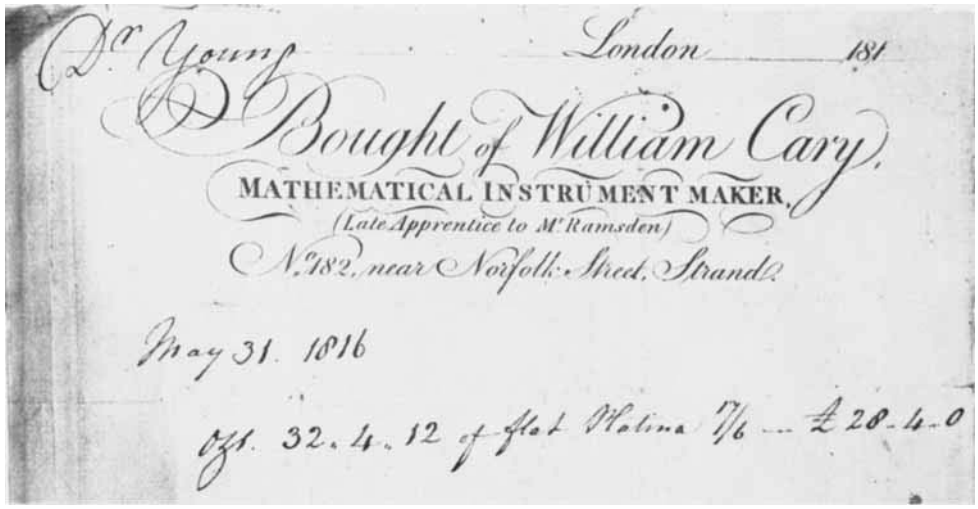

Fig. 1 One of William Cary's bill-heads, invoicing platinum sheet in May 1816 to Wollaston's friend Thomas Young, well known to physicists for his work in optics and to engineers for originating the concept of modulus of elasticity. During the long period that Wollaston was one of the Joint Secretaries of the Royal Society Young served as Foreign Secretary

period we know that he graduated MB at Cambridge University in 1788 and left the following year to further his medical education in London. He set up his first medical practice, lasting only a few months, in Huntingdon; his second at Bury St. Edmunds in 1792; and his third and final practice in 1797 at 18 Cecil Street, off the Strand, London. In 1800 he decided to abandon medicine as a career and to devote himself to research in the other sciences (5). During the period of his residence at Bury St. Edmunds, Wollaston paid occasional visits to his father's home at Chislehurst where, being himself interested in astronomy, he would have had ample evidence of the excellence of Cary's work as an instrument maker. If Wollaston did not meet Cary at Chislehurst, he would certainly have done so on several occasions between 1798 and 1801 when, living close to Cary's shop in the Strand, he bought from him almost all the scientific apparatus he required at that time apart from chemical glassware and ceramic items (6).

It was in December 1800 that Wollaston and his friend, the chemist Smithson Tennant (1761–1815), made their first joint deposit amounting to nearly £800 for the supply of 5,959 ounces troy of crude platinum ore (7) and in the following year Wollaston proceeded to extract from some of this ore a quantity of fairly pure and fully malleable platinum metal using methods that he did not disclose until 1828 (8). By August 1803 the partners had acquired an additional 1,358 ounces of ore, of which we know that "About 166 oz were lost in the confusion of a Fire near y^{e} Temple (in Essex Street)", according to an entry in one of Wollaston's notebooks (9); and shortly afterwards a total of 5,350 ounces of malleable platinum had been produced from 7,015 ounces of this stock of ore (10). Further deliveries of ore were obtained in 1807 and from 1810 through to 1814, and by the time of Tennant's death the partnership had been responsible for the processing of 20,850 ounces of ore yielding 15,800 ounces of malleable platinum (9). This total includes 2,090 ounces of platinum reprocessed in 1808 and 1810 from waste metal and other scraps (10). After Tennant's death in 1815 the processing of ore and the reprocessing of scrap was continued by Wollaston; the total quantity of metal processed, including scrap

