To William Powell Esqr
with the most respectful
regards of W. Sitwell

Birmingham
Sept 6 - 1866.

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THE

EARLY HISTORY OF BRASS

AND THE

BRASS MANUFACTURES

OF

BIRMINGHAM.

THE PRODUCTION OF STATUARY, &c., IN BRONZE AND COPPER, BY CASTING AND ELECTRO-METALLURGY.

THE REVIVED ART OF METAL-WORKING ON TRUE PRINCIPLES.

THE MANUFACTURES IN PAPIER MACHE.

THE MANUFACTURE OF COFFIN FURNITURE.

BY

W. C. AITKEN.

Extracted from a Work, "The Resources, Products, and Industrial History of Birmingham and the Midland Hardware District," published by Robert Hardwicke, 192, Piccadilly, London.

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PREFACE.

THE meeting of the British Association at Birmingham in September, 1865, led to the formation of a Local Committee for the purpose of compiling a series of reports on the numerous and varied products of the Midland Hardware District, of which Birmingham is the most important and practically the central town. At the request of that Committee the writer drew up the reports which follow. In these he has attempted to trace the period of the introduction of each trade or manufacture reported upon, their progress, and the names of those individuals whose exertions have operated in extending the trade and improving the products. As time rolls on the difficulty of the identification of the introduction or improver becomes more uncertain, and advantage has, therefore, been taken of this opportunity afforded to the writer to record, for the benefit of future enquirers, the rise, history, progress, and present position of five important branches of local industry, as far as they appeared to him to present features interesting to the public and the general reader. As regards the curiosities of the manufacture, where such presented themselves and appeared worthy of notice—new varieties of objects introduced, increase of production, new sources from which the supply of raw material may be procured, description of old processes, and of new, where introduced, whether machine or hand-labour is employed, the effect of improved methods of manufacture on the cost of production, where new machines or tools have

been invented—these have, as far as possible, been described; and where articles similar to those of Birmingham manufacture have been produced elsewhere, the locality has been named, the material consumed in the trade treated of has been stated, the number of workpeople, the proportion of the sexes employed, and their earnings stated, the diseases under which they labour, and the effects arising from the employment of women in manufactories have been pointed out. Other influences which have operated on the expansion and development of the particular trade or manufacture, in connection with the importance of general, scientific, and artistic education, have not been overlooked.

How far the writer has succeeded in accomplishing the work undertaken he leaves it to his readers to determine. The reports have been written *con amore* at intervals, amid the graver responsibilities of business, with frequent interruptions (by no means favourable to literary composition). Where defects and imperfections occur, for these he claims the indulgence of those kind friends to whom these monographs are presented for their acceptance and perusal.

Stockfield Place,
The Lozells, Handsworth,
Birmingham, August 20th, 1866.

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BRASS AND BRASS MANUFACTURES.

THE EARLY HISTORY OF THE METAL; THE INTRODUCTION OF THE MANUFACTURE OF BRASS INTO ENGLAND; ITS DEVELOPMENT; INTRODUCTION INTO BIRMINGHAM; PROGRESSIVE AND PRESENT CONDITION OF THE MANUFACTURE.

By W. C. AITKEN.

It is matter of regret that, with the exception of a brief, indefinite, and partial allusion to the Brass trades of Birmingham, made by William Hutton, to be found in his celebrated history of the town, we have no record to guide us as to the introduction, rise, and progress of one of our now most important branches of local industry.

The Brass manufactures of Birmingham, and their introduction into the town, appear to present an exception to the ordinary rule, viz., that some circumstance of ancient date now little known had a share in determining the locality of particular manufactures, and equally so as to the idea that in the early history of a manufacturing community, before cheap modes of transport were extensively introduced, it will be found almost always that manufactories were placed near those spots where nature produced most abundantly the raw material. As regards the manufacture of brass articles, if we except the fuel which is in the immediate vicinity of this town, and an abundance of fine casting sand of which to form the moulds in which the articles are cast, no natural facilities present themselves favourable over any other locality, calculated to make Birmingham the head quarters of brass founding and the brass trade. The reader need scarcely be reminded that copper, which is the principal metal used in the production of brass, as also calamine, or ore of zinc or spelter, the union of which with copper produced and now produces brass, are both metals procurable only at some distance from Birmingham.

There is, however, one element which operated far more potently than the presence of raw material, that is the existence of skilled labour, or industry trained in a particular direction. This, from personal observation, we believe to be hereditary, transmissable and transmitted from sire to son, even down to specialities or special kinds of manipulations of materials. Thus, in a Birmingham working population there is a tendency to perpetuate a special qualification for the manipulation of metals. On this head Mr. Smiles remarks, "There seems reason to believe that the capacity for skilled industry is to a certain extent transmissable, and that the special aptitude for mechanics which characterises the population of certain districts is in a great measure the result of centuries of experience, transmitted from one generation to another." Combe says, "Form, size, and quantity of brain are transmissable, and hence dispositions and talents are transmissable also." Morell maintains equally "That the power of specialised instincts is transmitted, and, when the circumstances favour it, goes on increasing from age to age in intensity, and in a particular adaptation to the purposes demanded. All confirmed habits which become a part of the animal nature, seem to be imparted by hereditary descent; and thus what *seems* to be an original instinct, may, after all, be but the accumulated growth and experience of many generations."

It is impossible however to claim for archaic Birmingham artisans the merit of furnishing the ancient Britons "with the swords, spears, shields, and scythes of *iron* with which they fought and resisted their Roman invaders," as has been done by Hutton when he says, "We have every reason to believe our forefathers were supplied with the necessary implements of war by the black artists of the Birmingham forge"—the historian here appears to have forgotten, in his zeal for his adopted town, that there is no evidence to prove that at the time of the Roman invasion that industry in iron was at all in existence, the manipulation of that metal understood, or its existence known; whereas there is abundance of evidence on the contrary to prove that the weapons used by the ancient Britons were composed of bronze, produced from the copper and tin procured from the mines of Cornwall.

There are, however, authorities to guide us as to the knowledge that as a metal working locality Birmingham has long been celebrated, and we are told that its superiority in the manufacture of cutlery and hardware was as conspicuous in the days of Henry VIII. as it is at present. Confirmation of

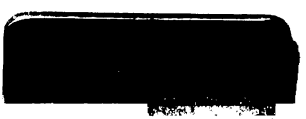
this we gather from the Itinerary of old Leland, who tells us, in the quaint language of the period, that "There be many smithes in the town that use to make knives and all manner of cutting tooles, and many lorimers (*i.e.*, bridle cutters or saddlers) that make bittes, and a great many naylors; so that a great part of the town is maintained by smithes, who have their sea-cole out of Staffordshire." In reference to the "lorimers" it is curious to remark that their existence as a trade is confirmatory of the existence at the period of the manufacture of leather (one of the earliest manufactures of the town), the use of which in connection with metal is, as is known, very ancient, and is a combination such as promises to endure as long as the human species. The trade of the lorimer still exists as a special business, trade, or manufacture practised in Birmingham and Walsall, and is known as that of saddlers' ironmonger. It is alluded to, as it is more than probable that the earliest or among the earliest introductions or applications of brass were as decorative enrichments to the results of the lorimers' or saddlers' ironmongers' labours. After the lapse of half a century from the period alluded to by Leland, Camden writes of Birmingham as "swarming with inhabitants, and its streets resounding with the noise of anvils." It will be remarked that both the authorities quoted conveyed the impression that, for a long series of years prior to their visits, the inhabitants of Birmingham were familiar with the manipulation of metal, that metal being iron. Brass is not named, nor could it possibly have been; the manufacture of brass, as will be shown, was only introduced as a manufacture into England about the middle of the reign of Queen Elizabeth, though there are reasons for supposing that brass was known in England so far back as the reign of Henry VII., that monarch prohibited the exportation of copper as the doing so might interfere with the production "of brass guns."

The intention, in giving prominence to the working of iron, is to show that the inhabitants of the town had acquired a certain amount of skill in the working of metals, which they could readily adapt to the working of the new metal, brass, when it was presented for their acceptance to be worked on. However much division of labour may operate, as it now does, in circumscribing the individual manipulative skill of the artisan, one thing is certain, that at a former period the worker in metal worked equally well and with equal facility in all metals; there is, therefore, every reason to believe that on the introduction of the new metal, brass, into Birmingham it found

an almost ready trained class of artisans prepared to deal with it. The preparation of a mould in which to cast iron is identical with one in which to cast brass; a fitter of articles in iron could and would easily adapt himself to the fitting together the several portions of articles in brass—a metal much more easily turned or filed than iron. The earlier styles of finish in both metals were identical, *i.e.*, they were polished by abrasion or friction, and hence the facility with which the production of articles in Brass or Brass founding naturally, as it were, took its place among the trades of Birmingham. In the brief space of some fifty years after the introduction of the new metal, the manufacture of articles in it had become one of the specialities of the manufactures of the town, and so important had the demand for brass articles of Birmingham manufacture become, that the demand for the raw material procured from Cheadle, Macclesfield, Bristol, and elsewhere, previous to 1740, in that year induced a spirited manufacturer of the name of Turner to embark in the manufacture of brass. The first brass house erected in Birmingham was in Coleshill Street, and occupied the ground immediately in front of that, on which stands the solid brass tube manufactory of Alston and Green, now the property of and worked by The Elliots Metal Company.

Hutton maintains that the only, at all events the chief, manufacture of Birmingham from its earliest existence to the restoration of Charles II., was in iron, "Of this was produced instruments of war, and husbandry, furniture for the kitchen, and tools for the whole system of carpentry." In reference to Brass Foundry he states, that though curious, it is less ancient than profitable, and less healthful than either. He declines to enquire whose grandfather was the first brass founder, and leaves that knotty point to their grandsons, to settle with his successor who should next write the history of Birmingham, and, evidently drawing on his imagination for his facts, *believes* that the first Tubal Cain, so far as regards brass in this town, figured in the reign of King William, *i.e.*, somewhere between the years 1689 and 1702; and though he "sold his productions at an excessive price, he did not, like the moderns, possess the art of acquiring a fortune."

