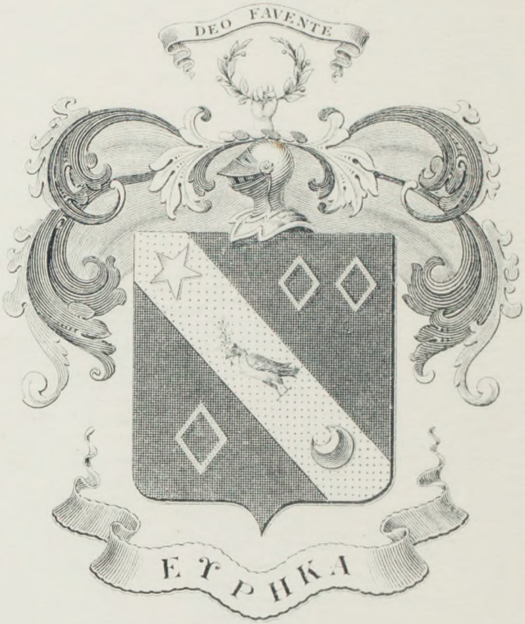
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TIN:

ITS CHEMISTRY & COMMERCIAL VALUE.

BY

WM. BIRKMYRE,

LATE ASSAYER, BANK OF VICTORIA; AND FORMERLY TO THE PORT PHILLIP GOLD MINING COMPANY.

Author of Paper on "The Produce of Gold and Silver" in the "Times" of 21st May, 1852; and of the Essay on "The Most Remarkable Specimens of Native Gold in the Catalogue of the Victorian Exhibition, 1861;" &c.

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PRICE TWO SHILLINGS.

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PREFACE.

In England there seems to be much mischief arising from misstatements as to the yield and to the continuance of the Australian tin mines. Thus, in November, 1875, it was said at a meeting in Cornwall, by the Purser of a tin mine—who most unfortunately advised the adventurers to withhold selling their ore—as he believed "the supplies from Queensland and New South Wales will continue to diminish, and that a much better price for tin will be obtained in 1876 than in 1875." The price, on the contrary, has declined from £102 in January, 1875, to £83 on the 1st January, 1876, and to £70 10s. on the 2nd March of this year, which is the lowest price since 1845. The stock of Straits and Australian tin, in London, on the 1st of last December was equal to 7931 tons, being an increase of 1981 tons on the previous year. Simultaneously with the increase in the quantity, a considerable improvement has taken place in the extraction of the colonial ore and in the smelting of the metal. An Australian mining company alone smelted, in the six months ending 31st of last December, 846 tons of ore, and with six furnaces is now able to smelt with ease 2000 tons in the same period. Hence, the only way out of the dilemma for the old mines is the immediate adoption of improvements in the working of them, and in the smelting of the ore, &c. I have therefore thought that some of the *data* in this pamphlet may be of service to others, here and elsewhere, as they have been to me since the discovery of tin ore in Victoria in 1852.

W. B.

South Yarra,
Melbourne, March, 1877.

TIN.

THIS useful metal has been known from the earliest times, yet it has always been extracted from the ore commonly called *black tin*, a compound of tin and oxygen (binoxide of tin), coloured usually with the oxides of iron and manganese. For ages the metal has been chiefly obtained in Cornwall ; most likely a portion was also raised in South-Eastern India, as it certainly has been in large quantity since 1710. It was then won from the stanniferous gravels of the Dutch Island of Banca ; in 1793 from the Peninsula of Malacca ; and within the last four years in enormous quantities in Queensland, New South Wales, and Tasmania.

Formerly (in 1845) Cornwall and Devon supplied—mostly from *tinstone*—5,500 tons tin per annum, which was more than half the produce of the whole world, the entire yield not exceeding 10,300 tons. The average price at that time was £72 per ton, or £396,000 for 5,500 tons of Cornish and Devon tin, while the foreign imports in that year were only 1278 tons. The yield of the colonial mines in 1875, or in the third year after the great discovery, was equal to 7,300 tons tin, obtained exclusively from *stream* tin.

The progressive usefulness of the metal is proved by the fact that in 1875 the yield of the Cornish and Devon mines is stated at 9614 tons; the mere imports into the United Kingdom of foreign and colonial tin (without including ore) amounted to 16,788 tons, which, at the average price for the year—namely, £86 per ton—are equal to £1,453,000 (see Table No. 3). Thus the yield of the West of England mines was 4,114 tons more than that of 1845, while the quantity of the imports was 13 times as much as the imports in 1845; still the price rose £14 per ton, or 19 per cent. The quantity of tin left for home consumption in the United Kingdom in 1873 was about 13,266 tons, in the United States in the same year, 4,313 tons; in France, 3,578 tons—equal to 21,157 tons per annum.

The physical properties of tin are quite distinct from all other metals. There is a great tendency to crystallise. If a rod of tin be bent a peculiar crackling sound is heard—the cry of tin, *ecri d' etain*—owing to the friction of crystals against each other ; if quickly bent backwards and forwards it becomes very hot. Tin has a somewhat disagreeable taste, and it exhales, when rubbed, a peculiar odour, which depends upon the action of organic matter upon the metal. The specific gravity of the pure metal is 7·28, a cubic foot weighing 455 lbs.; by hammering it may be condensed to 7·29. When a mass of tin is allowed to cool slowly, the crystals (prisms) then attain the density of 7·37. As the ordinary specific gravity of tin in the solid state is only 7·28, that of pure tinstone from 6·96 to 7·1, and since tin, like other metals, expands when melted, there is really very little difference in their specific gravity, so that in smelting, some slag and tinstone sink in the metal, but come gradually to the surface. A good deal of metal, in globules, is absorbed in the slag, and often leads to heavy loss, unless it be very fluid. Tin slightly contracts on cooling, hence a want of sharpness in casting ingots. It conducts heat 6·9 times slower than silver, or only 14·5 to 100 silver; and electricity 7·1 times slower, or 14 to 100; but the rapid conduction of both heat and electricity is impaired by foreign metals, especially a little arsenic. Thus copper wire will vary from 100 to 14; iron, from 100 to 72. Tin melts at the low heat of 442° Fah., or 228° Cent.—that is, 40° Cent. lower than the singular metal bismuth, and 87° Cent. lower than lead. Its ductility is feeble; but at 212° Fah. it may be drawn into wire, the tenacity of which, if $\frac{1}{10}$ of an inch diameter, will just sustain 47 lbs.; a lead wire of the same dimensions only supports 18 lbs. Its malleability on the other hand is remarkable. Tin-foil is about $\frac{1}{1000}$ of an inch in thickness; and white Dutch metal is in thinner leaves. Unfortunately, much of what is called "pure tin-foil" contains one-third its weight of lead. This alloy is of inferior quality, being neither so light nor so tough as pure tin, while it is dangerous, producing a white powder when it comes in contact with acids, it being as poisonous as lead. Tin is one of 51 metals, or one of the 65 elements recognised by chemists. This metal is little affected by air or water. On that account it is much employed to protect the surfaces of iron and copper; but when a clean surface of tin is heated, it soon becomes iridescent from absorption of oxygen. If tin be raised to a white heat, it is volatilised; at a lower heat in the open air it oxidises rapidly or burns, and is converted into putty-powder—white peroxide of tin, formerly known as *Flores Jovis, S. flores stanni* (flowers of tin), which may also be obtained in crystals. Pure tin is nearly as white as silver; it is softer than gold, but harder than lead; it can hardly be scratched by the nail. Till within the last few years the native metal tin was not supposed to exist. I have, however, seen small pellets of tin with alluvial gold, and very recently native tin has been detected along with bismuth in minerals from Mexico and Oruru in Bolivia. Tin containing only 0·3 per cent. of foreign metals, has become by severe cold in St. Petersburg extremely brittle; but this in part may have been owing to the tin not having been cast at the proper heat. The toughness of tin, of gold, and other metals, though pure or nearly so, depends upon the proper heat for casting. The best heat for casting tin, for lustre and cohesiveness, is when the surface of the melted metal is bright—that is, neither too hot nor too cold. If melted at a low heat, although quite fluid, and then cast, it will be at once dim and fragile. It readily combines with other metals, forming valuable alloys; with the liquid metal mercury, an amalgam. The atomic weight of tin is 58 or 116, and its specific heat (water being 1) is ·0562 x 116; the product of specific heat and atomic weight, 6·51.

ALLOYS OF TIN.