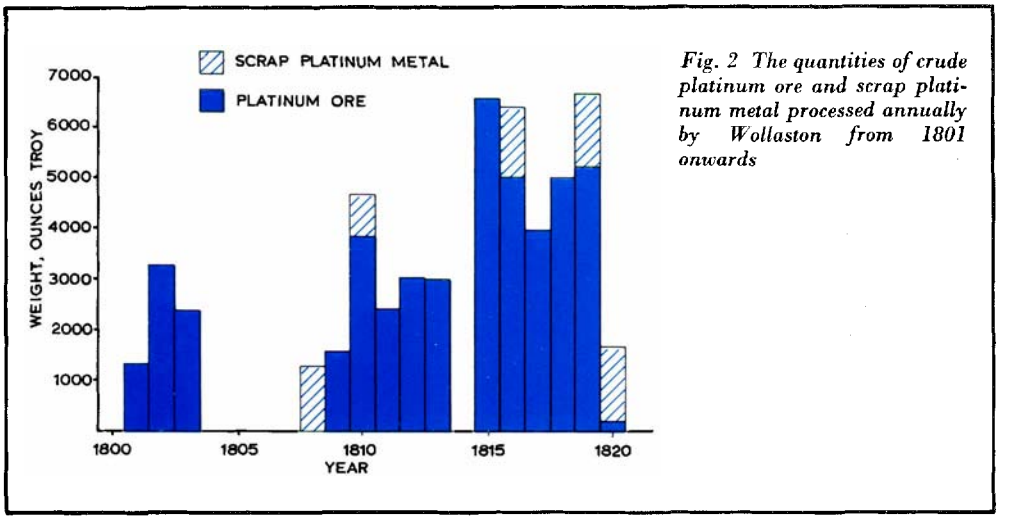

Fig. 2 The quantities of crude platinum ore and scrap platinum metal processed annually by Wollaston from 1801 onwards

recycled, over the years from 1801 to 1820, amounted to 53,200 ounces from which some 36,000 ounces of malleable platinum were produced (9, 10). The quantities of ore and scrap metal handled each year over that period are shown in Figure 2.

Wollaston's Suppliers of Platinum Ore and Scrap Metal

In 1778 the Spanish Government attempted to monopolise the trading of platinum ore found in their South American colonies but their efforts met with little success and most of the ore which reached Britain was probably smuggled out of the Choco area of Colombia by way of Jamaica (11). In view of the nature of this trade there were wide fluctuations in the amounts available, resulting at times in long delays in meeting orders. Usselman mentions an occasion when 670 days elapsed from the time Wollaston placed an order until delivery was made, delays of 200 days being the norm (12).

Wollaston recorded details of thirty separate transactions involving the purchase of ore but in only a few instances did he specify the names of his suppliers (13). However, by comparing the details of these purchases with payments made by draft from Wollaston's account with the London bankers Thomas Coutts & Co (14) it is possible to identify six suppliers who between them provided at least 86 per cent and possibly more of the ore used: Dr. E. Bollmann who at one time lived next door to Wollaston (15); Hodgson; Hutchinson; Knight, probably the Richard Knight who had earlier devised another process for rendering platinum malleable but did not put it to commercial use (16); John Johnson, an assayer of ores and metals practising in the City of London, whose eldest surviving son Percival Norton, founded Johnson Matthey & Co Limited; and James Paterson. Table I provides a breakdown of the quantities of ore supplied to Wollaston and Tennant, and the total payments made to each supplier, the latter including interest charges calculated from the time orders were placed until delivery was made. Individual prices ranged from a high of 4s. per ounce charged by Knight, to a low of 1s. 6d., the average being 3s. an ounce after taking into account transport and interest charges.

Between 1810 and 1822 Wollaston also acquired small amounts of scrap platinum metal from some of those who supplied him with ore, the price paid being 5s. an ounce. Much larger amounts of platinum, in the form of cuttings, filings and chips, also reached him from customers to whom he had supplied ingots of malleable platinum, and these were collected by William Cary for return to

Wollaston. Details of these transactions are shown in Table II. Fletcher, who supplied platinum metal as ingots, was probably associated with the firm Thorp & Son of Manchester.

By May 1808 Wollaston had carried out his first reprocessing of platinum, involving 1,272 ounces of what he described in a notebook as "chips". These chips had probably been taken back as waste metal, at a cost of around £320, from gunmakers who had begun to use platinum instead of gold for making touch-holes and stamps for the breeches of sporting guns and pistols, a practice initiated in 1804 or 1805 by either Joseph or John Manton (17). The Mantons certainly acquired some, if not all, of their platinum from Wollaston who supplied it to them in the form of ingots (18).

Other supplies of scrap platinum, amounting to some 1,000 ounces, came in the form of clippings or cuttings from sheet platinum used in the fabrication of sixteen large boilers supplied to the sulphuric acid industry. The first boiler was made by Sheffield, the second by Miles who may have been a brother-in-law of John Johnson, and at least ten others by John Kepp, a London coppersmith and brazier, all working for and under the supervision of Tennant or Wollaston. The clippings remained the property of Wollaston

Table I

Supplies of Platinum Ore Purchased by Wollaston and Tennant

Supplier	Dates	Weight oz troy	Weight per cent	Cost £
Hutchinson	1800	5,959	12.7	795
Knight	1801	800	1.7	160
John Johnson	1806–1819	13,365	28.5	1,945
James Paterson	1810–1817	17,600	37.5	2,938
Dr. E. Bollmann	1817–1818	2,084	4.4	298
Hodgson	1819	600	1.3	87
Not known but possibly John Johnson	1802–1816	6,558	13.9	890
Totals	1800–1819	46,966	100.0	7,113