It is curious to remark that whereas in the introduction of the manufacture of brass into this country Birmingham is not entitled to any credit, yet such is the assimilative and adaptive nature of its industry, that in a very few years after the introduction of a knowledge of that metal into the town, it



rapidly absorbed, and may now be said to have almost monopolised the manufacture of articles in brass; the spirit of its manufacturers, the skill of its artisans, gave the alloy new forms, and applied it to purposes until then unthought of. What Manchester is in cotton, Bradford in wool, and Sheffield in steel, Birmingham is in brass; its articles of cabinet and general brassfoundry are to be found in every part of the world; its gas fittings in every city and town into which gas has been introduced, from Indus to the Poles—on the railways of every country and on every sea, its locomotive and marine engine solid brass tubes generate the vapour which impels the locomotive over the iron road, and propels the steam-boat over the ocean wave—its yellow metal bolts, nails, and sheathing hold together and protect from decay "wooden walls" of our own and other countries' ships—its "Manillas," once made in tons, are the circulating medium of the natives of the Gold Coast—and its rings and ornaments of brass, sent out in immense quantities, are the chief decorations of the *belles* on the banks of the distant Zambesi.

Having introduced the subject, attention will now be directed to the early history of Brass, the introduction of its manufacture into England, where made, how it was and is now made, and the sources of supply of the copper and zinc, of which it is an alloy.

Though mention of the metal Brass, or a word translated as brass, is frequently introduced by early sacred and profane writers, there is not the most remote probability of identifying it, or the so-called brass, with the metal which bears that name in the present day. The word should not be translated brass, since brass is a combination of copper and zinc, and all specimens of ancient objects formed of "æs," and translated and supposed to mean brass, are found upon analysis to contain no zinc. The brass of an early period of the world's history was unquestionably a mixture of copper and tin, which constitutes or forms the alloy called Bronze. The early references, therefore, in the Bible to the "hills from which brass might be dug," with numerous other allusions to brass must not, therefore, be accepted literally to mean the metal known as such in the present day. As weapons of wood, bone, or stone preceded those formed of metal used by the aborigines of every country, so bronze preceded brass. "The bronze age" was a reality, as the existing antiquities in the museums and private collections abundantly demonstrate. Sir Gardner Wilkinson believes that the granite which forms the

materials of which the temples and obelisks of Egypt were built, was cut and incised with chisels of bronze. Layard exhumed from the mounds which mark and cover the site of Nineveh, portions of swords, armour, tripods, cooking utensils, and innumerable objects made of bronze. In Greece bronze equally formed the metal used for useful and ornamental purposes. In Italy, at first, a similar combination of metals was used for the production of objects of utility and ornament. In Russia the produce of its copper mines, mixed with tin (in greater proportion) took, in addition to useful forms, that of immense bells. In France, Germany, and Sweden the early inhabitants of these countries fought with bronze weapons, and the ancient Britons resisted the legions of Imperial Rome with "celts," swords, and daggers also of bronze, the copper and tin of which it was composed being procured from the mines of Cornwall. In all the examples of existing metallic remains, these early works, when subjected to chemical analysis, give distinct traces of tin—zinc is absent; that ores of copper and calamine may have been found in close proximity to each other, and were melted together accidentally by ancient metallurgists, is not to be doubted—the result produced the "yellow copper" of the ancient writers; but it is very evident that the cause which produced the change in colour, was not understood until after the Christian era, and then only by nations considerably advanced in civilisation and refinement. Chief among these were the Romans, who issued coins which, on being subjected to an analysis, give distinct evidence of zinc in alliance with copper in proportion approaching very nearly the brass of the present day. A metal designated by the Romans as Orichalcum or Aurichalcum, appears to have been composed of the same metals as our brass. Watson, in his Chemical Essays, published in 1786, maintains the identity of the two metals—in this opinion he is confirmed by Dr. Percy. The similarity of certain mixtures of copper and zinc, somewhat richer in copper than the ordinary brass, and therefore more golden in hue, will account for the fraud so easily perpetrated by Vitellus on the temples of Rome by despoiling them of their gifts and ornaments of gold, and replacing them by similar objects in Orichalcum. It, however, must be admitted that Pliny appears to have arrived at very nearly a solution of the brass problem; he had observed that copper placed in close proximity to cadmia or calamine, *i.e.*, ore of zinc, on being exposed to heat, increased in weight, by absorption of the

calamine; and he evidently thereby anticipated the process of converting copper into brass by cementation, as practised in England after the lapse of 1700 years from the period in which he lived.

Corinthian brass, was not brass at all, but a composite metal accidentally produced by the conflagration which devastated the city of Corinth, and fused together, indiscriminately, its treasures of art, composed of gold, silver, copper, and other metals, the so-called brass varying in colour as the gold, silver, or copper preponderated in the mixture.

The brass of Delos was that which first became famous; all the world came to purchase it (at least, so says Pliny), and Birmingham cabinet brassfounders may be interested in knowing that the Delian artisans were celebrated for the feet and supports of dining couches made of their brass. Æginetan brass was celebrated for the skilful manner in which it was annealed, and probably it would be found that the works made there were produced by the "repoussé" or "beaten" method of working. The island of Ægina was, it appears, famous for the manufacture of sockets only, for lamp stands, while Tarentum was equally so for the branches.

The desire for conquest, which in so peculiar a manner distinguished ancient Rome, was doubtless the means of carrying into the countries subdued by its legions a knowledge of the arts they practised, and to this may be attributed an advance in the metallurgical arts north of the Alps. Germany and Flanders acquired and practised the manufacture of brass at a very much earlier period than England; and we have abundant authorities which show that the thin plates or slabs of "laton," or "latten," or "brass," of which so many are to be found in our cathedrals and churches, and which have been used as monumental brasses—the material on which the inscriptions are incised or cut—were procured from the countries named. In Westminster Abbey, "that temple of silence and reconciliation, where the enmities of twenty generations lie buried," we have the monuments of Henry III. and Queen Eleanor, made in the years 1272 and 1295, by William Torrel, an Englishman; and 165 years thereafter, in 1460, was erected in the Beauchamp Chapel, at Warwick, that most magnificent monument in brass which covers the remains, and commemorates the greatness of Richard Beauchamp, Earl of Warwick, also the work of an Englishman, *i.e.*, William Austin, citizen and founder of London. In all probability, the brass out of which these works were made was imported from Germany,

the Netherlands, Flanders, or from the town of Nuremberg—the Bavarian Birmingham of that day—which, among the other specialties for which it was celebrated, numbered brass sheet metal, and brass wire of great excellence, in addition to its other hardware products.

But England had within her bounds all the elements for the manufacture of brass of the best quality: she had abundance of labour to be directed, forests from which to procure wood charcoal for smelting, and mineral fuel; the sea-washed mountains of Cornwall were rich in copper ore; those of Somersetshire and Derbyshire, &c., possessed abundant supplies of the ores of zinc. Intelligence alone was needed to work the raw materials profitably. In the reigns of Henry VIII. and Edward VI., several Acts were passed prohibiting the exportation of brass, &c., under the penalty of forfeiting double the value of the quantity exported. It was not, however, until the reign of Queen Elizabeth that any systematic effort appears to have been made to economise the mineral and metallurgical resources of this country; by doing so, she furnished the means of increasing the supply of material for old industries to operate on, and created new. Chief among the latter was that of the manufacture of brass. Other branches of industry were introduced into this country, by encouraging foreign artisans—such as the manufacture of cloth, silk, and glass. A similarly wise policy marked the introduction of the manufacture of brass, and was accomplished by Elizabeth granting to William Humfrey, "say" Master of the Mint, and to Christopher Shutz, an "Almain," born at St. Amien Berg, under the obedience of the Elector of Saxony, a patent for working Calamine stone and making Brass. Shutz is stated, in the quaint language of the period, to have been a man "of great cunning, knowledge, and experience, as well in finding of the calamine stone *(i.e.*, ore of zinc,) as in the right and proper use thereof, for the composition of the mixed metal commonly called 'latten,' viz., brass, in reducing it to be soft and malleable; also in apting, manuring, and working the same into all sorts of battery wares, cast work, and wire." The patent, which secures to Humfrey and Shutz the exclusive right to practise the mining for zinc and the manufacture of brass, bears date the 17th September, 1565, and from it may be traced the rise of the manufacture of brass in this country. With the intention of further encouraging metallic and chemical industry, on the 28th of May, 1566, Queen Elizabeth granted additional letters patent to Humfrey and Shutz, in

addition to those previously granted to Cornelius de Voz, for getting alum and copperas, and divers "ewers" of metals; and to Houghsetter and Thurland, for getting gold, silver, copper, and quicksilver; and they, with the Lord Chancellor, and other principal Ministers of State, to be Societies of the City of London, by the name of Governors, Assistants, and Societies of the City of London, of and for the Mineral and Battery Works. Humfrey and Shutz had, however, an exclusive grant for the sale and proper use of the calamine stone. These patentees and the Society held unlimited sway in things mineral and metallic. They gained additional privileges from James I., in 1609; Charles I., in 1631 and 1639, and from Charles II., in 1668—in whose reign the several interests of the heirs and successors of the patentees already named were merged into one sole and entire united company, bearing the title already given. It had its Corporate Seal, had a Mineral Master General, in addition to other officers; held Courts, let, and set mines, and up to the year 1710, at least, continued as a power in the industries within its province. No doubt, in the early stage of these industries, its influence was beneficial; but it ceased to be so when private enterprise took the place of national patronage, and mines passed from being national, or the property of the monarch of these realms, into the hands of the private smelter.