The metal tin and its alloy (bronze) were well known to the ancients. Tin and copper (bronze) were then cast on an enormous scale. The bronze gates of the city of Babylon must have weighed many hundred tons, the large casting of Chares of the "Colossus of Rhodes" one or two hundred tons, and their almost inimitable bronze statues in Athens, Corinth, and elsewhere, were cast in thousands, and must have weighed many thousand tons. They knew that the alloy became soft when heated and quenched in water, but regained its hardness on being heated and cooled slowly, being exactly opposite to the later discovery of hardening or tempering steel. Their sharp-edged swords and other warlike instruments endured better than iron the action of air and moisture, though in other circumstances were far inferior to the recent discovery of cast steel on a vast scale. Indeed, cast steel guns, because of their lightness and incomparable strength, &c.—as proved in the late Franco-German war—are fast displacing the modern bronze cannon of six years ago. Even the great bronze cannon of 29 inch calibre that guards the Dardanelles is now being replaced by cast steel guns. It is probable that many of the big guns on those straits were cast from some of the 1500 works of Lysippus, rather than the whole of his statues decayed by age, inasmuch as in the Tomb of Agamemnon recently discovered, although 3000 years old, the bronze articles seemed to be as perfect as the golden ornaments.

Bronze cannons contain 9·5 tin and 90·5 copper, their specific weight 8·76; whereas cast steel is only 7·93, or 10·5 per cent. lighter. As there is a difference of 1·64 in the specific gravity of the two metals tin and copper, and 1554° in their melting points, and a much greater attraction of tin for oxygen at the same temperature, the formation of the alloy requires many precautions. It is necessary to melt the copper in a crucible, then to add half its weight of tin. This alloy is more fusible and harder than copper (hard metal). It is then added to the proper quantity of copper melted in the reverberatory furnace, excluding the air and stirring the alloy with a pole before casting.

The alloy varies in composition and properties—thus the compound of 100 tin and 100 copper has the real specific gravity of 8·79, being a good deal more dense than the calculated specific gravity of 8·05. Bell metal is composed of 22 tin and 78 copper, the specific gravity being 8·815; this mixture is compact, fusible, and sonorous; but in very ancient times the small bells of Nineveh seemed to have been composed of only 1 of tin to 10 of copper. The Chinese forge their gongs, tam tams, and cymbals, which are made very thin, by a hammer. The quantities are immense of tin and copper absorbed in bells in some countries—in one bell cast in Russia in 1734 it was as much as 192 tons. There is a considerable import into the United Kingdom of bronze and brass; in 1872 it was 868 tons, equal to £109,775; in 1873, 641 tons, or £98,377; and 1874, 602 tons, in value £111,942. Bronze, although far more durable than iron, still, under certain circumstances, such as warm water, air, and gas, decays in a few centuries into cassiterite (binoxide of tin) and covelline (sulphide of copper). The speculum of the Earl of Rosse's great telescope is composed of 31·5 tin and 68·5 copper. Tin was struck with a stud of copper in the centre for small coin in 1680. The convenient bronze coin of the present day is formed of 4 tin, 1 zinc, and 95 copper. According to the Fifth Annual Report of the Deputy Master of the Mint, 1874, it appears that £1,205,743 (nominal value) has been issued of bronze coin from 17th December, 1860, to 31st December, 1874, and £564,017 5s. 8d. (nominal value) of old copper coin has been purchased and withdrawn from circulation in the time above specified—or an apparent profit of £641,725 14s. 4d.

The nominal value of bronze money circulating in the United Kingdom and the Colonies in 1871 was about £1,051,088; in France in the same time, £2,460,000; in Italy, £3,400,000; in Belgium, £482,430; total in these four countries only, £7,393,519—about 20,652 tons. On the 18th December, 1872, Scandinavia agreed to a common monetary system, whereby their bronze coin is composed of 3 metals, in the same proportion as the British. A ton of bronze, composed of 95 copper, 4 tin, and 1 zinc, costs nearly £100, which, when converted into coin, is worth £358, yielding a profit of £258. A penny-piece weighs 145·8 grains, or one-third of an oz. avoirdupois, but is only legal tender to the value of 1s.

Tin-plate (sometimes called white iron—*fer blanc*) is made of the best sheet iron, thoroughly cleansed of all oxide by dipping into warm diluted hydrochloric acid, or good sulphuric acid (containing 1 acid to 16 water), washed in three or four waters, drained, dried, then dipped into a pan of melted tin, covered with tallow to prevent oxidation of the tin. 225 plates of 13¾ inches by 10, weighing 112 lbs., are effectually coated with 8¼ lbs. of refined tin. The export alone of tin-plates is very large. In 1875 it was 138,563 tons, in value £3,691,000, which quantity must have consumed upwards of 12,000 tons of tin. Price of tin-plates in London 24th November, 1876, 1 C (charcoal) common, No. 1, 1st quality, £1 3s. 6d. per box; block tin plates, *or doubles*, have a thicker coat of tin, and are polished on a smooth anvil. They sell common doubles, C D, 16¾ inches by 12½—100 = 3 qrs. 21 lbs.—at £1 17s. Tin, lead, or zinc *protects* the iron in weak acids, hence they are more oxidisable, or electro-positive, than iron.

Tin-plates should possess strength, colour, and flexibility. This is only attained by using the best description of iron, and by skill in the rest of the manufacture. It may be stated here that the consumption of this very useful alloy is fully 6 times as much as in 1845, being a great deal more than the decline in the consumption of tin for bronze guns.

Terne-plates consist of sheet-iron coated with an alloy composed commonly of 1 tin and 2 of lead; the quantity of alloy used per box is from 12 to 14 lbs.; but this varies according to the weight of lead employed in the alloy. These plates are sold about 2s. 6d. per box below tin-plates of like brand. They are largely consumed for roofing in Canada. The waste (or clippings) of tin plate is large, it is said to be 6 per cent. of tin ware; fully 20 tons are produced in Birmingham weekly. The tin can be easily dissolved off tin in hot muriatic acid; it is quickly precipitated by zinc. The metal is also dissolved by hot caustic potash or soda and a current of air. The tin scraps, too, may be employed with advantage in de-sulphurizing antimony glance; a useful alloy is then formed of tin and antimony.

Galvanised iron, which is now well known, was at one time produced by covering iron articles with zinc, by attaching them to the negative end of a weak galvanic battery, and plunging them in a solution of white vitriol. The zinc was deposited by the galvanic current upon the iron, hence called *galvanised;* but this process is both tedious and expensive. Another plan was adopted by dipping sheet-iron, cleansed of oxide of iron, into melted zinc covered with powdered hydrochlorate of ammonia (sal ammoniac), which salt dissolves the oxide of zinc from the surface of the melted zinc. The above process was improved in 1841 by coating the iron previously with tin, then dipping the tinned plate into melted zinc; sheets of galvanised tin plate were exhibited of the uncommon size of 8 feet by 3. A medal was granted to the exhibitors by the Jury on Metallurgical Operations at the Exhibition of 1851. Since then the second bath is frequently dispensed with, as a few pounds of tin added to the zinc (like lead to the tin in the formation of terne-plates,) have the same effect. The products of this useful invention are much esteemed in Australia. The exports of galvanised corrugated sheet-iron, from the United Kingdom in 1874, amounted to 34,358 tons, in value £877,796. The common selling price in Melbourne of 26 gauge of English galvanised iron is £26 per ton. It may be worth while to mention that plate and sheet iron are classified according to their thickness; the word plate includes all strengths above No. 4 Birmingham wire gauge, which corresponds to a thickness of 0·238 inch; all under that thickness are sheets. Singles from No. 4 to No. 20 wire gauge 0·238 to 0·035 inch thick; Doubles from No. 20 to No. 25 wire gauge 0·035 to 0·020 inch thich; Trebles or Lattens from No. 25 to No. 27 wire gauge 0·020 to 0·016 inch thick.

Tin and lead form a useful alloy. *Fine solder* employed for tinwares contains 2 parts by weight of tin, and 1 of lead; *common solder*, or plumbers' solder, of equal weights; *coarse solder*, 1 of tin and 2 of lead. These alloys melt at a lower heat than tin. Pewter is composed of 80 per cent. tin and 20 lead. An excellent type metal is formed of 1 tin, 1 antimony, and 2 of lead; it is a hard alloy, and takes a sharp impression from the mould. An alloy of 1 part tin, 1 lead, and 2 of bismuth fuses at 202° Fah.; this alloy instead of expanding by heat from 110° Fah. to 156° contracts, but from that temperature to 346° expands fully 3 per cent. On cooling to 90°, it will suddenly give out 60° of heat. An alloy with 4 parts tin, 8 lead, 3 cadmium, and 15 bismuth melts at 140° Fah.