Table II

Supplies of Scrap Platinum Metal Purchased by Wollaston and Tennant

Supplier	Dates	Weight oz troy	Weight per cent	Cost £
William Cary	1805–1822	2,146	82.7	536
Unnamed but possibly James Paterson	1810	4	0.1	1
Fletcher	1816	312	12.0	176
John Johnson	1817–1820	59	2.3	38
Dr. E. Bollmann	1820–1821	74	2.9	18
Totals	1805–1822	2,595	100.0	769

Fig. 3 A platinum crucible and lid made by Wollaston and retained by the family until 1932

who charged his customers only for the quantities of platinum present in the finished boilers and for labour and other incidentals involved in their manufacture (19).

Thus, of the total 6,450 ounces of scrap metal reprocessed between 1808 and 1821 by Wollaston, 2,595 ounces came from the sources named in Table II, 1,272 ounces from gunmakers, and about 1,000 ounces were returned by Sheffield, Miles and Kepp; there is no indication in Wollaston's records of the source of the remainder amounting to about 1,580 ounces.

Uses for Wollaston's Platinum

Wollaston enumerated a variety of uses for his malleable platinum. Crucibles and covers, oil of vitriol boilers, evaporating pans, ladles, spoons, tongs, slips, wires, tubes, and the tips of blowpipes were all listed in the chemical field; touch-holes were mentioned for gunmakers; thermometers, scales and quadrants for makers of scientific instruments; knives for the cutlery trade; and medals (20). He made no mention of the possible use of platinum in the jewellery trade or in dentistry, the absence of any reference to the former probably indicating that Wollaston had drawn up his list before the summer of 1805, for by that time he had supplied platinum to a London firm, Rundell, Bridge and Rundell, who were jewellers and goldsmiths to the King and Queen (21).

In 1805, or even perhaps somewhat earlier, Wollaston fashioned some of his malleable platinum into crucibles, probably for his own use (see Figure 3). Shortly afterwards, in a letter published by William Nicholson and dated May 1806, Kidd referred to his own use of "a small crucible of platina, prepared by Dr. Wollaston" (22). Notes of the payments received by Wollaston and Tennant from the sale of their malleable platinum reveal that by 1821 almost 18 per cent of their total platinum output had been used to meet the needs of firms engaged in the manufacture of sulphuric acid (7, 19); boilers made of platinum were constructed for concentrating the weak acid produced by the lead chamber process, and Wollaston designed a special form of siphon tube (see Figure 4) also made of platinum for drawing off the acid after concentration (23). A typical summary of the materials involved in making one such boiler and siphon, and the overall cost, is shown in Figure 5. Two platinum thermometers, probably of the bimetallic type and consisting of a strip of copper plated on one side with platinum, were made for Wollaston by Charles Malacrida in 1807. Tennant had one of these platinum thermometers and Wollaston the other (24). Bar and ingot platinum was sold by Wollaston to friends and to those with whom he had business contacts, and these direct sales brought the total to some 22 per cent of his output of platinum (see Table III). Most if not all of the platinum supplied in this way to Troughton was fashioned into arcs on which

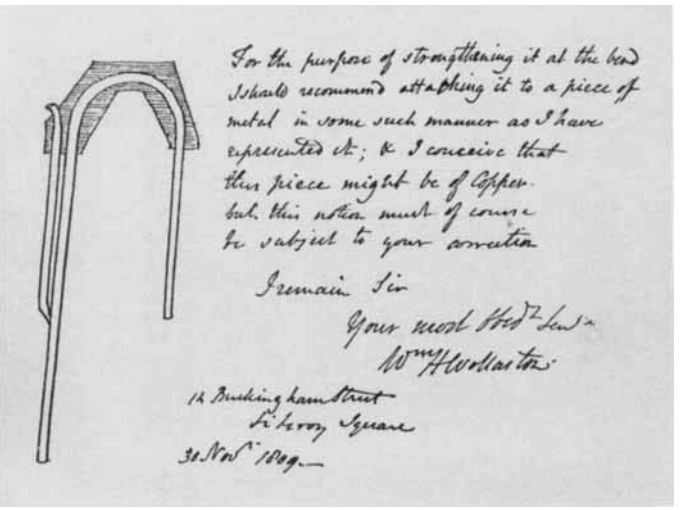

Fig. 4 Wollaston's sketch of a siphon which he designed in 1809 for use with a platinum boiler currently under construction for Thomas Farmer. The siphon was made of platinum and was strengthened at the bend by attaching it to a block of copper

were divided the scales attached to some of his astronomical instruments and sextants (25).