During the reigns of James I., and Charles I. and II., the manufacture of brass appears to have been practised with varied success, and the manufacturers, like all who but recently had embarked in new undertakings, appear to have been harrassed by the importation of foreign products of a similar kind to those produced by them; they, therefore, adopted a Conservative policy, and petitioned that foreign imports in brass should be prohibited, or the import duty thereon increased. In 1625, the copper of the King of Sweden was specially singled out for increased duty, as "the Swedes had determined to sell their goods at a loss, in order to undersell those of English manufacture." Brass wire was then selling at £8 per hundredweight, but the introduction of Swedish wire had reduced it to £5 5*s*. "If the introduction of Swedish wire was not prohibited, or the duty largely increased, it was alleged that the suspension of labour in the calamine mines of Somersetshire, &c., and the copper mines of Wales, must follow as an inevitable consequence. The continuance of the brass works, it was held, was of the utmost importance. In 1639, a further extension of the prohibition was asked for, and

obtained; the petition sets forth that, before the year 1665, there was not any wire made or drawn by such devices, tools, or engines, as were devised by Humfrey and Shutz; before which time all English wire was made and drawn by "man's strength." The precarious and fluctuating nature of the brass trade, as indicated by what has been already stated, does not appear to have hindered other manufacturers entering the field. In 1649, Jacob Monimia and Daniel Diametrius, both Germans, established brass works at Esher, near Surrey, on which they expended the sum of £6,000; but which, after being in operation thirty-four years, and making good profit, they were compelled to give up working, to their own ruin, and, as they expressed it, to the prejudice of the kingdom, in losing so beneficial an art—having here, *i.e.*, in England, the best copper and calamine of any part of Europe. Battery works, however, were being rapidly extended even in the face of the failure alluded to. An ancestor of Lord Byron leased brass battery works at Nottingham, at a rental of £400 per annum. Daniel and Joseph Houghsetter (descendants of the Houghsetter named in Queen Elizabeth's grant) were working the Goldscope Copper Mine, near Keswick, and were licensed to convert the copper found into brass. This mine, reputed to be very rich in copper, at which 4,000 artificers and labourers were employed, in the Cromwellian wars of 1650 and 1661, had its smelting houses destroyed, its working put a stop to, and most of its miners were killed or followed the Protector. The working was resumed by Dutch miners, brought over by William III.; they were driven from it in 1715, and no effort has since been made to resume operations. The mouth of the level, surrounded by heaps of grass-grown *débris*, serves to mark the spot where thousands toiled, "and mines existed so valuable that they served the whole kingdom."

The Battery Works, as might be supposed, were not confined to the production of articles in metals: they embraced the production of chemical substances, with the exclusive right to get the raw materials—the production of glass, colours of all kinds, oils fit for the lamps of princes and noblemen, enamelled and other earthenware, &c., rock and various other mineral salts, &c. As regards the strictly metallic department of the battery works, an enumeration of their varied products cannot fail to be particularly interesting after the lapse of 160 years, as it indicates the condition in which the raw material was supplied to manufacturers engaged in the industries in copper and brass; besides, we gather from it a

knowledge as to the existence of processes and mechanical appliances at a much earlier period than we of the present generation could have anticipated as likely to have then been practised. The products of the battery works were as follows:—"Copper battery plate, copper hoops, copper rods, copper wire, fine brass or "latten" battery plate, ditto in sheets planished; ditto in hoops, in rods, in wire, in pins, in sorts, in thimbles, needles, aurichalchum; ditto in sheets, ditto in thin leaves, ditto in wire, fine wire flated for weaving; ditto for knots for head dresses, &c., ditto in leaves for gilding, ditto in shells for painting and writing, commonly called shell gold; lead in sheets, strained by water engines; rolled tin in leaves, for foils for looking glasses; metal colours in powder." The term "Battery Works" suggests that one establishment in Birmingham—*i.e.*, that of the late Mr. Benjamin Gibbons, in Digbeth, (now conducted by his sons)—still bears that title; its commencement, however, was within the present century; it had no connection with any of the old establishments whose name it bears, though some of the articles manufactured are produced by the same processes, as neptunes, guinea pans and kettles, Lisbon pans, &c., viz., that of "battery," or hammering.

The making of brass at Bristol is an important link in the history of the progress of the brass manufacture in England, and as from it Birmingham received a portion of its supply in the early period of her brass manufacture, an allusion to what was done there cannot fail to be interesting.

Brass works were established at the Baptist Mills, near Bristol, early in 1700, by Mr. Darby, an ancestor of the present Darbys, of Coalbrook Dale, and by a Mr. Lloyd, from North Wales, who carried on the manufacture of brass under the name of "The Bristol Brass Battery Company." At these works were made ingot brass, battery-work, and rolled brass, the "strips" for the latter being cast in two ingots formed by granite stones, and afterwards beaten or rolled out.

In a few years after the establishment of the Baptist Mills Works, they were transferred to other parties, and the style of the firm altered to that of Joseph Loscombe and Brass Works Company, who immediately proceeded to erect other works in the neighbourhood, viz., at Keynsham, Kelson, Salford, Weston near Bath, and Warmley, and they erected three hammer mills on different parts of the river Chew. At Keynsham they had rolling mills and wire mills, and at the other works hammer mills for battery work.

All the foregoing works were carried on by Joseph Loscombe and Brass Works Company for nearly fifty years, they were then taken to by a new firm, composed of three or four of the family of the Harfords, a Sir Jarret Smith, and a Mr. Battersby, who styled themselves "Harfords' and Bristol Brass Battery and Wire Company." These works were all carried on for the manufacture of brass for more than a half century, since which the majority of them, one after another, have been discontinued. The works at Weston, and the two mills on the river Chew, were discontinued about fifty years ago. The mills at Weston are now used for grinding logwood, and the two upon the river Chew, one for cement and the other for flour.

The Baptist Mills Works were discontinued about thirty-five years since, and are now used for pottery purposes. The mills at Kelson were abandoned about twenty years ago, and are now in ruins.

The works at present in operation for the manufacture of brass in the neighbourhood of Bristol are those at Keynsham, Salford, and one of the mills on the river Chew. The Bristol brass was originally made from copper and calamine, the latter being obtained from Shipham, on the Mendip Hills, a distance of about sixteen miles from Keynsham. For the last twenty-five years spelter has been substituted for calamine.

The production of brass in the neighbourhood of Bristol, during the last fifty years, has certainly diminished more than one half.

The partners of the firm of "Harfords' and Bristol Brass Battery Company" have changed several times during the present century; lately all the old partners have gone out, although the style of the firm remains the same, the present company consists only of Messrs. Henry Elford, Donald Bain, and Alexander Steed, the two former having been in the service of Messrs. Williams, Foster, and Company. The "Harfords' and Bristol Brass Battery Company" commenced copper smelting in the neighbourhood of Bristol, at Crews' Hole and Conham, about a century ago, and continued to manufacture copper for general sale and the use of their brass works for upwards of fifty years, having discontinued copper smelting early in the present century.

They rolled copper at their mills at Kelson, and had also some copper mills at Bitton, but discontinued rolling copper soon after they discontinued smelting. In 1710, the right to work for copper and convert it into brass, as regards Ireland,

was granted to one Thomas Oswin, whose works were erected in the vicinity of Dublin.

The progress of the manufacture leads us nearer home, to Staffordshire. Cheadle brass was also celebrated, and from it, as from Bristol, Birmingham drew a portion of its early supplies. The Cheadle Copper and Brass Company first commenced operations in 1717, when they erected copper smelting works at Bank Quay, near Warrington. I have heard my father say, (writes W. H. Keates, Esq.,) that the first entry in their books was characteristic—"Paid for ALE, to men digging foundations." Originally all the copper they used in making brass was smelted at Bank Quay.

The brass works were built near Cheadle, in Staffordshire, soon after the erection of the copper works at Bank Quay—the locality was probably chosen on account of there being an abundant supply of suitable coal, its being about midway between the supply of copper, from Lancashire, and of calamine, from Derbyshire, and its proximity to the river Churnet, at Oakamoor and Alton, which supplied the necessary power for the rolling and wire mills. Originally copper was carried from Bank Quay to Cheadle on the backs of horses, afterwards in waggons, and, finally, by canal. "I recollect," says Mr. Keates, "calamine being brought to Cheadle on the backs of mules from Derbyshire." On discontinuing their smelting works at Bank Quay, they erected others near the brass works, and also at Pencowdd, and Neath Abbey, in South Wales.

From the time of the erection of their works at Cheadle, until about the year 1830, all the brass was made by the old process of cementation, and, probably, at no place in Europe was this process conducted more successfully, or at which brass of better quality was produced. About the year 1830, the old process was discontinued, and the company began to make brass at their rolling and wire mills, at Oakamoor, by directly combining the two metals, copper and spelter.

The furnaces at Cheadle were similar to those used in brasshouses generally, and consisted of circular dome-like chambers, lined with fire-bricks, terminating in a circular flue. At some distance from the bottom, provision was made for setting the pots, nine in number, *i.e.*, a large centre or "king pot," and eight smaller pots—the contents of which consisted of shot copper, calamine, and ground chemical, under each of the pots a flue hole was introduced, which admitted air, and increased the action of the fuel and heat of the furnace. The contents of the eight pots, when melted,

were emptied into the "king pot," its contents, after being well stirred and mixed, were poured into ingots. Four such furnaces were placed in each "melting house," the works originally consisted of two such houses—or eight furnaces, which produced about 2½ tons of brass per week, these were gradually increased up to thirty-six furnaces, and the produce of brass raised to about 600 tons per annum. Of this quantity, about three-fourths was converted into wire and sheets—the latter called "latten," and the remainder was cast into ingots of 6 or 7lbs. each.

The brass for wire and sheets was cast into "plates," which weighed from 96 to 100lbs. each, and varied in dimensions from 5ft. 2in. to 5ft. 10in. long, and 11 to 15in. broad. The moulds in which these "plates" were cast were formed of two massive slabs of granite of at least 6ft. 4in. long by 2ft. 9in. broad, and about 8in. thick. One face of each slab was plastered over with fire-clay and loam to give it the requisite smoothness, and strips of iron were inserted between the two slabs to determine the length, width, and thickness of the "plates" of brass, and the whole was then screwed together by machinery, at a proper inclination, to receive the melted metal. The brass intended for "latten" consisted, as nearly as possible, of two-parts copper and one-part zinc—as also did the wire, denominated "pale," used for various purposes; but the wire intended for pins contained a little more zinc, as also did the ingot brass.