Tin and mercury rapidly combine; the amalgam is denser than the mean of the two metals. It is much employed for silvering looking glasses: the process is simple. A perfect sheet of tin-foil, somewhat larger than the plate of glass, is spread evenly upon a table of slate, which is surrounded with a trough for collecting excess of amalgam; the quicksilver is poured upon the tin-foil and spread evenly, and rubbed with a roll of flannel; more quicksilver is added, and the excess is run off. The amalgam should be $\frac{1}{16}$ of an inch in thickness. The surface of the amalgam is cleansed of dust by passing a cloth gently over it; the edge of the clean glass dips below the surface of the amalgam; the glass is then pushed forward carefully, when all the bubbles of air are expelled. The glass adheres to the amalgam, and the plate is covered with flannel; for weights are placed upon the flannel to squeeze the excess of amalgam to the groove at the edges of the stone, which is gently inclined to enable the excess to drain off. After the first 24 hours it is placed upon a wooden table, which has a greater incline from day to day until the glass is vertical. In a month it is thoroughly drained, when the mirror is fit to be framed.

SYNONYMS.—The metal tin was early known as *kassiteros*, afterwards as *stannum*; to the alchemists as Jupiter ♃—also called by them *diabolus metallorum*—(they believed that tin made gold extremely brittle; this is nearly true of lead, but with regard to tin it was proved to be erroneous, about 93 years ago, by Mr. Alchorne, of the London Mint, who found that gold containing 2·7 per cent. tin could be rolled and coined); it is known to chemists, by the symbol Sn. In commerce at the present day as—1, *tin*, or *white tin*, Eng.; 2, *etain*, Fr.; 3, *zinn*, Ger.; 4, *tin*, Dutch; 5, *tinn*, Danish; 6, *tenn*, Swedish; 7, *blächa*, Rus.; 8, *stagno*, Ital.; 9, *estaño*, Span.; 10, *estanho*, Port.; in South-Eastern India as *tima*, Malay.

TIN ORE, TINSTONE, BLACK TIN, FIBROUS, WOOD, OR TOAD'S-EYE TIN, CASSITERITE, PEROXIDE OF TIN, STANNIC OXIDE, SnO_2.

The pure ore is colourless, in which state it is frequently found in Bolivia; it then contains 78·3 per cent. tin, and 21·7 oxygen. As the ore is a dense mineral (sp. gr. 6·9) there is an unusual quantity of oxygen in a given bulk, or weight, as compared with the peroxides of lead and copper. Occasionally it is obtained of a beautiful ruby tint, being coloured by a trace of gold, as in the crystals of the ore in the Beechworth district, Victoria. These crystals give 78·0 per cent. tin—almost absolutely pure.

Wood, fibrous, and toad's-eye tin occur in reniform and radiated structures, composed of concentric coats; they are found in low grounds, and on mountains 9000 feet high, as in Durango, Mexico.

Tin ore of the best quality is found, as stream tin, in deposits on lands, in the beds of creeks or small rivers, being the alluvial *débris* of tin lodes or veins.

At the present time, in favourable situations, there can be no doubt that oxide of tin is being deposited from solution of stannate of soda or potash. In the province of Durango, Mexico, stream and mine tin are found in great abundance. Where tin ore can be raised and smelted at 1d. per lb. there appears to be undoubted evidence of the continued reproduction of wood tin.

It is found as tinstone, in lodes traversing granite, quartz, or slate; often in small crystals disseminated in the rock itself. Now and then it is accompanied with small quantities of tin pyrites—bell-metal ore.

Although tin ore is not so widely diffused as the ores of iron, copper, and lead, it is now found far more abundantly than it was at one time supposed. The annual yield of tin being now about 33,000 tons, which implies that 50,000 tons of concentrated ore, and about 3,300,000 tons at least of alluvial deposit and tinstone, are raised and dressed. The yield of foreign and colonial tin is rapidly on the increase; the imports into the United Kingdom in 1874 of tin only were 9217 tons, equal to £904,769. The import in 1875 amounted to 16,788 tons valued at £1,453,000. As the import in 1845 was only 1278 tons tin, and the import in 1875 16,788 tons, it had therefore increased 13 times. Notwithstanding the fall in the price of tin from £111 per ton in 1874 to £90 per ton in 1875, the production of tin in Australia not only did not decrease, on the contrary, there was an increase of 2,200 tons. It is still increasing, and at the present time the yield exceeds Devon and Cornwall. In this year (1877) there is every probability that Tasmania alone will cast upwards of 2000 tons of ingot tin from native ore. And just now, in New Zealand, "a great quantity of stream tin has been discovered in two creeks." It is also true that the yield of all metals has greatly increased. The mere imports into the United Kingdom of foreign and colonial iron and steel have risen from 33,511 tons in 1845 to 270,018 tons, eight times as much as in 1845. The imports in 1845 of foreign and colonial lead in the ore and smelted lead were only 5519 tons; in 1875 there were 9532 tons of lead in the ore, 79,825 tons of smelted lead, and 347 tons manufactured lead, being sixteen times as much as in 1845; those of copper in 1845 were only 130 tons, in 1875 they had risen to 39,527 tons (exclusive of old copper), or 304 times. While the imports of tin, lead, and copper are increasing, the home production is decreasing. In fact the times are ominous of a great change in raising and smelting not only tin, but lead and copper. Fortunately, with the increase of production, the demand for consumption frequently increases almost in the same proportion. But the above reference to the import of foreign and colonial metals, and the decrease of the home production of tin, lead, and copper, show the imperative necessity of adopting in the United Kingdom all kinds of improvement in working mines and in smelting ores.

At present the Australian mines, or rather diggings, furnish the largest supplies of tin, those of Banca, Billiton (Bleotong), and Malacca, stand next; then follow the mines of the West of England, Bolivia in South America, Saxony or Germany, and Bohemia in Austria.

TIN ORE, BLACK TIN, WOOD TIN, IN CORNWALL.

1. Stream tin is, or rather was, found in fine grains or pebbles at the bottom of ancient deposits, covered, in some instances, by 70 feet of sand and clay, and therefore similar to the alluvial deposits of gold in Victoria; but the latter were often raised from a greater depth, namely, 420 feet, as in the Band of Hope, Ballarat.

2. Tinstone is found in slate (killas) and in granite (growan) in stockwerk deposits (small veins intersecting each other).

3. By far the largest part of tinstone is obtained in Cornwall from *true veins;* these are most productive at the junction of the slate and granite. Thus, in 1874, from 230 mines in Devon and Cornwall the quantity of *black tin* raised was 14,715 tons, in value £753,241, of which weight only 186 tons, value £8675, were stream tin; total amount of white tin 9724 tons, value £1,084,081; average price per ton, £111. In 1875 the yield from 183 mines was a little less according to the official account, being 13,996 tons *black tin*, in value £735,606, equal to 9614 tons; *white tin*, in value £866,266, average price, £90.

Black tin is relatively a heavy mineral, its specific gravity being 6·9., as compared with clay, 2·2, sand 2·5. The ore is found either as *stream tin* or *mine tin*. In the early ages the ancients smelted the stream, or alluvial tin ore, as they obtained it near the surface, and much purer than the mine tinstone. It sometimes exists in large crystals; masses of almost pure cassiterite weighing 50 lbs. have been found in Queensland. Great masses, too, but of mine tin, have been raised in 1750 at the Polberro mine, St. Agnes, Cornwall; a block in that mine was discovered weighing 664 lbs., which gave, without stamping or concentration, 57 per cent., even in those days when metallurgy was but imperfectly understood. Another mass from the same mine is said to have weighed 1200 lbs.

The impurity in the surface tin ore has been separated by long action (weathering) by air and moisture, whereas to obtain the vein tin stone equally pure, it has to pass through the following operations too often, in the present day in Cornwall: thus it has to be raised from a great depth, in one or two instances as much as 1800 feet, yet the average yield of that tinstone may not exceed 2 per cent. *black tin*, or 18s. per ton (which is, as near as may be, half the value of the auriferous quartz raised in the Western District of Victoria), and were the ore selling at £86, instead of the present price of £43 per ton, and raised from a moderate depth, it is even possible to make 1 per cent. pay. Indeed, it was stated some years ago—"It is well known in Cornwall that in 1836, unless the ores contained 15s. worth of tin per ton it was of no use raising it; whereas, in 1856, thousands of tons were profitably raised and dressed that did not contain more than 2s. 6d. worth of tin in the ton."