By 1805 Wollaston and Tennant's stock of malleable platinum probably exceeded 5,000 ounces. The partners lack of any marketing experience and a disinclination to become deeply involved in the large scale manufacture of small items of chemical apparatus may well have decided them to turn the commercial side of their platinum activities over to someone more fitted to handle it; that person was William Cary.

Cary's Platinum Transactions

No evidence has come to light of any announcement concerning the intended marketing of Wollaston's malleable platinum by Cary. No advertisements have been found in the contemporary press announcing the availability of Wollaston's platinum, and as far as one can judge it was not until 1817 or later that Cary produced a printed catalogue listing items offered for sale at his shop in the Strand; the first printed statement, that "the metal may now be had, at Cary's, No. 182, Strand, London", appears in a chemical textbook published in 1810 (26). Before then, news of Cary's involvement may have been spread solely by word of mouth or by correspondence, perhaps initiated by informal talk

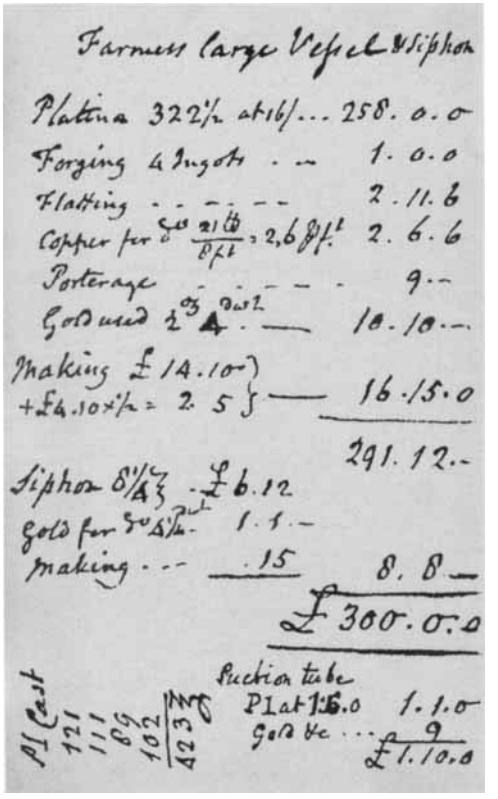

Fig. 5 A page from one of Wollaston's account books showing the charges to be met in 1809 by Thomas Farmer, a manufacturer of concentrated sulphuric acid, for the construction of his first boiler and siphon

Table III

Quantities of Platinum Sold Directly by Wollaston and Tennant from 1805 Onwards

As equipment for concentrating sulphuric acid			As ingots or bars		
Apparatus	Dates	Weight oz troy	Purchaser	Dates	Weight oz troy
Boilers	1805–1819	6,902	Edward Troughton	1806–1820	317
Siphons	1809–1820	297	Perrin, Geddes & Co	1807	30
Miscellaneous	1810–1818	193	John Johnson	1809–1815	156
			Dr. E. Bollmann	1817–1818	66
	Total	7,392		Total	569

between Fellows of the Royal Society of London. Their President, Sir Joseph Banks, wrote to the chemist, Richard Chevenix, on 22 March 1805 stating that Wollaston

> has now opened a Manufactory of Platina Crucibles, &c, which are sold in his name to such as chuse to bespeak them, by Carey, the Mathematical instrument maker (27).

Such a statement might lead one to believe that Cary merely retailed crucibles that had been made elsewhere; but this is unlikely, for Wollaston set down in one of his notebooks the precise lengths of his platinum ingots which, after forging and flatting, would yield sheet platinum of thicknesses appropriate for Cary to make specific numbers of crucibles of particular sizes (21).

News of Cary's involvement in the platinum business soon reached Scotland. In a letter of 18 March 1805, Sir James Hall, who later became President of the Royal Society of Edinburgh, wrote to Dr. Alexander Marcet, one of the physicians at Guy's Hospital, London, saying

> I am told that Cary the mathematical instrument maker has charge of selling pure platina for Dr Wollaston.

He informed Marcet that he had

> once before transacted some business with Cary & found him very able and attentive

and he asked Marcet to place an order with Cary for the supply of six platinum tubes or cups, with a lid or cover for each cup (28). When he wrote to Marcet on 14 May 1805, to let him know that the crucibles made by Cary had arrived safely, Hall commented:

> The crucibles are indeed beautiful—so much so indeed that I can hardly find in my heart to use them (29).