Four qualities of ingot brass were made at Cheadle, viz.:—

B B—Made of best copper, and same quantity of zinc as the "plates" for "latten."

B C—Inferior copper, and slightly more zinc.

A M—Some copper and calamine, tainted with lead.

Y Y—Made of ash metal and other inferior materials.

The B C ingots were always broken through the middle, and hence known as "B C, broke."

Wolverhampton and Sheffield took the Y Y ingots—not much of which was made—the latter town also took some B B; the great bulk of all the rest went to Birmingham. Of all sorts, ingots, "latten," and wire, I suppose Birmingham took from Cheadle about 350 tons per annum; the rest went to London, Gloucester, Warrington, and Manchester, principally as wire, for pins.

The quality of copper, for making good brass for sheets and wire, was of the utmost importance in the old process of cementation, and to obtain this, the Cheadle Company, and

Messrs. Harfords of Bristol, prepared it from the ore themselves, on this account, chiefly, the brass made at Cheadle and Bristol was much esteemed.

It is worthy of note, that though various calamines were used—dug from Derbyshire, Flintshire, Somersetshire, and Yorkshire—from long experience and care, the percentage of zinc in the different qualities of brass produced was secured with as much certainty as it is by the method of direct mixture now practised.

In addition to the works at Cheadle, the company had for several years works at Greenfield, in Flintshire, where the brass made was converted into pans by the battery process—(these works were undoubtedly those visited by Matthew Boulton, as will be shown in the history of the Birmingham Brass and Spelter Company, established in 1781, to be introduced hereafter).

The Cheadle Company produced also small quantities of Prince Rupert's metal, known as "prince's metal," composed of equal quantities of copper and zinc, which was rolled into sheets, and drawn into a particular kind of wire, for the weaving of wire cloth, to be used in the webs of paper-making machines, the strings of pianofortes, and other musical instruments, which wire held an intermediate place between ordinary brass wire and that which is now known as "red wire." After the erection of the works at Cheadle, "brass houses" sprung up in various parts of the county. The Coleshill Street Brass Works, in Birmingham, began operations in 1740, and others were erected at Stoke, Macclesfield, and Framilode, Swansea, and Llanelly, the two last named made only ingot metal; the others, in addition, sheet metal, for the production of battery and other works produced from sheet metal.

In the year 1720, *i.e.*, that of the Great South Sea Bubble, additional works for the manufacture of brass were included among other projects of a speculative character; shares of the Temple Brass Works, situated on the River Hackney, near London, originally established under the patronage of Prince Rupert, and celebrated for the production of prince's metal, brass guns, &c., on which the sum of £10 per share had been paid, realised in the Change Alley £250 per share. The success of this scheme induced the projection of other companies for "the improving of English copper and brass;" these, however, appear to have shared the fate of numberless projected companies which in so peculiar a manner distinguished that eventful year.

In the following year, 1721, William Wood (a leading iron master who undertook the coinage of the copper halfpennies for the kingdom of Ireland, which he executed in so inferior a manner as necessitated their being called in, and for which, in the celebrated "Drapier Letters" of Dean Swift, he received a severe and merited castigation) issued a pamphlet by which we learn that not fewer than 30,000 individuals (probably an exaggeration as to numbers) were employed in the manufacture of brass, *i.e.*, as miners of copper, and calamine, in the mills for rolling, wire drawing, &c. It was refined by pit coal. "The abundance of *lapis calaminaris* and copper, to be found in many counties in England, Wales, and Scotland, was set forth, therefore the nation could supply itself with its own brass, if such duties were laid on foreign copper and brass as would discourage their importation, and at the same time encourage the sale of English metal."

Having disposed of the early history of brass, glanced at the introduction of its manufacture into England, and where it was made, the progress of the brass trade in Birmingham will now be entered upon.

About fifty years after the introduction of the metal into the town (or of "Hutton's First Brassfounder") as we have stated, the demand for raw material was such as to induce the Turners to start a brass house in Coleshill Street. Unfortunately we have no record to guide us as to the kind of brass articles first made—no doubt they possessed all the peculiarities and defects of articles produced at an early period of a new industry; in all probability there was queer fitting, abundance of material, their finish imperfect, of form there was little, of ornamentation less, the patterns were imperfectly made, as the numbers required to be cast therefrom were small in comparison to what is now required, the tools at the command of the workman were few and imperfect, and manual labour alone was employed; the era of "power" had not arrived, and the division of labour, which marks an advanced era in manufactures, was then not understood. The position of the brass trade between 1689 and 1760 was that of making only—it had not reached the dignity of manufacturing—the former epithet referring to the production of a *small*, the latter to that of a *very much larger number of individuals*. The then industry of Birmingham was, as has been well said, "of a staid and steady character;" while the fame of the brass articles produced had even, in those days of imperfect roads and limited means of transit, reached many of

the larger towns of the empire; the manufacturers remained at home and let the orders come to them; customers did come, and brought with them, not three or six months' acceptances to pay for their purchases, but produced the cash from their saddle bags, paid for what they had, and took their limited purchases away in the same receptacle, or, if too bulky, had them forwarded by the first carrier's van, drawn by four horses.

The era of travellers and blue bags had not then arrived, Oak brass-bound boxes, filled with pattern cards, on which are displayed samples of the articles made by the house represented, had not then been called into existence; and of pattern books, folio in size, with representations of the articles "done," in all the glories of chromo-lithography or copper-plate printing, there were none.

With improved roads and means of conveyance, the Birmingham brass trade grew; then came the era of Inland Navigation, and the genius of Brindley appeared upon the scene. A canal, cut in the year 1768-9, connected the collieries of Staffordshire with the furnaces of Birmingham; the town being in the centre of England, other branch canals speedily opened up communication with Gloucester and Bristol on the one side, and through the Trent to Gainsborough and Hull on the other; all tended to reduce the cost of conveyance of raw material, and that of the carriage of finished articles to their destination. Still, however, Birmingham manufacturers lacked that which kings covet, "power," in plain words, they depended entirely on manual labour for the production of their articles, and on other localities for their chief supply of ingot, sheet, or rolled metal; the water supply in the immediate vicinity of the town was poor, and the genius of all-conquering steam had not as yet dawned in Birmingham. It is true, that in 1700 a Rolling Mill, driven by the limited water power at command, existed down at the Nechells; and in 1756 another was set in motion by the diversion of the waters of Hockley Brook by means of a cutting, half a mile in length, and the formation of the lake at Hockley (which still exists), the head of water from which drove the rolls in a somewhat feeble mill erected below; eventually the lease of this mill and the surrounding property passed from the then lessee, Mr. Edward Rushton, to Matthew Boulton, and then the height above the lake named, was crowned with the once world-celebrated Soho Manufactory. At Dog Pool, in another direction, there was also a rolling mill driven

by water, and the waters of Edgbaston Pool gave motion to a fourth rolling mill at Edgbaston; very soon, however, Birmingham men appear to have learnt that water power of so feeble and uncertain a kind as it is in their locality could be but little depended upon, and the first who seems practically to have obviated its use was a Mr. Twigg, who erected, in the year 1760, an infant steam or "fire engine," on the principle of Newcome and Cawley, on the premises in Water Street now occupied by Mr. P. H. Muntz. Boulton, at the Soho, erected a similar engine for a similar purpose, *i.e.*, that of metal rolling. In all probability observations on the defective working of that engine led to his appreciation of the invention of James Watt, and eventually led to the partnership of these two celebrated men. The Phipsons had a "fire machine," erected at a somewhat later period in Fazeley Street, at the mill now in the occupation of Mr. Clifford; the engine was, after its erection, improved or re-modelled by Boulton and Watt; and there was yet another, belonging to the New Mill Company. Allusion is made to the erection of rolling mills, as the period had arrived when, in the brass trade, their operation was of the utmost importance, for in 1769 the process of producing brass articles by means of the stamp and die was introduced, and the era of Stamped Brassfoundry began. Previously, all articles in brass had been cast; the new process, the cheapness of the articles, in comparison with those produced by casting, and their superior finish, gave an immense impetus to the trade, and all the more that the sheet brass from which they were produced could be had in the town by means of the rolling mills named, thereby obviating the necessity of sending for it to Cheadle and Bristol, from whence Birmingham manufacturers had previously received their supply of metal in that form, as has been already stated.

Mr. Twigg's "fire-engine" may again be alluded to, as it refers to, and marks the introduction of "Power to Let," for, in addition to giving motion to four pairs of rolls, which was the purpose for which it was erected, he was the first to let out his surplus power, by the erection of premises through which shafting was conducted, the rooms being rented at so much per week by small manufacturers or workmen who were unable to erect small engines for themselves, owing to their limited means. In Bailey's Directory, of the year 1783, we find the following advertisement:—"Charles Twigg and Co., Rollers of Metal, Grinders and Borers of Gun Barrels, at the Steam Mill, Snow Hill. N.B.—This mill is erected for the above

purposes, and also for the polishing of steel goods, finishing buckles, buckle chapes, and a variety of other articles usually done per foot lathes. The whole is worked by a steam engine, and saves manufacturers the trouble of sending several miles into the country, to water mills." "Power to Let" accommodation, though still taken advantage of by many of the smaller trades of the town, is only exceptionally so now by brassfounders, and by those of limited means; almost every small brassfoundry has now a steam-engine of its own erected on the premises, which gives motion to lathes and other appliances, to facilitate the execution of the work.

In 1780, Hutton placed the consumption of brass at 1,000 tons per annum in Birmingham—in all probability this was only an ideal approximation—it may, therefore, be said to have consumed about 650 tons of copper; thirty times that quantity, or nearly what may be stated at 20,000 tons, independent of old brass reconverted for use, is now annually consumed, or was in the year 1865.