The tinstone, or tin stuff, is first roughly dressed or washed upon a grating, then picked and broken with a hammer, the iron and arsenical pyrites rejected, while the copper pyrites, in part, are sold as copper ore. The tinstone is now pulverised in water by iron stamps (these stamps, unless of white cast iron, are soon destroyed, the hardness of the tin ore being 6·5, it is therefore almost as destructive to iron as auriferous quartz). The crushed ore is allowed to flow into reservoirs, and is then, especially in the first tank, in a great measure, freed of clay and sand. In the first reservoir is deposited most of the tin ore, but various contrivances are adopted for purifying the slimes or *débris* of the stamped ore, such as by the *rack-table*, *buddle*, or *keive*. To separate the other and heavier substances, it is necessary to calcine this ore in *burning* houses, containing reverberatory furnaces; about 10 cwts. are thrown into a furnace, the heat at first is moderate, to prevent the fusion of the sulphides; on raising the heat and almost constantly stirring, towards the end of sixteen hours much of the sulphur of the iron, copper, manganese, lead, zinc, tin, antimony, and of molybdenite, is volatilised, the copper and manganese are partly converted into soluble sulphates of copper and manganese, while the density is reduced of the native sulphides and oxides. The mineral called mispickel (sulphide of arsenic and iron) parts with a great portion of its sulphur and arsenic, the latter is condensed and sold as soot arsenic at £7 per ton—if refined, it sells at £12 per ton up to £17, in retail at 26s. per cwt. for lump arsenic—tin or copper ores, in England, being the great source of commercial arsenic. In 1874 it was raised in 25 mines in the West of England to the extent of 4768 tons, in value £21,483. One mining company produced 1842 tons, in value £12,762, or £6 19s. per ton. The roasted tin ore is exposed for a few days to air and moisture in small heaps. It is well perhaps to mention here that merely damp crushed ore left exposed to the sun, or in a warm place, will speedily yield the salts, sulphates of copper, iron, and manganese; therefore some precautions should be taken to prevent pure water being contaminated with these salts. Sulphide of manganese (*manganblende*) is very common in tin and gold mines, and is one of the first minerals in a damp warm atmosphere to oxidise into the soluble sulphate of manganese. The calcined ore is now thrown into a wooden tank and stirred, the sulphate of copper and sulphate of manganese quickly dissolve in the water; after remaining there a short time the solution becomes clear, when it is drawn off into another vessel, and the copper from the *blue water* extracted by iron, effecting a deposit of copper almost chemically pure—the *copper of cementation*. By washing again the roasted ore on an inclined table with a ledge three or four inches high, the lighter particles are washed away, leaving the tin stone comparatively pure. This process of dressing the ore by water, generally the last before smelting, chiefly depends for success upon the density of tin ore, namely 6·9.

The minerals associated with tinstone possessed originally the following specific gravities :—*Iron pyrites*, iron and sulphur (sulphide of iron), 4·9 ; *copper pyrites* (sulphide of copper and iron), 4·2 ; *Manganblende*, sulphide of manganese, 4 ; *galena* (sulphide of lead), 7·5, with careful treatment in the furnace this mineral may be oxidised into *minium*, containing 10·3 per cent. oxygen, having the low sp. gr. of 4·6 ; *blende* (sulphide of zinc), 4 ; *antimonite* (tersulphide of antimony), 4·6 ; *molybdenite* (bisulphide of molybdenum), 4·6 ; *mispickel* (sulphide of arsenic and iron), 6·2 ; *tin pyrites* (sulphide of tin and copper, iron and zinc), 4·5—containing 26 per cent. tin, 28 copper ; *hematite* (peroxide of iron), 5 ; *melaconite* (peroxide of copper), 5·9 ; *pyrolusite* (peroxide of manganese), 5·9. The tin ore after roasting was further improved, about forty years ago, by treating it with muriatic acid or sulphuric, according to the foreign substances present with the tin ore. The calcination of the tinstone, containing a portion or all of the first 12 minerals above specified, will cost nearly £1 per ton.

In some localities, besides the above-named minerals, there are two known as *scheelite* (tungstate of lime), 6 ; and a heavier body called *wolfram*, or *mock lead* (tungstate of iron and manganese), 7·3 ; this tin ore must be treated differently, and further expense incurred. It requires fusion with carbonate of soda, when the tungstic acid of the lime, and of ferrous tungstate, combine with the soda, forming tungstate of soda ; this salt is used in the arts, yet the value of tungstate of soda and wolfram produced in 1873 does not appear to exceed £520. The salt is easily crystallised in hexahedral tables, soluble in 4 parts of cold water ; the solution is applied in calico printing, also to starch and to muslins, which, when steeped in a solution containing 20 per cent., the texture is not injured, they may be held in a flame without taking fire.

TESTS FOR NATIVE TIN ORE.

In Victoria it is found generally in small particles, which are mostly dark, sometimes white, less often of a ruby colour. They are heavy, and occasionally water-worn. The best criterion of tin ore is its weight, the sp. gr. being 6·9 ; there is only one rather common mineral that surpasses it in weight, namely wolfram, sp. gr. 7·3. This mineral, because of its weight and colour, may possibly mislead ; but the blow-pipe at once tells whether it is tin ore or wolfram ; a little powder of the mineral in question mixed with carbonate of soda, will show bright particles of tin, if tin ore be present. On account of the small size of tin ore in Victoria, it is very liable to be contaminated with titaniferous iron sand. This mineral is of a black colour, and remains so when powdered ; tin ore, on the contrary, becomes of a lighter colour. As titaniferous iron only possesses the sp. gr. 5·0, and being in smaller particles usually than tin ore, it may be sifted, or readily washed away. The ore of New South Wales and Queensland is frequently in large, dark, water-worn crystals, of a white, and occasionally of a red, colour. The same tests apply to the dark and white tin ore as that of Victoria. Zircons, hyacinths, or jargons often accompany tin ore. The zircons have a red and brown colour, they lose their colour before the blow-pipe, alone are infusible, their sp. gr. is 4·7; schörl, or tourmaline, has generally a brown or black colour, fuses before the blow-pipe; its sp. gr. is only 3·1.

BEHAVIOUR OF THE SALTS OF THE PROTOXIDE OF TIN AND PEROXIDE OF TIN WITH REAGENTS.

Salts of Protoxide.

With—

Hydrosulphate of ammonia	A brown precipitate of sulphide, sparingly soluble in excess.
Ammonia	A white precipitate, soluble in excess
Chloride of gold	A purple precipitate.
Red prussiate of potash ...	A white precipitate.

Salts of Peroxide.

Hydrosulphate of ammonia	A yellow precipitate of persulphide of tin, soluble in alkalies.
Ammonia	A white precipitate.
Red prussiate of potash ...	No precipitate.

Dr. Clark's glasses are the most convenient for holding these solutions of pro and per oxides of tin.

ASSAY OF OXIDES AND OTHER COMPOUNDS OF TIN BEFORE THE BLOWPIPE.

A small grain of crushed tin ore may be taken and mixed with carbonate of soda, or, better still, with cyanide of potassium; then place the mixture on charcoal and direct the reducing flame on it, when the metal is instantly produced. The longer the tin is kept bright is a good test of the skill of the operator. Metallic tin before the blow-pipe can be obtained by reduction, as well from the persalts, or compounds, as from the protosalts of tin.

ASSAY OF TIN ORE BY THE CRUCIBLE.

Take 400 grains of the pulverised ore of high percentage, 80 grains of dried carbonate of soda, 80 grains of calcined borax, and 70 grains of ground charcoal, and mix intimately. Place the mixture in a No. 1 black lead crucible, and cover; then submit the contents for ten minutes to a moderate heat, and after, for fifteen minutes, to a strong heat. The slag is very fluid, and sufficient to cover the surface of tin, preventing oxidisement and small globules. The button of tin will generally weigh 304 grains, or 76 per cent. Lest the slag contain a particle of tin, it should be pounded in a mortar and sifted, the globules, if any, weighed.

ANALYSIS OF NATIVE OXIDE OF TIN.

Reduce the ore to fine powder, mix it with five times its weight of caustic potash or soda. Heat the mixture to dull redness in a covered silver crucible for thirty minutes; then dissolve the fused mass, which is usually green, in muriatic acid; drive off nearly the excess of acid, add water, then precipitate the tin of the hydrochloride as sulphide by hydrosulphuric acid. Filter, then convert the precipitate of sulphide, by nitric acid into peroxide. Of course the filtered solution from the sulphide contains protochloride of iron, manganese, &c.; peroxide it by boiling with nitric acid, neutralise with ammonia; and precipitate peroxide of iron by neutral benzoate or succinate of ammonia; on filtering from the precipitate of benzoate or succinate of the peroxide of iron, manganese, if present (the green colour of the melted flux and oxide of tin is generally owing to oxide of manganese), may be precipitated by hydrosulphate of ammonia.