Cary took his first delivery of malleable platinum from Wollaston and Tennant in February 1805 and by the time the last delivery was made in 1822 he had received a total of 30,300 ounces. Of that total Cary sold 28,147 ounces and the remainder, comprising scraps (1,225 ounces), gunmakers' chips (715 ounces) and metal of poor quality (213 ounces), was returned to Wollaston for reprocessing. By the end of 1822 Cary had used 2,247 ounces in the manufacture, to order, of various items of chemical apparatus (see Table IV), and from the known weights of Cary's crucibles, which could be as high as 7 ounces for a large and only $1\frac{1}{4}$ ounces for a small one, it is evident that Cary's output of platinum crucibles must have run into several hundreds (21). The production of laminated slips of pure platinum was welcomed by chemists on account of the low thermal conductivity of the metal, which made it possible for a slip to be held by the fingers at one end even though the other end was being exposed to quite an intense heat (30).

An inspection of Wollaston's register of platinum issues reveals that in 1805 the manufacture of items for chemical use constituted the bulk of Cary's platinum activities (see Figure 6). In subsequent years he appears to have been involved much more in the retailing of platinum as bars or ingots, over 2,000 having been delivered to him in the years from 1806 to 1822. Cary advertised platinum, in various forms, in his catalogue (31) which was printed in or after 1817; in a section devoted to mineralogical instruments he listed the following items as being available from his London shop:

	£.	s.	d.
Platina Spoons	0	4	6
Platina Nippers from 4s. 6d. to	0	6	6
Pepys's Improved ditto.			
Platina Ingots, per oz.			
Ditto in Wire, per oz.			
Platina Crucibles, Lamina and evaporating Basins at per oz.			

The only persons actually to be named in Wollaston's register of platinum issues for sale through Cary are, in chronological order: Stodart, Sylvester, Manton, Edelcrantz, Knight and Rundell between 1805 and 1808, and Ruspini in 1815. Between them these seven were supplied with 137 ounces of platinum in the form of rods, bars, ingots or, as in one instance, a cube (21). James Stodart, of London, and Charles Sylvester, of Sheffield, independently investigated the possible use of platinum for cladding base metals. Stodart, a surgeon's instrument maker and cutler, wrote to William Nicholson in July 1805 describing a method of using platinum to coat steel and brass (32); and in December 1805 Sylvester, a chemist, produced "fruit knives of Platina" and plated zinc with platinum by soldering (33). The order for Sir Abraham Niklaus Edelcrantz, who was a member of the Swedish Academy and private secretary to the King of Sweden, included a platinum bar to be made into an evaporating pan (21). Rundell, a London jeweller and goldsmith, is also noted elsewhere in the register as having returned

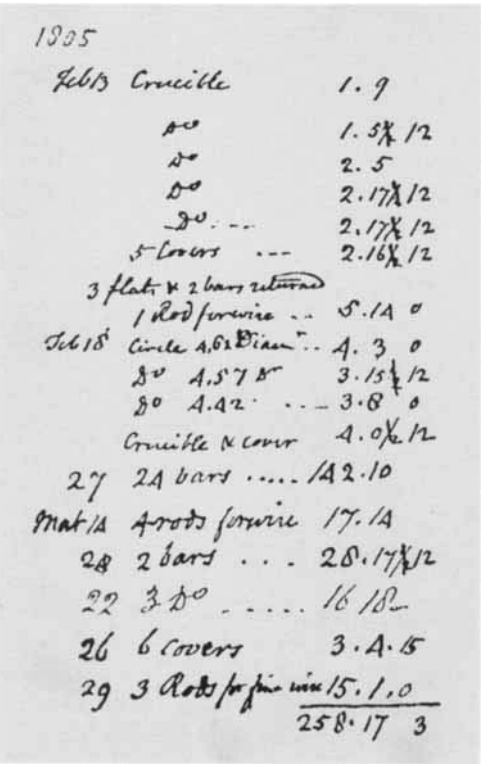

Fig. 6 The first page of the register in which Wollaston recorded all the issues of malleable platinum made to Cary in February and March 1805. The weights are stated in ounces, pennyweights and grains troy

Table IV

Quantities of Platinum Metal Used by Cary for Making Chemical Apparatus

Type of apparatus	Weight oz troy
Crucibles and covers	1,693
Wire	285
Evaporating pans	139
Laminated slips or plates	52
Scale pans	70
Weights	5
Blowpipes	3
Total	2,247

Table V
Cary's Sales of Platinum Metal to London Jewellers

Purchaser	Dates	Cost £
Rundell, Bridge & Rundell	1805–1808	7
Thomas Parsons	1810–1822	2,852
John Phillips & Sons	1811–1813	30
Jn. Brown	1812	70
James Godwin & Son	1812	20
J. & W. Johnson	1819	77
Guest & Cradock	1821	30
	Total	3,086

5 ounces of platinum to Cary in August 1805, possibly because of its poor quality (21).