In 1780 occurred one of those episodes in connection with the copper and brass trade, which have, more or less, during the last eighty-four years, harrassed and perplexed manufacturers of brassfoundry. The production of copper in Cornwall and Devonshire, which, in 1771, amounted to 3,347 tons, of the standard value of £81 per ton, fell in 1780 to 2,932 tons, and the standard rose to £83 per ton. As copper is the chief element in the composition of brass, it was (brass) advanced £12 per ton, viz., from £72 to £84 per ton. At £72 per ton, copper being £81, brassmakers were realising, in clear profit, £12 6*s.* 8*d.*, or nearly 15 per cent. per ton, after all expenses of material, wages, wear of furnaces, &c., were paid; at £84 per ton, (there had been only £2 per ton advance in the copper), copper being £83; zinc or calamine ore, coals, and labour remained the same, they (the brass makers) realised about £18. 13*s.* 4*d.* per ton, and gained 25 per cent. The brassfoundry trade was taken at a disadvantage; up to that time nothing had disturbed the even tenor of its way. It was a growing trade, rapidly approaching the dignity of a manufacture; the one brassfounder of the reign of King William had increased to upwards of thirty—many of them men of wealth, and leaders of what were then considered large works. They met in conclave at "The Swan," and issued a notice, of which the following is a copy, interesting as it records the names of the chief brassfounders eighty-six years ago. It was as follows (and suggests, by the expression, "advance of seven

and a half per cent.," that brassfoundry goods were then sold at net prices) :—

Birmingham, August 28, 1780.

BRASSFOUNDERY.

At a Meeting held This Day, at The Swan, in Bull Street, we, whose Signatures are here annexed, in Consequence of the late Advance in the price of Ingot Brass, find ourselves under the disagreeable Necessity of advancing the Price of Brass Foundry Goods, Seven and a Half per Cent.

Timothy Smith,
Samuel Parker,
William Wheelwright,
Thomas Underhill,
John Barker,
Townshend and Longmore,
John Simmons,
Richard Webster,
Charles Power,
Smith, Cocks, and Taylor,
Grew and Sheriff,
John Rotton,
Whitworth and Yates,
Price Pritchit,
Atkins and Longmore,
Boole and Barber,
William Lowe,
Richard Beach,
Thomas Smith.

The crisis alluded to, which called forth the advertisement, those familiar with the pages of Hutton will have no difficulty in identifying with the paragraph which is now introduced, viz. :—

"In 1781, a person, from affection to the user, or resentment to the makers, perhaps the *latter*, harangued the public in the weekly papers; censured the arbitrary measures of the brazen sovereigns; shewed their dangerous influence over the trades of the town, and the easy manner in which works of our own might be constructed; good often arises out of evil: this fiery match, dipt in brimstone, quickly kindled another furnace in Birmingham. Public meetings were advertised, a committee appointed, and subscriptions opened to fill two hundred shares of £100 each, deemed a sufficient capital; each proprietor of a share to purchase one ton of brass annually. Works were immediately erected on the banks of the canal, for the advantage of water carriage, and the whole was conducted with the true spirit of Birmingham freedom."

Being anxious, if possible, to ascertain the nature of the "harangue," on searching the files of *Aris's Gazette*, it was there discovered. As it is a very extraordinary document, of a thoroughly patriotic character, conceived and written in the language and peculiar phraseology of the period, by permission of the proprietors, it has been copied, and is here printed in extenso. The writer, as it will be seen, contends manfully for the exalted position which the brass trade had even then reached, after barely one hundred years from the date of its introduction. Let the "harangue" speak for itself, it is as follows, and is designated by the writer as—

A Serious Address to the Merchants and Manufacturers of Hardware, and particularly the Inhabitants of BIRMINGHAM and the adjacent Towns.

GENTLEMEN,

Suffer me to call your attention to a few Strictures I take the liberty of making upon some late Incidents respecting the articles of Raw Metals, matters that so essentially concern you, that I am much astonished that no one has stepped forward to explain them, and show the injury you sustain, and the dangers your manufactories are exposed to by the same.

I should have been happy in seeing some more able pen employed in this business, but rather than Sentiments should lie longer obscure (that I am persuaded are held by almost every individual), and not communicated in general to each other, I have taken the Liberty to give you mine at large, in Hopes it may excite you to take them into Consideration, and rouse you from all supine neglect to a State of active attention to your Interest and Consequence, which can best be effected by carefully guarding the grand source—I mean Raw Materials.

The Consequence of this kingdom exists in its Manufactures, and yours are a large and valuable Part in the Scale of Commerce. You have surprised all Europe in Invention and Execution; you have sought Honour and Profit, and it has been found in every Quarter of the Globe. Nothing then can be so essential to you as the Maintaining and Improving such well-earned reputation. Your competitors in other nations are jealous of your superiority, and, with unwearied attention, watch every opportunity to share with you a trade they cannot equal, much more excel, and yet often partake materially of, from the too frequent fluctuation of Prices, owing, I presume, to the unsteady state of Raw Materials, the which I conceive to consist principally in Iron, Brass, Copper, and Spelter; all others may be considered subordinate to them. As for Iron, the Amount is so small in comparison with Copper, Brass, and Spelter, that the fall of 20*s.* or even 40*s.* a ton (and more it seldom undergoes) does not become a grievance, since the London, Bristol, and Hull Markets live and continue to supply you with the fabricks of the Black Country, that moderates that Article, keeping down the price of English Iron (which might otherwise be very high), and leaves you without Complaint, especially in the finer Branches. It is not so with Copper and Brass; therefore to that very considerable and consequential, and of Raw material so necessary to your manufactures, I wish more particularly to call your attention, while I endeavour to point out to you the late absurd Conduct of the makers of Copper and Brass, and the dangerous tendency they have to your manufactories. Advance upon any articles should ever be avoided until necessity obliges, for variety of reasons, and Falls should be as carefully made, and not before all Circumstances evince the propriety, and that no local inducements can create a speedy Advance; in such case they are of benefit in General. But, on the contrary, when a Fall is made without intention of stability, it deceives and becomes a real injury, as is fully felt upon the recent Advances upon Copper and Brass, after the strongest assurances that circumstances would render the former Falls permanent, in consequence of which you generously declined taking the Advantage to yourselves, but as a body emulous to promote the reputation of your Manufactories, you gave those advantages to the public, by lowering your prices or increasing your discounts adequate to the various Falls upon Copper, Brass, and Spelter; the Consequence of which is that, from the avaricious disposition of some, the capricious conduct of others, with a combination of the whole body of makers of Copper and Brass, they attempt to avail themselves of an Extraordinary advantage, by imposing on you an enormous Advance of more than twenty pounds per ton on Copper, and upwards of thirteen pounds per ton on Brass, without any other reason than that they presume to reckon on Their Power under such Association, and that the same

must and will be received tamely by you. From this unexpected and wanton Stretch of Power, thousands of industrious artists, who are not able to raise the articles they have fallen, at once lose the profits of their Labours, at a Time they were so ably contributing to the Honour and Support of their various Branches. This naturally leads me to descant on the Motives that incite the Makers of Metals, and request you will take a Retrospective View of their Conduct during Your own experience, and you will be convinced that Avarice and Power were predominant Passions by which they have been governed, and to which you have for a long Series of years submitted; in the infant state of your Trade, you are shackled with Difficulties to which it was prudent for you to submit, because Industry and Prudence alone would soon free you. That happy period has long been arrived: you are emerged from every Degree of Dependence, as a Body numerous and Wealthy, who have rendered yourselves honourable in employment—the pride of England, and Admiration of the World. With such well-deserved Consequence, shall a few designing Men presume to insult you, and arrogate to themselves a Right of dictating to, or restraining your free Inclinations—by monopolising, confederating, and prescribing Regulations, as despicable as they are weak and absurd? In former years the Company (now called the O. C.) assumed the Whole controlling Power; they rose and fell prices at Discretion; but as all persecutions beget Resentment, so Resentment creates Opposition, and Opposition produced Adventurers not in the least intimidated by such formidable Powers. So boldly stood forth the Champions of Liberty, and, in defiance of Oppression, ventured to erect works and risque their Fortunes therein; but such (to the O. C. presumptious intruders) had dared to withdraw themselves from their Power, so they became Victims marked for punishment—no less than total Ruin. Prices were lowered upon them, to that Degree calculated to sink their works, and make their fate inevitable; no matter if it cost the Company £10,000 or £20,000, that sum could be realised on a future advance, when Opposition was removed. Witness Mr. Turner's brass-house, and the many Falls they have made upon his infant trade, and which must have been crushed but for the Protection of the Warehouses. Again, when the new Company at Birmingham had erected their works, the price was reduced at three different Falls fifteen pounds per ton; and afterwards, Mr. Emerson building a spelter house, they fell that Article from £74 to £48, and under. Such was their Mortification when any rival presumed to set up in Opposition against them; your Patronage and Support preserved their works, and convinced the O. C. that Measures must be changed, and new Modes of enslaving adopted; accordingly, this very Company, who so lately endeavoured to destroy their Works, condescended to court a Reconciliation with their Opponents, who have been persuaded to enter into a grand League, for the sole Purpose of advancing Metals. What a strange Fatality must attend those Men, who could so inconsiderately desert their Protectors, forget every Obligation, and combine with a Company who so recently pursued them for Destruction. But ingratitude is no Foreign Exotic, it springs spontaneously in every Clime.

The great Consumption of Metals in the manufactories of Birmingham undoubtedly lies in Brass and Spelter; therefore, Copper being of little Consequence, it is less necessary to erect works for that Purpose; but where it is considered the latter to be the principal Metal in making the former, you see the Necessity there is to build a small smelting-house or Copper Works for the Purpose of making such quantity only as will be used in the making of Brass. Besides, the present Advance upon Brass (no way proportionate to the rise upon Copper) Points out a further Necessity to make it, towards the Disadvantage which the makers of Brass only are subject to; from hence may be seen the Implacability of the O. C., for though a Union has been made with the Works at Birmingham, the present price of Brass shews them they are yet unforgiven, and may one Day or other become a Sacrifice to that Power which only wants an Opportunity to be enforced.