SMELTING OF TIN ORE.

In Cornwall they employ reverberatory furnaces, in Saxony blast furnaces (blowing houses), also in the island of Banca, in the adjacent isles and coasts; but although the ore in those Eastern isles be very pure, yet the loss of tin is excessive, but, when well smelted, the tin is remarkably pure, being as high as 99·96 per cent. The blowing houses or blast furnaces are not very unlike the Catalan forge, which has been used from time immemorial for smelting iron from high-quality iron ores of the Pyrenees. Both furnaces comprise a blowing machine, *trompe*. They lose more ore and consume more fuel than the English processes of reducing iron and tin ore. The blast furnace loses fully twice as much tin as the reverberatory. Formerly, two or three centuries ago, these blowing houses abounded in Cornwall. The scoria of a work at Redmoor contained 22·8 per cent. oxide of tin, but the slag may have been unskilfully treated, as it certainly was in 1853 in a reverberatory near to Melbourne, as I found in the scoria of that smelting work as much as 32 per cent. tin; yet as the ore was purchased at £46 per ton, while the smelted tin was worth £126 per ton in England, exclusive of the value of 20 ozs. of gold per ton which it contained, this specimen of early smelting of tin ore in Victoria proved to be profitable in spite of the heavy loss of tin in the slag. In fact, all those who took common precautions to have their ore assayed found their shipments to England very profitable.

SMELTING TIN ORE IN CORNWALL.

For every ton of ore in Cornwall, freed as much as possible from foreign substances, they take about 365 lbs. ground coal or charcoal, and a little lime, which are closely mixed and then damped, to prevent loss when throwing the mixture upon the bed of the reverberatory. In this operation, the fire-door is at one end, with another over it, to moderate the draught; in the centre is the charging-door, and near the chimney is the working-door. The charge is gradually heated for five or six hours. The carbon or coal, with the tin ore, partly becomes carbonic oxide and carbonic acid, while the carbonic oxide and the hydrocarbons of the fuel take more oxygen from the ore, reducing it to the metallic state. A low heat with closed doors is required to prevent the oxide of tin combining with silica, for which it has a strong affinity. At the end of six hours the heat is greatly increased, while the smelter stirs the melted tin and flux, to facilitate the separation of the tin. The slag is now made as fluid as possible; it is then skimmed off. The reduced tin is allowed to flow into an iron pan, where it settles, when more slag comes to the surface, and is raked off. The tin is ladled into large granite or iron moulds, which contained 3·34 cwts. previous to the abolition of the Duchy dues of 4s. per cwt. on the 10th Oct., 1838. It may be mentioned here that the import duty of 6s. per cwt. on foreign ingots, bars, or slabs, and 3s. on colonial ingots, was repealed 4th June, 1853. On the 3rd March, 1860, the duty of 15 per cent. on tin manufactured, and 6d. per lb. on tin foil, was repealed. Since then there has been no duty whatever on tin.

The slag is a silicate of oxide of tin, oxide of iron, lime, and alumina, containing about 7 per cent. tin in the state of oxide, and 5 or 6 per cent. in globules of tin. The richest part of the latter is crushed and added to the next charge; but the upper portion of the slag, containing very few particles of tin, is thrown away—irretrievably lost. From one cause and another, there is a very great discrepancy between the price of 72 per cent. tin ore and English block-tin, this being as much as much as £40 = 80 to 100 per cent. There is usually a heavy loss in the smelting of tin ore. It arises partly from insufficient attention to the flux. The lime should not exceed 55 parts to 45 silica; when soda is used, it should be not less than 10 to 90 silica; carbonate of soda as a flux, weight for weight, is more powerful than carbonate of potash. The slag is generally too thick; but it might economically be made thinner by adding to a smaller quantity of lime a small quantity of soda-ash (this chemical substance can now be had for about £9 per ton), say 40 lbs. = 3s. 6d.; the advantage would be less time required in the smelting, and less absorption of oxide and metal in the slag, the gain thereby amounting to at least £3 10s. per ton of tin; its fluidity as silicate of soda being much more as compared with silicate of lime, the smaller the quantity of flux used to effect liquidity the greater will be the out-turn. It must be remembered, too, that the iron smelter operates on ores, which often do not exceed 30 per cent. before smelting, yet he obtains from such low class ores as much as 29 per cent. iron. The consumption of coal is about 2 tons for 1 ton of tin, which is about 1-5th of that used in the smelting of 1 ton of copper (from Cornish ores). The tin smelter operates on ores containing 72 per cent. tin, whereas the average of Cornish copper ores do not exceed 7 per cent. (the yield of copper ore for the year ending on the 30th June, 1876, being 57,173 tons, sold by public ticketing at 6¾ per cent. copper). It is the chief reason why the tin ores of the West of England are all smelted there, instead of South Wales.

The ingots of tin may contain a little lead, copper, iron, antimony, arsenic, gold, bismuth, tungsten, and molybdenum ; these metals are got rid off, to a great extent, by the process of *liquation* and *boiling.* They are placed in a reverberatory and melted at a low heat, when the tin liquefies and flows into a *refining basin* ; when 5 or 6 tons have been collected in the *refining pan*, logs of wood are kept down in the pan, then the heat of the metal evolves from the wood a great quantity of steam and gas, which give the appearance of boiling; this process has the effect of carrying much of the impurities to the surface, and are skimmed off. In about three hours the wood is withdrawn, the metal is left quiet for an hour or two, the foreign metals go to the bottom, while the upper part is nearly pure. The ingots cast from the upper part are known as *refined tin*, from the middle as *block tin ;* the lower portion is too impure, and must be refined. The ingots of refined tin at the point of solidity are extremely brittle, so that if let fall from a height they split up into *grain* or *dropped tin.* Occasionally a process called *tossing* is employed—that is, the melted tin is raised by ladlefuls to some height, and then let fall into the melted tin, which, after standing as before, is divided into three qualities.

It is strange, however, that an old and extensive mine, at one time famous for copper ore (Dolcoath, West Cornwall, but since 1853 for tin ore, and now the chief mine in Cornwall), having raised in 1874 1121 tons tin ore, equal to £65,500, or about 200 tons of tin stuff per diem, yet it does not even smelt its prepared ore, notwithstanding a difference of £40 per ton, or 80 to 100 per cent., between a ton of its black and white tin. Still, as the same mine is reaping great benefit from the new mode of boring rock by machinery, and by new blasting powder, it will, doubtless, soon be tempted to smelt at least its own ores, especially when tin ore is only about £43 per ton. The mere fact of two Australian colonies raising of surface tin ore 10,300 tons in a year, and smelting a portion of it—and that in the fourth year of its discovery there—suggests the necessity of immediately adopting every improvement in raising and smelting ore from the deep mines of the West of England. Even in the third colony (Tasmania), where tin ore was last discovered, the yield is becoming very large, and the ore is being smelted there in large quantities.

PRODUCTION OF THE OXIDES OF TIN.

There are three oxides of tin—1st, protoxide of tin, monoxide, stannousoxide, $Sn\ O$; 2nd,* sesquioxide of tin, $Sn_2\ O_3$; 3rd, peroxide of tin, binoxide of tin, dioxide, stannic acid $Sn\ O_2$.

The first oxide may be obtained by dissolving tin in muriatic acid or nitric acid, diluted with ten times its volume of water. It is a valuable salt, largely employed by dyers and calico printers. When decomposed by carbonate of soda, and the precipitate carefully washed and dried at a heat under 212° F. it is a hydrated protoxide. It may be obtained *anhydrous* by heating the above to redness in a retort filled with carbonic acid. In this state it is a black powder, possessing the specific gravity of 6·6. It has great affinity for more oxygen, if touched with a red-hot wire will burn like tinder into peroxide. In the state of hydrate it dissolves easily in muriatic, sulphuric, and in dilute nitric acid, also in soda and potash, but is insoluble in ammonia, carbonate of soda and potash. A solution of protoxide of tin produces a purple precipitate with chloride of gold. The ignited oxide (in close vessels) contains 87·7 per cent. tin.

The sesquioxide of tin is obtained by mixing hydrated sesquioxide of iron with a solution of protochloride of tin, and boiling, a portion of the oxygen of the iron, forms the sesquioxide of tin, and the iron is reduced to the state of proto-chloride, thus— $2\ Sn\ Cl + F_2\ 0_3$ become $Sn_2\ 0_3 + 2\ Fe\ Cl$. This oxide, in solution, gives a purple precipitate with chloride of gold; it is soluble in ammonia, and is thus distinguished from protoxide.