The appearance of Ruspini's name in the register points to an application of Wollaston's platinum in dental prosthesis. Before 1808 it was customary for a denture to be baked as a single block of porcelain, but early in that year an Italian dentist practising in Paris, Giusep-

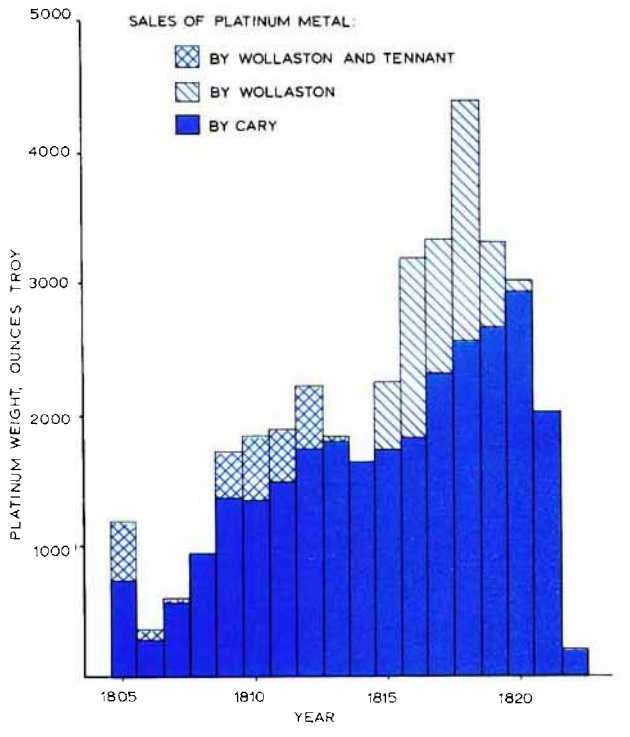

Fig. 7 The quantities of platinum metal sold annually by Cary and the Wollaston-Tennant partnership from 1805 onwards

pangelo Fonzi, pioneered a method by which single mineral teeth could be attached, one by one, to a dental plate made of platinum or gold (34). The Ruspini entry in Wollaston's register cannot relate to Bartholomew Ruspini, who died in 1813, but probably to his sons, James Bladen and George Bartholomew Holwell, both of whom had assisted their father in his dental practice in Pall Mall, London, and continued to practise there after his death (35).

Further information about Cary's sales of platinum comes from ledger entries relating to Wollaston's personal account at Coutts' Bank. Cary's name does not appear in these ledgers until August 1809, an indication that before then all payments due from Cary to Wollaston were in cash. From then onwards Cary made deposits direct to the bank, 60 per cent of the total sum being by cash payments and the remainder by promisory notes and bills of exchange (14). Seven persons named in the ledgers in connection with some of these notes and bills have been identified as jewellers, following searches made in London directories of the period (see Table V). Taking the average price charged by Cary for platinum ingots or bars as 14s. 6d. an ounce, these seven London jewellers must have bought over 4,250 ounces of platinum; other sales may well have been made to jewellers working outside London, but in order to settle the point it would be necessary to make a search of provincial directories.

Speculation that the majority of Wollaston and Tennant's platinum metal was used from 1805 onwards in the manufacture of touch-holes for sporting guns and pistols arose because the issues to Cary of some 19,000 ounces of platinum, as recorded in Wollaston's register, are noted as "Ingots for touch-holes" or merely "Th". Further support for this view comes from the fact that one-third of the waste platinum returned to Wollaston via Cary was in the form of "gunmakers chips" (21). Entries in Coutts' records for Wollaston's personal account and in one of his notebooks reveal that Manton (possibly Joseph and John) made payments, some direct to Wollaston and others through Cary, amounting to £955, a sum which would probably have bought them over 1,300 ounces of platinum. Neal considers that the Mantons made at least 12,000 guns in which platinum would have been used, some double-barrelled and so requiring two touch-holes; on the likely assumption that the average weight of a platinum touch-hole did not exceed 0.1 ounce, the Mantons would have needed at least 1,200 ounces of platinum for that purpose (36).