The first production of this wonderful Coalition was the enormous Advance, before mentioned, on Copper and Brass (as for Spelter, that at present remains reduced, not having lost all Hope of annihilating Opposers in that Article, and recovering back their former Monopoly). The Second Fruits were Regulations and Restrictions. The O. C., with singular Indifference and Ingratitude to their Old Friends, establish One Single Agent at Birmingham, to the entire Exclusion of those who had so long and faithfully served them, and open a Warehouse there for the sale of their articles, Wholesale and Retail; not content with this, but flushed with Power, the Associations (who owe their Consequence to your indulgent, fostering Care), with peculiar Rashness, tell you that "If you dare to sell at a less price than they have fixed, you shall not be served at all." Gentlemen, this is such an arbitrary Extension of Power; such a proscription of Liberties that belongs to no set of Men whatever to impose. I appeal to your Feelings as Men, to your Consequence as Tradesmen: Indignation spurns the Idea. Under these alarming circumstances, founded on facts, shall so respectable a Body of Merchants and Manufacturers become the Dupes of a set of Capricious Monopolists in the articles of Brass and Spelter on which their trade depends? No! you must rouse yourselves; tame Submission would be Ignominy. Reflection will bring you to a sense of your Danger, and dictate to you the Expediency of becoming Independent in the articles of Raw Materials; be no longer governed by Strangers when you have the Power to help yourselves at Home; the Path is plain and easy; the making of Copper and Brass is familiar and without Risque; what then should prevent the Merchants and Manufacturers from making their own Metals, by which every advantage may be expected? In Order to accomplish this desirable End, it will be necessary to raise a Fund sufficient for the Purpose, to be divided into shares, and every Merchant and Manufacturer to be subscribers. It may be said, who will conduct the Undertaking? I answer, who so proper as Yourselves. Let a Committee be chosen out of the Subscribers, who shall superintend the Business, with an allowance for their Trouble; and let Power be invested in them to appoint Clerks to carry into Execution the Plans formed by the Committee, you will then be your own makers of Metals; all Combinations against you must fall to the Ground; and though the Monopolists may play their old Game of sinking Prices, to tire out the Concern, what will be more, your Advantage will be found in the Price of Metals; as Manufacturers, Let, therefore, a Meeting be called, and Plans brought for the Design; the Prices of Our Calamy, Coal, Carriage, &c., will be laid before you, and will be but a just Punishment on the O. C. (as Makers and Promoters of every rise upon Metals that has been made for these Fifty years past) for the Manufacturers to unite and subscribe to an article under a penalty, not to use any brass made by them; but however this may be, feel your own Conscience; let Unanimity prevail between the Warehouses and Manufacturers; let no Underhand Schemes separate you—consider yourselves as Men joined in one interest, one Common Cause, by subscribing to a capital of Thirty, Forty, or even Fifty Thousand Pounds, or more, if needful, to be divided into One Hundred Shares, these Shares paid by Instalments, as Occasion requires, and each Share transferable by Sale. This plan I conceive will secure your Manufactories, bring Reputation and Profit to yourselves, and must effectually crush all opposition.

In the infancy of your Trade you are not able to perform a Design of this Magnitude, but the Enlargement of your Concerns, and Success in them, has made you by far more capable to execute such a Scheme than any Company in the Kingdom, and for this plain Reason, because being Makers of Metals, you will find and use your own, consequently your works must stand.

Thus, Gentlemen, I have presumed, as a mere spectator, to throw together a few crude and Undigested Thoughts, upon a Subject I cannot help considering of the utmost Importance to you, and a zealous Well-wisher to the Manufactories of this Kingdom, and of yours in particular. It would give me infinite Pleasure

should they be in any Degree productive of furthering the Completion of your perfect Independence in the Articles of Copper, Brass, and Spelter.

I am, truly and faithfully,
Gentlemen,
Your humble Servant,
BRISTOL.

Extracted from *Aris's Gazette*, October 9th, 1780.

The "Serious Address" seems to have had some effect, and the result was, that on the 21st November, 1780, the following advertisement (evidently written by the writer of the address) appeared in the *Gazette* :—

"*To the Merchants and Manufacturers concerned in the consumption of Metals in the town of Birmingham and places adjacent.*

"GENTLEMEN,

"You are earnestly requested to meet at the Hotel, in Temple Row, Birmingham, on Tuesday, 28th November inst., at Three o'clock in the Afternoon, to deliberate on a plan and to enter into a subscription for forming a Company among yourselves for the making of Brass, &c., for your own Consumption, agreeable to the Design proposed to you by that friend to your trade, who addressed you in this paper of Monday, the 9th of October, and thereby to relieve yourselves from the Imposition of a set of mercenary men whose machinations manifestly tend to the Injury of the trade of your Town and Neighbourhood."

The strife seems to have been continued, and "no surrender" was the order of the day. The metal dealers refused to supply the local warehouses where brass was sold, and appointed special agents, the Harfords, of Bristol, then a leading house in the brass trade, advertising the appointment of one Joseph Sheldon as their agent, on the 20th November, 1780. A preliminary meeting was held on the 28th November, according to the advertisement, and the consequence was, that the idea of forming a new Brass and Spelter Company was decided upon. An interim committee was appointed two months thereafter, *i.e.*, on February 2nd, 1781; and we learn that, "on Friday, at a respectable meeting of the principal Merchants and Manufacturers of this town, respecting erecting a Brass Works in order to relieve the manufacturers from the uncertainty of Brass, from the Report of the Committee, a subscription was opened for the purpose, and the sum of Twenty Thousand Pounds subscribed for its execution."

It is singular to remark that Hutton, with his great talent for collecting gossip, should have failed to ascertain, or if he ascertained, did not record the fact of Matthew Boulton's

connection with the new company in the early part of its existence; yet Boulton was the "guide, philosopher, and friend" of the shareholders in the difficulty in which they felt themselves placed. Was Matthew Boulton the writer of the "Serious Address:" did he plan the company, and knowing that, did the shareholders ask his aid?—as they did, and as we will presently show—or did they recognise in him a "power" which could alone help them to wage the unequal war? At the period named, Boulton had erected, at that time and for fifty years thereafter, the unequalled Soho manufactory, of which, alas! no traces remain, save heaps of débris and grass-covered mounds, to tell where hundreds toiled, where the steam engine was perfected, and from whence issued the coinage of the nation. Seven years previously, he had formed a partnership with James Watt, already their patents were being disputed and infringed, law proceedings were pending, and the issues of these trembled in the balance. In addition, Boulton had to attend to that department of the Soho peculiarly his own, to the production of costly works in precious and plated metals, to clocks ingeniously constructed and with ornamental cases, to fine art bronzes and articles in ormolu, to filagree work, buttons, buckles and clasps, lamps, brackets, candlesticks, and tea urns; improvements in the process of coining were engaging his active mind; he was a large producer of rolled metals, and the occasional bad health and despondency of Watt formed no small part of his anxieties, and troubles; to crown all, there was his banker's balance against him, but, as has been well said by Mr. Smiles, "he was a noble, manly man, a true leader of men, lofty-minded, intelligent, energetic, and liberal; he was one of those who constitute the life-blood of a nation, and give force and dignity to the national character," being so, when his fellow townsmen called to him, he responded to their call, and though he declined the office of the chairmanship of the Birmingham New Brass and Spelter Company, as will be shown, he gave good, excellent, and important advice for which, as the sequel will show, he was repaid with the basest ingratitude.

The true history of the New Brass and Spelter Company which arose out of "the arbitrary measures of the brazen sovereigns" of the year 1780, of "another furnace kindled in Birmingham," according to Hutton, is as follows:—"The manufacturers of brassfoundry goods in Birmingham were dissatisfied with the apparently to them, inexplicable advance made by the metal merchants, of £12 per ton on brass, viz., from £72 to £84, and

they proposed to start a new company; they wrote to Mr. Boulton, then in Cornwall, on the subject, asking him to take a leading part in it, and if so, they offered to raise the sum of £60,000. He tried to dissuade them, pointing out as the cause of the advance, that the mines were badly and unsatisfactorily worked; the miners preferred to work for tin in preference to copper; the absence of efficient pumping machinery to drain the mines increased the difficulty of working them; "if, however, they determined to proceed after considering his letter, he offered them his assistance and advice." This correspondence Boulton showed to Mr. Wilson, of the Chase Water Copper Mines Company, where he was then superintending the erection of an engine; at the same time he expressed, as his wish, if the New Brass and Spelter Company was formed, that he would, if possible, induce it to purchase the copper used from the Chase Water Company, which he would undertake to enable to produce such quality of copper as would be best for making brass to be used in the Birmingham trade; he then proceeded to sketch out a scheme for the new company—its capital to be not £60,000 but £20,000—no person to hold more than four shares; every holder to covenant to purchase from the company one ton of brass per annum for any share held. From this may be gathered some idea of the limited extent of the consumption of brass in 1781 as contrasted with what it now is in 1866. The scheme issued by the new company was generally approved of, the share list filled, this Boulton saw, and then regretted he had not extended his list of subscribers to embrace 300 instead of 200; as the Company was intended to embrace consumers only, the sale of 200 tons of brass would have been secured. He then suggested that tenders for the supply of copper should at once be invited, and those accepted which were most advantageous, he only asking as a return for his labours, that in the event of equality in price, he should be permitted to decide in favour of the Chase Water Company. The superiority of its copper and its power of supplying with regularity appear to have formed his grounds of preference; that favour, he says, "is all the reward I shall expect for correcting the errors of the Brass and Spelter Company, and leading them to make such brass as I know suits best the different branches of the Birmingham brass manufactures." In furtherance of his desire to aid the New Brass and Spelter Company, he, in visiting Shropshire, extended his journey to Holywell, in Flintshire, and examined the calamine mines there, for in the then state of the metal market

the new Company "had reason to suspect that the sorts of calamine known to make the best Bath brass would be attempted to be monopolised," and he further enlightens us by stating that the best "Bath metal brass made in any part is the best Cheadle, and the very best Cheadle brass is made only with Flintshire calamine;" he tells us that the best Cheadle brass was not made there, but at a brass house near Holywell. Certain predilections on the part of manufacturers existed as to Bath metal being made best from Derbyshire calamine; this opinion he combated, maintaining the superiority of the Flintshire ores of zinc, and also the consideration that the freight to Swansea, which he held was the proper place to erect the brass house of the new Company, was cheaper than the freight from Mendip, in Derbyshire. So minute was he in his enquiries, that he names the cost of carriage per ton from Holywell to Swansea into Bristol as from 11*s.* to 12*s.* per ton; and the price of the ore as from £4 4*s.* to £4 10*s.* per ton. He thought the Holywell ore of better quality, and, as a precautionary measure, had settled a correspondence with a man who used to buy for the old company, who could procure any quantity. He brought home, on his return, specimens of the ore for trial, and put himself to some trouble to get a sight of Mr. Hind's brass furnace, but failed in the attempt; on this head he remarked, "ignorance and mystery always accompany each other." He would have built a furnace at the Soho to test the various kinds of calamine and their fitness for making brass but for the pressure of his own business, for he justly maintained that if the quality of the brass produced by the new Company was not good, "contracts ever so favourable would be fruitless."