Peroxide of tin is easily formed. If tin be submitted to a high temperature, it burns, and this oxide is produced. It is also rapidly produced by projecting saltpetre upon red-hot tin. Moderately strong nitric acid oxidises the tin into a white powder, developing much heat, with the formation of nitric oxide, nitrous acid, and some nitrate of ammonia. This peroxide, if fused with glass forms *white enamel.* Jewellers' putty, or tin putty, is the peroxide of tin produced by burning the metal; this is levigated, and the powder used for polishing hard bodies. If tin be fused with alkalies, the compound is soluble in water, and is known as a stannate of soda or potash. The stannate of soda is largely used by calico printers as a mordant. This salt is easily prepared; tin ore may be heated with a solution of hydrate of soda, and the temperature raised to 550° Fahr., when the tin ore is dissolved; another mode of making this salt is by fusing the ore with nitrate of soda, the nitric acid is expelled, and stannate of soda is formed, which crystallises in hexagonal plates, these crystals are composed of $Na_2\ O.\ Sn\ O_2.\ 4\ Aq$. The solution of stannate of soda has a strong alkaline reaction, and yields, when neutralised by an acid, a precipitate of $H_2\ O.\ Sn\ O_2$ hydrated stannic acid. When ignited it is converted into meta-stannic acid ($Sn_5\ O_{10}$); it has then a yellowish colour, and hardness like tinstone.

* A compound between a monoxide and a dioxide is called a sesiquioxide.

SULPHIDE OF TIN ($Sn\ S$).

This compound is easily made by heating a mixture of tin and sulphur. It forms a grey, brittle substance, fusible at a red heat. It is found in combination with sulphide of copper at St. Michael's Mount in Cornwall, and is known among mineralogists as tin pyrites; but the pure sulphide of tin is like the protoxide, never found alone.

BISULPHIDE OF TIN ($Sn\ S_2$).

This substance is generally known as Mosaic gold, *aurum mosaicum S.*, *aurum musivum*, or bronze powder; but the commercial powder is now chiefly made by powdering with a little oil thin leaves of alloys of copper and zinc; it is much used in decoration. In 1857 the value of bronze powder, orsedew, and metal leaf, not gold, imported into the United Kingdom, was £39,716; in 1870, £52,404. It was discovered in 1765 that Mosaic gold was made in the best way by taking a mixture of 12 parts of tin and rubbing it with half its weight of mercury; it then gave a brittle amalgam, which was powdered and mixed with 7 of sulphur and 6 of sal ammoniac. The mixture was placed in a flask, and gently heated till it ceased to emit the smell of hydrosulphuric acid; the heat was gradually raised to dull redness. The Mosaic gold is produced in yellow scales at the bottom of the vessel; if well manufactured it is in soft golden flakes, friable, and adheres to the fingers. Like gold, it is not dissolved by muriatic nor nitric acids, but easily by nitro-hydrochloric acid *(aqua regia)*. It is also soluble in caustic soda, but is partially decomposed. When sulphuretted hydrogen is passed through a solution of permuriate of tin, a pale yellow precipitate is formed, which is a hydrate of the bisulphide of tin. The pure native bisulphide of tin is unknown.

SALTS OF TIN.

These salts, in crystals and in solution, have been extensively used in Europe and the United States in dyeing scarlet and other colours upon wool, and also in *steam colours* in calico-printing. Since 1630, when salts of tin were first applied in Europe to the dyeing of scarlet, there has been a great demand. They are commonly known as a mordant, or *preparing salt*, and are also called in the language of the dye-house *spirits*, with a prefix to indicate their special application, such as red spirits, yellow spirits, &c.

To make the protochloride of tin, the metal is *feathered*—that is, by melting it in an iron pan, and pouring it by an iron ladle in a gentle stream into cold water, the tin is granulated, and is ready for solution in muriatic acid in heated glass or tinned copper vessels. The proportion of feathered tin may be 1 part by weight and 1 of muriatic acid, when hydrogen gas is evolved, sometimes containing arsenic, either from the tin or the acid, the solution yields prismatic crystals, (Sn Cl. 2 Aq.) *salts of tin*, containing 52 per cent. tin. They are soluble without decomposition in a small quantity of water. If further diluted it is necessary to add a slight excess of acid to make the solution clear. A large quantity of water poured upon the crystals partly decomposes the salt into hydrochloric acid, and a white powder—an oxichloride of tin—composed of one atom of protoxide of tin and one of protochloride of tin, and two of water, containing 32·6 per cent. tin.

Protochloride of tin absorbs oxygen from the air, and also takes the oxygen from certain metallic solutions, which it deoxidises or revives. For instance, it reduces the persalts of iron to protosalts, arsenic acid into arsenious, and chromic acid into oxide of chromium. It has the same effect upon the perchlorides. Indeed it goes further—it reduces corrosive sublimate (perchloride of mercury) to a grey precipitate of metallic mercury. A variety of lakes are produced like those of alumina, in consequence of its forming insoluble compounds in vegetable infusions. With solution of gold in chlorine it forms a purple precipitate composed of protoxide of gold and sesquioxide of tin, much used for colouring glass of a fine crimson, in enamel, and painting on china. The anhydrous protochloride of tin (butter of tin) is in the form of a grey solid ; it contains 62·0 per cent. tin.

Protonitrate of tin $Sn\ O\ NO_5$ is easily formed by dissolving the metal in dilute nitric acid ; in this case it always contains some nitrate of ammonia. It may be obtained pure by dissolving the washed precipitated hydrate of the protoxide in dilute nitric acid.

PERCHLORIDE OF TIN ($Sn.\ Cl_2$).

This salt is prepared in various ways. It may be procured by distilling a mixture of persulphate of tin with chloride of sodium ; it is a colourless liquid, boils at 250° Fah., and has been known since 1600 as *Libavius's fuming liquor*. This liquid contains 44·9 per cent. tin.

Perchloride of tin is much used by dyers and calico-printers. It is often prepared by digesting feathered tin in single aquafortis, sp. gr. 1·3 ; to each pound of acid they add 2 ozs. of sal ammoniac. The solution is known among dyers as oxymuriate, or nitro-muriate, of tin. This stannic chloride easily forms double salts with the alkaline chlorides ; it affords the *pink salt* used by dyers, which is composed of perchloride of tin and hydrochlorate of ammonia, $NH_3\ Sn\ Cl_2$.

Stannate of soda is also used on a large scale as a mordant for calico printers. Tin ore, freed of foreign substances and in powder, is heated with hydrate of soda, and the temperature raised to 550° Fah. ; or the fine tin ore may be fused with nitrate of soda, when nitric acid is decomposed. If the salt be added to water, it crystallises in six-sided plates.

Metastannic acid ($Sn_5\ O_{10}$) is produced when tin is acted on by strong nitric acid; washing the peroxide with water, and drying at 212° Fah., it becomes $Sn_5\ O_{10}\ 5H_2\ O$. At a stronger heat it is as hard as tinstone, and is, when pure, almost colourless.

TIN ORE IN VICTORIA.

This mineral was first observed by the diggers at the Ovens River, (Beechworth), in 1852, and called by them *black sand*, its exact character was not known till 1853, when a considerable quantity was brought to Melbourne and exported to England. The black sand or tin ore consists chiefly of small dark brown crystals; remarkably pure, containing by assay 77 per cent. tin, in some of the samples there were 20 to 30 ozs. of gold per ton. Among the brown particles there was a very small percentage of ruby-like crystals. These red crystals, I at once examined, and found them to be coloured with gold. Of the red coloured tin ore I weighed 35 grains and smelted it by itself in a new crucible, and obtained a small button of tin, a portion of which was dissolved in pure muriatic, when there remained a little brown insoluble matter; this, on being washed in distilled water, and transferred to an agate mortar, and rubbed with the pestle, showed glittering scales of pure gold. Another portion of the smelted ore when oxidised by nitric acid possessed a light purple colour, the well-known *purple of Cassius.* It is interesting to observe with respect to this substance that the great Swedish chemist Berzelius considered it as a compound of sesquioxide of tin and protoxide of gold, with about 7 to 8 per cent. of water. In the beginning of this century it was observed that fine gold leaves dissolve in fuming nitric acid; and more recently it was discovered—almost at the same time in London and Melbourne—that gold dissolved to a notable extent in a mixture of strong nitric and sulphuric acids, thus showing that oxide of gold is produced without the aid of chlorine or bromine, and not unlike the oxide of other metals; hence the probability of finding compounds of the precious metal to exist more frequently than is generally supposed. But it is at the same time evident, on testing for gold in small quantities in tailings, to avoid the presence of nitric acid, as gold may be dissolved and vitiate the test. While on this subject it is worth observing that most probably there is a large quantity of very fine gold-dust in some districts of Victoria, requiring special apparatus to collect it. For gold is associated with a most unlikely mineral, carbonate of bismuth (besides being the red colouring matter of some crystals of tin ore); the gold with that substance may be disintegrated into very fine gold-dust. A small nugget and this salt were found close to the Blanche Barkly nugget, and it was mentioned by the discoverers of the largest of all the nuggets (at Moliagul) there is much fine gold in the same neighbourhood.