To sum up, the disposal of the 36,000 ounces of platinum metal produced by Wollaston was as follows:

Through Wollaston & Tennant	
(a) for oil of vitriol boilers	7,392 ounces
(b) to named persons	603
Through Cary	
(a) for making chemical apparatus	2,247
(b) to jewellers	4,250
(c) to cutlers and dentists	96
(d) to gunmakers (the Mantons)	1,300
(e) unknown (possibly gunmakers)	20,112
	36,000 ounces

Income from the Sales of Platinum

The quantities of platinum sold annually over the years from 1805 to 1822 are shown in Figure 7. Sales by Cary always exceed those of Wollaston and Tennant, and in the years 1808, 1814, 1821 and 1822 the only sales made were those of Cary. Precise details of the agreement reached between the Wollaston-Tennant partnership and Cary concerning the marketing of platinum are not known, but from entries in Wollaston's notebooks of income and expenditure (7, 37) it is clear that Cary was allowed 10 per cent commission on his sales (see Figure 8). An analysis of the entries also reveals that over the years from 1805 onwards the total sum due from Cary after deducting his commission was £18,345,

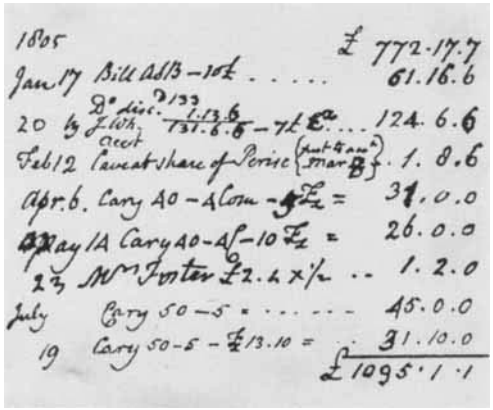

Fig. 8 The page from Wollaston's notebook showing his income for the first part of 1805. The entries relating to Cary indicate that Cary's commission on sales of platinum was 10 per cent; the sums deducted for payments to Tennant varied according to the expenses incurred separately from time to time by the two partners

a figure which accords reasonably with that of £18,401 deposited by Cary in Wollaston's personal account with Coutts Bank (14). The average retail price per ounce for the platinum sold by Cary, most of it as bars or ingots, was thus 14s. 6d. In 1805 Cary's platinum crucibles were available at 17s. 6d. the ounce while platinum wire was 16s. (38). As shown in Figure 1 Cary's invoice for the supply of laminated platinum to Thomas Young in 1816 recorded a price of 17s. 6d. an ounce, the additional charge of 3s. an ounce being levied presumably to cover labour and other costs involved in flatting an ingot (39).

Neglecting any profit that Cary may have earned by fabricating some of the platinum sheet into crucibles, his income derived purely from the marketing of Wollaston's platinum would have been £2,045.

The profits earned by Wollaston from his platinum activities have long been a subject of speculation, a figure of £30,000 having been quoted in 1829 (40). Gilbert, in what was intended as a preliminary survey of the Wollaston papers then only recently discovered, concluded that the figure was probably no more than £17,000, of which £3,000 would have gone to his partner Tennant on the basis of the sales of platinum achieved during the latter's lifetime, leaving Wollaston with £14,000. This figure appears to have been derived following an analysis of the income and expenditure notes relating to the activities of both partners; but Gilbert pointed out that the partnership was also engaged in other activities, namely, the manufacture of tartaric and oxalic acids and oxalates, and of citric acid, and that it was virtually impossible to isolate the income and expenditure associated with these activities in the notebook entries (1).

The income derived from the sale of platinum is now known fairly accurately from a comparison of the Coutts records of Wollaston's bank account with Wollaston's own notebooks, as also are the costs involved in purchasing platinum ore and scrap metal. Only a few weeks after Wollaston's death, one of his friends, Henry Warburton, wrote that the cost of manufacturing the pure metal did not exceed 3s. an ounce, presumably referring to the weight of finished metal rather than of ore (41). The following income and expenditure statement is drawn up using this Warburton figure, and it leads to an estimated overall profit of nearly £11,620.

Income	£	Expenditure	£
Platinum sales:		Purchase of ore	7,113
(a) by Cary	18,400	Purchase of scrap platinum	769
(b) by Wollaston and Tennant	6,500	Refining costs	5,400
			13,282
		Excess of Income over Expenditure	11,618
	£24,900		£24,900

On the basis of sales of platinum achieved by the time of Tennant's death in 1815, this overall profit would have yielded Tennant almost £2,460 as his share from the platinum enterprise, and Wollaston about £9,160.

Acknowledgements

The illustration in Figure 1 is by courtesy of the Council of the Royal Society of London, those in Figures 3 and 4 by the Director, Science Museum, London, those in Figures 5, 6 and 8 by the Syndics of Cambridge University Library.