At this stage of progress in the formation of the Company a hitch occurred; large consumers of brass were disappointed by being excluded from participation in the new Company, and Boulton began to fear that another Company would be formed, and joined to one already established, the operations of which the new Company was intended to control. He used all his eloquence to induce the latter to extend their share list, but in vain, the base of the new Company he said, if they extended it, would thereby be rendered solider and sounder. A meeting was held to consider the possibility of extension, but Boulton's well-meant intentions were defeated; shareholders came and brought with them proxies of others absent, "and the very men who, a few days before, were struggling to emancipate themselves from their oppressors,

changed their note; a bonus of £5 per share had been offered, they would not consent to have the concern extended, or the number of shares increased." Fothergill, the partner of Boulton, wanted only four shares, but even this the shareholders would not agree to, and, as was remarked by Boulton, "Congress-like, after obtaining power, they showed a disposition to exercise it to their own advantage only."

A few days after this extraordinary display, with the unpleasant effects still upon his mind, we find Boulton still aiding in the work, and in a letter to a shareholder (Mr. Capper), instructing him how to proceed in getting a good manager, not an ornamental appendage, but a thoroughly practical man, one who knew his work and would do it, of good character, intelligent, and well up in the metallurgy of copper and the making of brass. He was to find security, workmen and coals, with every other expense; the copper and calamine alone to be found by the Company, the remuneration of the manager to be paid by a royalty of between £5 and £6 per ton for every ton of brass produced. He further gives the proportions that for every two tons of copper and three tons of prepared calamine he should be required to return three tons of brass. By adopting these suggestions, says Boulton, "the Company will be placed on a certainty as regards expense, will have no clerks to pay, will be exempt from frauds, thieves, and all other risks." He would not object to teach such manager the way to make best Bath brass, but would object to teach two hundred workmen; he had hoped the Company would retract their rash decision at the last meeting, and "will yet act according to common sense;" he dissuaded shareholders who held his views from selling out. In the selection of a place to erect the new brass-house, he differed from the majority; and held that Swansea, and not Birmingham, was the proper locality—this he had arrived at from calculations made by himself and from other considerations, among which were, that the moment the foundation was laid in Birmingham of a brass-house, he would consider that the game they were playing against the other brass Companies was lost, smelters in copper would sell brass without profit for the sake of selling the copper it contained, they would thereby be getting money, while the new Company were losing; whereas, if their works were erected at Swansea, in the middle of the copper works, a less dead weight of stock copper would be required to be sustained, and, more important still, if the copper purchased was not of the proper quality, it could be more readily exchanged

than if the works were 100 miles asunder; "without good and pure copper it is impossible to make good brass," therefore it was better to correct any error of the kind soon than late. Coals were cheaper in Wales than in Birmingham, and any improvements in the manufacture of brass which might be discovered in practice could be more readily preserved by the Company than they could be in the town wherein it was intended to consume the brass made. Boulton had also an abhorrence of the interference of shareholders dressed up in a little brief authority; anticipating this, he writes, "if the works are erected in Birmingham, the work will be constantly deranged by the interference of 100 blockheads, and, instead of being assisted, will be incommoded by every subscriber that chooses to take an idle walk by ye banks of ye canal." Various letters to friends show how bitterly Boulton felt the ingratitude of those he had joined at their earnest request to help; this, added to his increasing business and responsibilities, eventually induced him to withdraw from all active participation in the Company he had so earnestly and at so much self-sacrifice aided, and by personal exertions assisted. On the 21st of May, 1781, he tendered his resignation in a manly and business-like letter, which is here given, nearly in extenso; in it he justly asserts himself, and by doing so, shows the Company what a valuable colleague they had lost; the resignation was merited by the Company—it was worthy of Matthew Boulton. The letter is as follows:—

In his view the Company had not been conducted on the liberal and laudable principle professed, the hope of carrying out which had induced him to join it. The original shareholders had rapidly closed the subscription list, and excluded from participation persons and firms who would have been large and excellent customers. The premium of £5 per share which they had asked for, and in cases obtained, outweighed with them the public interest, and the prosperity of the trade. The monopolising principle that this Company was instituted to counteract, now infected the new establishment, as much as it had done any of the old ones. "I thought it incompatible with the original motion, and I caused a general meeting to be held in order to rectify the complaint; but the decision of that meeting was against me." Mr. Boulton further held to the opinion he had often urged on the committee, that Wales was preferable to Birmingham as a situation for the new Company's works; and he says, "I could make as good, or even better, Bath metal brass in Wales than is now

made in Birmingham, and that without Staffordshire coal, or Derbyshire calamine. I have given you reasons why I should prefer Wales to Birmingham, and I have still other reasons not necessary to mention, as it is not likely you will be biased by anything more that I can say; I therefore decline further argument, or any dispute on the subject. You have followed your judgment, reason, and knowledge, the lights which ought to guide us, and I trust to your candour to allow me to do the same."

The Company had by this time determined to erect their works at Birmingham, and Mr. Boulton had learned that Mr. Capper, one of the shareholders, had retired in consequence—he alludes to the retirement, and says, "I do not presume to dictate, but offer my opinion, based upon some knowledge of the copper, brass, and spelter trades. I was anxious to serve the concern, had taken some pains in forming a plan for the establishment of the New Brass and Spelter Company, have made many essays and metallurgical experiments in seeking out the most notable calamine mines, and getting the necessary information; I have endeavoured to make the plan as diffusive as possible throughout ye neighbouring manufacturers, by extending ye subscriptions; but in vain. I have been made use of, but my advice has been rejected, and I stand single in my opinion. From these reflections, and from the consideration of my own business, which is of importance to myself, and a greater load than I can well sustain, I am induced to follow my own judgment, and Mr. Capper's example, by retiring. Whatever expenses may have been incurred, I am willing to pay my share." This terminated Boulton's public connection with the new Brass and Spelter Company.

The works were ultimately erected by the side of "ye canal," in Broad Street, Birmingham—"Brass House Passage," and the building in front now converted into the offices of the Birmingham Water Company indicates their site. Corpulent tunnels, or tapering chimneys were reared behind, under each of which were two furnaces, which with their complement of eight small and one king pot in each, aided the Birmingham brassfounders in their resistance to the oppression of the "monopolist" metal dealers, and helped them to their supplies of ingot metal. Hutton says, "on the starting of these works, the price of brass, on the part of the metal dealers, was reduced from £84 to £56 per ton." Whether that fall or the reduction in the price of

metallic zinc with increased facilities for procuring it, or the production of brass by the direct mixture of metallic copper and metallic zinc, gradually sapped the foundation of the old brass houses, "or the derangement of the work by the interference of one hundred blockheads" hindered its success, it is difficult to say; but when every brassfounder became his own brassmaker, the beginning of the end of the old method of brass making was not far distant.

In the year 1831, the Brasshouse alluded to became the property of the late Thomas Pemberton, Esq., Warstone Lane, who continued to make calamine brass there till within the last fifteen years. The building and land on which the Brasshouse stood in the year 1865 was sold to the Birmingham Water Works Company, and in consequence of the necessary alterations required, the last of the six stout, square, tapering chimneys was demolished on the 27th January, 1866. With the operation of this Brasshouse the manufacture of calamine brass terminated in Birmingham; the Brasshouse at Smethwick, which is still standing, having some years previously been diverted from its original intention, and changed into a steel converting house.

Birmingham, which has gained so much celebrity as the seat of liberal principles, whether as regards politics or trade, some three-quarters of a century ago exhibited another phase. In 1783 there existed in it an incipient Chamber of Commerce, designated by the euphonious title of "The Standing General Commercial Committee for the purpose of watching over and conducting the public interests of the town and neighbourhood," and the said Committee engaged in *opposing* a Bill then introduced into Parliament to allow of the free Exportation of Brass. They alleged that such Bill, if passed, might be of the greatest prejudice to the trade and manufactures of the town, and its environs; and, on the 15th July, 1783, we find the Committee of the S. G. C. presenting its grateful thanks to many noblemen and gentlemen who had generously and effectually supported in Parliament the trade of the town, by opposing the passing of the Bill. Some light is thrown on this proceeding by reference to an old Parliamentary Register, wherein we find that on the 17th June, 1783, a Mr. Birkdale, M.P., moved the second reading of the said Bill, which was met by an amendment, moved by Sir Robert Lawley, and seconded by Sir G. S. Shuckburgh (then both representatives of divisions of Warwickshire), that it be read that day three months: the reading was carried by a majority

of 22. Mr. Birkdale stated that the passing of the Bill was a necessity, as "hundreds of thousands of pounds paid lay idle, which merchants had expended on the purchase of brass;" in all probability, however, the "Standing Committee" felt justified in opposing the "Brass Masters' Bill" (as it was called) on account of their arbitrary proceedings in the year 1780, which has already been recorded. At a meeting of the S. G. C. Committee already named, held Oct. 8, 1784, we find the Chairman laying before the meeting the startling intelligence showing that, after the 1st November of the year named, the Emperor of Austria had prohibited the entry and the public sale in his dominions of many English manufactures; and he produced the copy of a letter from Vienna, proposing to one eminent manufacturer in this town to bring his people and settle in that country. This incident is introduced in order to contrast the past and present policies in trade matters, as it must be fresh in the memories of our readers that, by the exertions of the present Birmingham Chamber of Commerce, our manufactures are now admitted, or about to be admitted, into Austria, under a comparatively favourable tariff, with the ultimate prospect of a yet lower, or any duty to be paid being finally abolished. "The thoughts of men are widen'd with the process of the suns;" Conservatism in manufactures may be essential in their early stages, or as nations are emerging from a state of semi-barbarism into that of manufacturing communities, to receive from other countries their oppressed and persecuted artisans, and to succour and encourage these is noble, just, and right; and in doing so England has had her reward. (Of course the intention of the predecessors of Austria's Emperor, who holds sunny Italy in his iron grasp, was neither noble nor philanthropic). To the Lollards and the artisans of the States groaning under the iron rule of the Duke of Alva, we owe our manufactures in silk, wool, and glass; to the wise and enlightened policy of Queen Elizabeth, by granting privileges to Christopher Shutz, can be traced our present prosperous Brass trade, whether locally or nationally; the abolition of the fiscal duties on glass raised it into a mighty and gigantic industry, and when the labours of Richard Cobden culminated in Sir Robert Peel giving to this nation "untaxed bread," the days of Conservatism in trade and manufactures, so far as this country is concerned, were at an end.