The quantity of tin ore exported from Victoria from 1853 to 1861, according to the Customs returns in Victoria, was only 1480 tons 12 cwt.; but, according to the Customs of the United Kingdom, the quantity received was 1958 tons, and doubtless the exports of the more precious metal, gold, were also stated greatly under the real quantities. Except in one or two instances, tin ore in Victoria has always been considered, as it probably is now in New Zealand, a subsidiary product scarcely worth collecting. In all likelihood, however, it will be found in the banks and beds of existing streams only slightly auriferous, and in larger quantity in the deposits of ancient rivers in both colonies, as it is in New South Wales, Queensland, and Tasmania. A slight and inexpensive modification of the gold-sluicing apparatus might enable the gold miners in Victoria and New Zealand to extract the stream tin very profitably. At all events we know that New South Wales produced, in 1875, 8,080 tons of ore and metal, in value £561,311, and the yield promised to be as much in 1876. Since this was written, it is announced,—3rd March, 1877—what indeed was almost inevitable, the discovery (by Mr. Palmer, a prospector) in New Zealand of "a great quantity of stream tin in two different creeks," "some of the boulders being from 2 cwt. to 3 cwt." at Mount Rangitoto, County of Westland, N.Z.

TIN ORE IN NEW SOUTH WALES.

The Rev. W. B. Clarke, in his report on minerals in New South Wales, dated 7th May, 1853, first mentioned that tin ore occurred in New England, and he thought that it was plentifully distributed; it was not however till 1872 that tin ore in New England was raised in commercial quantities, and then, almost simultaneously, in Queensland. In that year, in New South Wales, it was raised chiefly at a place called Vegetable Creek—about 2000 feet above the sea level—with crude appliances, in very large quantities. It was accompanied with a little gold, small diamonds, and a variety of other gems. About 1000 tons of tin ore were raised in that year, and they soon began to smelt the ore at Tent Hill, about 4 miles from Vegetable Creek. Subsequently it was observed that there were two drifts; the older generally occurs at a greater depth; this drift is much water-worn, harder, and more solid, than the newer drift, often requiring stamps. In 1875 the puddling apparatus was so much improved that they could puddle at 8d. per ton. In this locality numerous crystals were found of tin ore within crystallized quartz, and also outside the quartz, proving that the tin ore and the quartz were at one time in solution.

Export

	Tons of tin	Value of Do
1879	5,107	£343,075
1880	5,476	440,615

1877 tin ore export tin — tin ore & tin Value
78
79 — £120,357

In Queensland tin ore was discovered in great quantities in 1872, in that year the quantity raised amounted to 1400 tons; and although the price of tin ore has fallen from £50 in December, 1874, to £42 7s. 6d. in December, 1876, the yield for 1876 may be estimated at fully 5000 tons.

The credit of the discovery of tin ore in Tasmania is due to Mr. James Smith, who has travelled alone for many years through a most difficult country, yet now seems likely to be well recompensed for his arduous labour.

Owing to the almost impenetrable scrub about Mount Bischoff, in Tasmania, where tin ore was discovered in 1872, there has not been that wonderful development of the ore as in the sister colonies. About four months ago, however, a mass of good tin ore was discovered on Mount Bischoff weighing 150 lbs. The quantity of ore and metal shipped last year was nevertheless equal to 586½ tons tin ore, and 1072 tons tin, the value of both being £93,000. The ore this year (1877) is coming forward in such quantities that one enterprising mining and smelting company, although capable of reducing 80 tons per week, find that it still accumulates on their hands. In fact, the ore is now obtained in increasing quantities from mountain top to the sea beach. Up to the present time there seems to be in Tasmania a steady progress in the deliveries of tin ore. In the four weeks ending 16th February, 280 tons were delivered in Launceston and 109 tons in Hobart Town. The price given on the 16th February for a lot of 11 tons 3 cwt. of 73·8 per cent. was £42 15s. 2d.; the price of the metal in London on the same day being £72.

No. 1.

Comparative Table of the Import of Tin into the United Kingdom and Holland in 1875 and 1876.

Import of Tin in 1875.				Import of Tin in 1876.			
Import of Tin into the United Kingdom from all countries.	Import into Holland from Banca and Billiton.			Import of Tin into the United Kingdom from all countries.	Import into Holland from Banca and Billiton.		
Tons.	Slabs.	Tons.	Total Tons.	Tons.	Slabs.	Tons.	Total Tons.
16,788	168,078	=5252	22,040	15,222	199,800	6243	21,465

Price in London of Australian Tin.

	per ton.				per ton.		
On 3rd December, 1875	£81	5	0	On 1st December, 1876*	£77	12	6
„ 11th February, 1876	77	5	0	„ 9th February, 1877	71	10	0
„ 18th do. do.	77	0	0	„ 16th do. do.	72	0	0
„ 25th do. do.	75	10	0	„ 23rd do. do.	71	0	0
„ 3rd March do.	71	10	0	„ 2nd March do.	70	10	0
„ 10th do. do.	71	15	0	„ 9th do. do.	70	0	0

* 75 tons, cash, £72 12s. 6d. per ton.

No. 2.

Annual Production of English and Dutch Colonial Tin Mines.

Production of English Tin Mines.		Production of Banca (and Billiton estimated).						Sold in Holland.	
		Banca.		Billiton.		Total B. & Billiton.			
	Tons.	Slabs.	Tons.	Slabs.	Tons.	Slabs.	Tons.	Slabs.	Tons.
1860	6,695	165,620	=5175†	8,000	= 250	173,620	=5425	151,513	=4734
1864	9,295	161,916	...5059	22,380	... 699	184,296	...5758	146,921	...4591
1869	9,356	135,868	...4245	68,291	...2134	204,159	...6379	110,800	...3462
1870	10,200	146,000	...4562	89,283	...2790	235,283	...7352	156,800	...4900
1871	11,320	134,906	...4215	99,700	...3115	234,606	...7330	164,091	...5127
1872	9,560	136,000	...4250	108,000	...3375	244,000	...7625	99,300	...3103
1873	9,972	140,000	...4375	102,000	...3187	242,000	...7562	135,200	...4225
1874	9,724								
1875	9,614								
1876*	9,000								

* Estimated. Banca and Billiton slabs weigh 70 lbs., or 32 to the ton.

† These weights, after allowing 70 lbs. to a slab, or 32 slabs to a ton, although carefully calculated, do not quite accord with Mr. R. Hunt's, Keeper of the Mining Records.

Table No. 3.—TIN.

IMPORTS.