References

1 L. F. Gilbert, "W. H. Wollaston MSS at Cambridge", *Notes and Records Roy. Soc. Lond.*, 1952, **9**, 311–332
2 F. Wollaston, "A Description of a Transit Circle, for determining the Place of celestial Objects as they pass the Meridian", *Phil. Trans*, 1793, **83**, 133–152 and tab. XV
3 *Gentleman's Mag.*, 1786, **56**, 2
4 D. Brewster, Article 'Circle', "The Edinburgh Encyclopædia", 1830, **6**, 484
5 "Dictionary of National Biography", 1900, **62**, 311–316
6 Cambridge University Library Add. MSS 7736, Henry Warburton's notebook summarising Wollaston's miscellaneous expenditure, 7, 17, 18 and 21
7 Cambridge University Library Add. MSS 7736, notebook **L1**
8 W. H. Wollaston, "On a method of rendering Platina malleable", *Phil. Trans*, 1828, **119**, 1–8
9 Cambridge University Library Add. MSS 7736, notebook **F**
10 Cambridge University Library Add. MSS 7736, notebook **D**
11 D. McDonald, "A History of Platinum", Johnson Matthey, London, 1960, 61
12 M. C. Usselman, "The Platinum Notebooks of William Hyde Wollaston", *Platinum Metals Rev.*, 1978, **22**, (3), 100–106
13 Cambridge University Library Add. MSS 7736, notebooks **D**, **E**, **K** and **L1**
14 Preserved in the archives of Coutts & Co, 440 Strand, London WC2R 0QS; these are at present closed to researchers but photocopies of folios relating to Wollaston's account can be seen at the library of University College, London, in the Wollaston Collection, box 13, file 2, encl. A
15 Holograph letter from Dr. E. Bollmann to Dr. Wollaston, University College Library, Wollaston Collection, box 13, file 3, encl. A
16 R. Knight, "A new and expeditious Process for rendering Plătina malleable", *Phil. Mag.*, 1800, **6**, 1–3
17 W. K. Neal and D. H. L. Back, "The Mantons: Gunmakers", Jenkins, London, 1967, 146–147
18 Cambridge University Library Add. MSS 7736, notebook **I**; see also Ref. 14, entries for the years 1809–1813, 1815 and 1816
19 Cambridge University Library Add. MSS 7736, notebook **H**
20 Cambridge University Library Add. MSS 7736, notebook **G**
21 Cambridge University Library Add. MSS 7736, notebook **I**
22 J. Kidd, "Analysis of a new Mineral found in Cornwall", *J. Nat. Phil. Chem. Arts*, 1806, **14**, 134–140
23 Holograph letter from W. H. Wollaston to Thomas Farmer dated 30 November 1809, Science Museum Library MS 3a–14
24 J. A. Chaldecott, "Wollaston, Malacrida, and the Platinum Thermometer", *Ann. Sci.*, 1971, **27**, 409–411
25 Examples in the National Maritime Museum, Greenwich, include the Greenwich mural circle (inventory M.5) and a sextant (inventory S.152)
26 W. Henry, "The Elements of Experimental Chemistry", London, 1810, **2**, 36
27 British Museum (Natural History), Sir Joseph Banks Correspondence, Dawson Turner copies, **15**, 338–340
28 National Library of Scotland MS 3813, ff 43r and v, 44r
29 Ibid., ff 45r and v, 46r and v. For the full text of this letter and the one mentioned in Ref. 28 see J. A. Chaldecott, "Contributions of Fellows of the Royal Society to the fabrication of Platinum Vessels: some unpublished manuscripts", *Notes and Records Roy. Soc. Lond.*, 1967, **22**, 155–172
30 A. Rees, "The Cyclopædia; or, Universal Dictionary of Arts, Sciences, and Literature", 1819, **27**, Article 'Platina'
31 W. Cary, "Catalogue of Optical, Mathematical, and Philosophical Instruments, Made and Sold by W. Cary", London, n.d., 12
32 J. Stodart, "Precipitation of Platina as a Covering or Defence to polished Steel, and also to Brass", *J. Nat. Phil. Chem. Arts*, 1805, **11**, 282–284
33 Cambridge University Library Add. MSS 7736, loose sheet of paper in notebook **O**
34 V. Guerini, "The Life and Works of Giuseppangelo Fonzi", Lea & Febiger, Philadelphia, 1925, 29, 71–118
35 J. M. Campbell, "Chevalier Bartholomew Ruspini 1728–1813 Surgeon Philanthropist Surgeon-Dentist", *Dental Mag. and Oral Topics*, 1953, **70**, 402–422
36 Letter from W. K. Neal to L. F. Gilbert dated 15 March 1951, University College Library, Wollaston Collection, box 8, file 2, item 3(i)
37 Cambridge University Library Add. MSS 7736, notebook **K**
38 T. E. Thorpe, "Essays in Historical Chemistry", 2nd edn., London, 1902, 558
39 Royal Society Domestic MSS, **3**, item 127
40 *Gentleman's Mag.*, 1829, **99**, (1), 646–648
41 Letter from Henry Warburton to Charles Macintosh dated 16 February 1829; see G. Macintosh, "Biographical Memoir of the late Charles Macintosh", Blackie, Glasgow, 1847, 93