	Import of Tin Ore Regulus.			Estimated Amount of Tin in the Ore.	Import of Tin.			Total Quantity of Tin in the Ore and Tin imported.	Import of Tin Ore Regulus and Tin.		Import of Tin Manufactures.	Bar and Refined Tin.	Charcoal Tin Plates, I C.
Years.	Tons.	Price per Ton.	Value.	Tons.	Tons.	Price per Ton.	Value.	Tons.	Tons.	Value.	Value.	Price per Cwt.	Price per Cwt.
		£	£			£	£			£	£	Bar.	
1845					1.278	72		1,278				86/2	
1846	4			3	1,015			1,018				98/10	
1847					1,165			1,165				93/.0	
1848	33			23	298			321				80/1	
1849	7			5	1,791			1,796				79/6	
1850					1,685			1,685				78/9	
1851	5			3	2,587			2,590				84/9	
1852	22			15	2.372			2,387				90/	
1853	156			104	2,487			2,591				112/9	
1854	81	66	*5,400	56	2,251	118	*267,312	2,307	2,332	*272,712		123/3	
1855	84	66	5,600	58	1,612	119	190,257	1,670	1,696	195.857		115/9	
1856	749		52,430	499	3,464	135	469,963	3,963	4,213	522,393		132/3	
												Refd.	
1857	1387		83,200	924	2.708	140	343,162	3,632	4,095	432,362		141/	40/
1858	628		40,820	418	2,955	119	351,942	3,373	3,583	392.744		122/	32/11
1859	563		36.595	375	2,700	136	370,976	3,075	3,263	407,571	1,035	136/	32/4
1860	674		43,810	449	2,911	136	387,307	3,360	3,585	431,117		138/	31/6
1861	552		33,670	368	3,658	122	435,277	4,021	4,205	468,948		124/	29/9
1862	551		33.060	476	4,393	120	508,909	4,869	4,944	541,979		120/	28/5
1863	539		33,640	359	2,727	124	327,234	3,086	3,266	360.874	3,045	122/	29/1
1864	529	60	31,784	352	4,904	107	497,328	5,256	5,433	529,112	3,065	111/	30/4
1865	639	60	38,340	426	5,698	92	529,803	6,124	6,337	568,143	6,536	98/	29/10
1866	395		21,045	263	5,523	85	444,478	5,786	5.918	465,523	6,782	92/	33/2
1867	309		15,450	206	5,429	91	481,344	5,635	5,738	496,796	2.837	93/	31/3
1868	470		25.239	313	5,625	95	545,041	5,938	6,095	570,280	5,521	99/	27/1
1869	538		29,105	358	5.442	128	670,157	5,800	5,975	699,262	6,533	129/	28/3
1870	364		21,564	254	4,712	126	601,076	4,966	5,079	622,640	4,498	129/	28/10
1871	448		31,767	313	8,533	127	1,082,186	8,846	9,095	1,113,953	6,543	139/	29/8
1872	1024		72,768	716	8,342	138	1,154,578	9,058	9,366	1,207,712	4,553	155/	42/1¾
1873	5612		400,136	3703	7,791	134	1,042,112	11,494	13,403	1,444,435	4.628	137/	42/1
1874	4305	68	277,463	2927	9,218	98	904,488	12,145	13,523	1,181,951	8,120	104/	35/6
1875					16,788	86	1,453,000					91/	30/6
1876					15,222	75	1,148,164						

Former Rates of Duty, before 9th July, 1842, were £10 per ton on Ore and Regulus.
Do. do. do. do. Blocks, Ingots, Bars, or Slabs.
Do. do. do. 20 per cent. on Manufactures.
Do. do. do. 25 do. Tin Foil.

Since 8 V., c. 12, 8th May, 1845,

Tin Ore or Regulus, of or from Foreign Countries,	Free.		Of or from British Possessions,	Free.		
Tin in Blocks, Ingots, Bars or Slabs	do.	do. 6s. per cwt.	Do.	do.	do.	3s. per cwt.
Tin Manufactures not otherwise enumerated	do.	15 per cent.	Do.	do.	do.	15 per cent.
Tin Foil	do.	do. 6d. per lb.	Do.	do.	do.	6d. per lb.

The Customs Duty on Tin in Blocks, Ingots, Bars, or Slabs, Free from 4th June, 1853.
Do. do. Manufactures .. .. .. Free from 3rd March, 1860.

* The real value not stated previously to 1854.

UNITED KINGDOM.

EXPORTS.

Export of Foreign and Colonial Tin.		Foreign and Colonial Tin left for Home Consumption.	Foreign and Colonial Tin and Tin in the Ore left for Home Consumption.	Produce of British Tin Mines.	†Export of British Tin.	British Tin left for Home Consumption.	British, Foreign, and Colonial Tin left for Home Consumption.	British, Foreign, and Colonial Tin and Tin in the Ore left for Home Consumption.	Export of British Tin Plates.		
Tons.	Value.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Value.	Years.
	£									£	
1,493				5,500	576	4,924			Quantities not specified before 1862.	615,729	1845
1,056				5,500	1,195	4,305				639,223	1846
573				6,000	1,711	4,289				462,889	1847
417				6,613	1,797	4,816				532,142	1848
447				6,952	1,766	5,186				709,788	1849
190				6,729	1,590	5,139				927,202	1850
				6,143	1,014	5,129				1,020,236	1851
				6,287	946	5,341				1,057,926	1852
1,072				5,763	1,277	4,486				1,181,069	1853
668	79,420	1,583		5,974	1,405	4,569	6,152			1,037,958	1854
280	33,087	1,332		6,000	1,347	4,653	5,985			1,110,843	1855
200	27,167	3,264		6,177	1,876	4,301	7,565			1,407,906	1856
380	49,008	2,328		6,582	2,187	4,395	6,723			1,500,116	1857
298	35,522	2,657		6,920	2,327	4,593	7,250			1,351,151	1858
395	54,335	2,203		7,100	2 803	4,297	6,500			1,522,618	1859
598	67,626	2,318		6,695	2,740	3,955	6,268			1,500,812	1860
958	114,239	2,695		7,450	2,833	4,617	7,312			907,947	1861
1,083	125,494	3,310		8,476	4,104	4,372	7,682		50,071	1,212,665	1862
1,135	136,206	1,592		10,006	4,415	5,591	7,183		55,796	1,309,673	1863
1,395	141,542	3,509		10,108	4,457	5,651	9,160		50,178	1,263,246	1864
2,004	186,442	3,694	4,120	10,039	5,185	4,854	8,548	8,974	62,718	1,481,098	1865
1,083	87,169	4,440	4,703	9,990	4,280	5,710	10,150	10,413	70,975	1,898,341	1866
1,328	117,820	4,101	4,307	8,700	4,191	4,509	8,610	8,816	78,984	2,060,410	1867
1,104	107,170	4,521	4,834	9,300	4,061	5,239	9,760	10.073	88,183	2,092,868	1868
1,112	136,980	4,330	4,688	9,760	5,082	4,678	9,008	9,366	96,657	2,302,820	1869
1,097	139,906	3,618	3,866	10,200	5,084	5,116	8,734	8,988	100,078	2,368,557	1870
2,059	266,105	6,474	6,847	10,900	5,710	5,190	11,664	11,977	119,605	2,900,625	1871
2,431	355,743	5,911	6,627	9,560	5,693	3,867	9,778	10,494	118,083	3,812,744	1872
1,443	193,344	5,348	10,051	9,972	5,757	4,215	9,563	13,266	120,468	3,952,841	1873
2,381	236,280	6,837	9,764	9,724	7,730	1,994	8,831	11,758	122,960	3,714,810	1874
				9,614	5,222	4,392			138,563	3,691,382	1875
									132,397	2,888,677	1876

† Which includes some Tin Ore imported and smelted in England.

No. 4.

The following table shows the quantity and value of Tin Ore and Tin, Colonial and Foreign, and average value of Tin per ton, imported into the United Kingdom in the years 1872-3-4-5 and 6.

Years.		Tin Ore.		Tin.		Average value of tin per ton.
		Tons.	Value.	Tons.	Value.	
			£		£	£
1872	Import from New South Wales	334	26,652	4	610	
	,, Queensland	Not stated	7,538	..	..	
	,, Victoria	371	27,115	45	6,597	
	Total Import of Colonial Tin Ore	705	61,305	49	7,207	
	,, Foreign Tin Ore	212	11,420	8,342	1,154,578	
	,, Colonial and Foreign Tin Ore	917	72,725	8,342	1,154,578	138
1873	Import from New South Wales	3,114	230,011	331	41,953	
	,, Queensland	1,302	97,081	103	11,893	
	,, Victoria	297	24,430	58	7,660	
	Total Import of Colonial Tin Ore	4,713	351,522	492	61,506	
	,, Foreign Tin Ore	886	47,604	7,297	982,793	
	,, Colonial and Foreign Tin Ore	5,599	399,126	7,789	1,044,299	134
1874	Import from New South Wales	1,915	134,997	2,293	234,120	
	,, Queensland	975	65,000	620	62,718	
	,, Victoria	672	42,025	1,105	102,408	
	Total Import of Colonial Tin Ore	3,562	242,022	4,018	399,246	
	,, Foreign Tin Ore	649	30,057	5,193	504,905	
	,, Colonial and Foreign Tin Ore	4,211	272,079	9,211	904,151	98
1875	Import of Tin from all Countries	..	..	16,788	1,453,901	86
1876	,, ,, ,, ...	..	..	15,222	1,148,164	75

No. 5.

THE TIN TRADE.

Shipments of Tin to the United Kingdom.

		Tons.
In the first eleven months of	1875, from Australia	5,701
Do. do. do.	1876, do.	6,071
Do. do. do.	1876, from Straits	7,099

Deliveries.

In the first eleven months of	1875	11,058
Do. do. do.	1876	9,707

The Import of Tin was less in 1876 than in 1875, but there was a decrease in the consumption, chiefly in the manufacture of Tin Plates, which is the probable cause of the decline in price, to £70 per ton, on the 9th March of this year.

MASON, FIRTH AND M'CUTCHEON, PRINTERS, MELBOURNE.