As one fact is more important than pages of argument, it may be stated that on the Bill allowing the exportation of

brass being passed in the year 1799, the quantity exported amounted to 77,033 cwt., or 3,851 tons 13 cwt.; its value at £154 13s. 4d. per ton, or £7 14s. 8d. per cwt., reached the sum of £595,728 15s. 5d. In the year 1864, when brass was very much lower in price, the value of brass articles and yellow metal sheathing exported, amounted to £3,313,406 ! !

SOURCES OF SUPPLY OF THE RAW MATERIALS USED IN THE FORMATION OF BRASS, AS COPPER, ZINC, OR SPELTER, AS IT IS CALLED.—TIN, USED IN THE COMPOSITION OF BELLS, BRONZE, OR GUN METAL.

The sources of the supplies of Copper in this country are the mines of Cornwall and Devon, North Wales, Isle of Man, and Ireland. From these, the greatest quantity is furnished by the Devon and Cornwall mines, which amounts to about three-fourths of this country's produce of Copper; the remaining fourth is received from the other mines already named, the average produce of the mines of the United Kingdom for twelve years being nearly 16,650 tons per annum, the lowest production being in 1865, amounting to 13,000 tons, the highest being in 1856, when it reached 24,257 tons. The home supplies, are totally inadequate to supply the English demand for copper, the quantity required for use in Birmingham alone amounting to nearly 20,000 tons. The estimated consumption of copper over the world at the present time is said to be 90,000 tons, of which England is said to consume or require 60,000 tons; of this is exported in a raw and manufactured condition 37,000 tons, leaving 23,000 tons for home consumption. Of the 90,000 tons consumed in the world in 1865, Chili furnished to England in 1865 48,372 tons. It is curious to remark that whereas the imports from that country in 1854 amounted only to 15,797 tons, in 1865 they rose to 48,372 tons. The supply from North America, which, in 1856, was little more than 4,000 tons, rose in 1861 and 1862 to 7,500 tons; but in 1865 it fell to 5,300 tons. California, a new source of supply, sent last year (1865) 4,500 tons, and there were imports of copper from the Cape of Good Hope, though these, at present, are small; it is satisfactory to learn that there is a prospect of its ultimately

helping the supply. Australia contributes its quota from the celebrated Burra Burra Mine to the extent of between 5,000 and 6,000 tons. Occasionally, small parcels are received from Russia and Siberia. From these countries, however, not much is to be expected, as the developing industry of Russia will absorb its production of copper. What effect the new commercial relations with Japan may have on the supply it is difficult to determine at present, but it is known that large and abundant mines of copper of excellent quality exist in that country.

The fluctuations in the price of copper are by no means a subject which may be overlooked on the present occasion, and there are reasons for supposing that on all occasions of advances these are not justifiable on the ground of deficient supplies; of this the recent operations in the copper trade, consequent on the declaration of war between Spain and Chili, are an example. From the 17th October, 1865, to the 15th November, copper was advanced £30 per ton, or from £86 per ton to £116; but in the face of the declaration of war, singular to relate, it has fallen, by one reduction of £10 and four reductions of £5, down to the original price from which it started, or to £86; the why and because is unveiled. It was *not* the demand for copper on the part of consumers, but the speculative spirit which induced the advance, the fall was a consequence of consumers holding good stocks of the metal, which, by their caution and foresight, they had purchased at a low rate; the bane and antidote is therefore before us. There are three separate elements in the copper trade—the miner, the smelter, and the broker or metal dealer; these do not on all occasions work harmoniously together. A fourth element will be recognised in the speculator, who frequently over-speculates. The smelter must sell, and therefore not unfrequently becomes the opponent of the speculator. To these causes, more frequently than the supply in the copper market, are the varying prices of copper to be attributed. In order to show the rise and fall of that metal, a table is appended, extending over a number of years, which embraces the average prices at which it has been sold from 1800 to 1865. Were it possible to compare the produce or supply in the market with the prices at which copper has been sold, a confirmation of the effect of speculation would undoubtedly be arrived at.

AVERAGE PRICES OF TOUGH CAKE COPPER PER TON IN EACH YEAR FROM 1800 TO 1865.

	£	s.	d.		£	s.	d.		£	s.	d.
1800	133	3	6	1829	109	14	0	1851	83	18	4
1801	117	8	0	1830	114	4	0	1852	95	0	0
1802	110	18	0	1834	106	11	0	1853	115	10	0
1804	136	5	0	1835				1854	126	0	0
1806	138	5	0	1840	93	0	0	1855	126	0	0
1808	100	7	0	1841	96	10	0	1856	119	0	0
1810	132	5	0	1842	88	11	0	1857	124	0	0
1812	111	0	0	1843	80	15	0	1858	108	0	0
1814	130	12	0	1844	83	2	11	1859	108	0	0
1816	98	13	0	1845	86	1	8	1860	105	0	0
1818	134	15	0	1846	90	10	0	1861	99	0	0
1820	113	15	0	1847	95	0	0	1862	97	0	0
1822	104	0	0	1848	84	18	0	1863	94	0	0
1824	110	0	0	1849	81	14	2	1864	101	0	0
1826	123	3	0	1850	84	2	11	1865	92	0	0
1828	112	7	0								

By reference to the above table it will be seen that the maximum of the price of copper was reached in 1806, when it realised £138 5*s.* per ton as an average throughout that year; in the months of March and April, 1853, it was nominally held at £145; of sixteen years, from 1840 to 1855 inclusive, the highest price reached was £135; and the lowest in 1843, when it was sold at £77 per ton. In the sixteen years beginning 1850 and terminating 1865, the highest average price was in the years 1854 and 1855, when it stood at £126; its lowest in 1851, at £83 18*s.* 4*d.* Copper, it is said, is £19 per ton below the average of the last sixteen years; but it is admitted that at £86 per ton smelters have a fair profit. Diminishing supplies are alleged, consequent on the Chilian war, the decreasing production of the mines of the United Kingdom, which has fallen from 24,257 tons in 1856 to 13,000 tons in 1865, and the Burra Burra Mine supply, from 7,500 in 1861 to 1862 to 5,300 tons in 1865. That mineral veins do work out is a fact known and patent to all metallurgists, as, for example, the Pary's Mine, in Anglesea, stated by a writer at the latter end of the 17th century to have a bed of ore forty feet thick, still worked; the Ecton Mine, in Staffordshire, is another illustration; it is not now worked; but as throughout all nature there reigns a law of compensation, if supply ceases in one direction it is compensated for by the discoveries of greater supplies in another, and thus the increasing copper trade of this country was provided for by supplies from Chili. The operation of the war there may for a short time interfere with these supplies, but there is no evidence that leads us to believe that

the power of these mines to produce copper has at all diminished. Gold mining has alone drawn the labour from the Australian mines; we may look for supplies from Lake Superior; California gives evidence of its being a copper producing locality; the indications of copper from the Cape of Good Hope are cheering; and there is no reason to suppose that one-tenth part of the copper-producing localities in the world are yet known. That energy which has hitherto operated, and which is shown by the fact that, whereas the produce of the Cornish mines from 1726 to 1735 amounted only to 64,800 tons of ore, in the same period of time from 1846 to 1855, the quantity rose to 1,622,152 tons, the value of which was £9,251,916, while that of the former was only £473,000. The introduction of improved pumping machinery to drain the mines, consequent on the improvement of the steam engine by James Watt, an improved knowledge of metallurgy, the overcoming a prejudice on the part of miners against working for "yellows," abandoning the workings when these presented themselves, the re-working of imperfectly reduced copper "scoriæ" or "slag" all contributed to the result last named. We undervalue the bounty of nature, and the energy and intelligence of our metallurgists—the latter enlarged by the operation of the teachings of our Schools of Mines—in supposing that the supply of copper will diminish. Taper and Tadpole, in "Coningsby," wanted a good cry to go to the country with, in their celebrated electioneering crusade; the "speculators" in copper in the Chilian war got a "cry;" failing very singularly in that however, the new cry is, the probability of diminished supplies prospectively. The lesson taught them on the occasion named can be repeated. If speculators will speculate, let consumers keep up their stocks; it may be predicted that there is no reason to fear that the supply of copper will be diminished, even though the increasing consumption of copper is estimated annually at the rate of 8,000 tons. Three qualities of copper are sold, popularly known as Tile, Tough Cake, and Best Selected. The quotations given in the table refer to Tough Cake quality.

ZINC OR SPELTER.

The chief supply of zinc with which to mix the copper and produce brass, up to the year 1758, had been derived from the carbonate of zinc ore, or calamine, as it was called. In that year John Champion, of Bristol, patented the production of

zinc, and the making brass from a stone called "Black Jack," or "brazill" and copper—"Black Jack" being a valuable ore of zinc, which, up to the period named, had been considered worthless, and had been thrown away or used for the purpose of road making or mending. This is probably one of the earliest instances of the recognition of the conversion of waste products, and should act as an incentive to the cultivation of applied science in connection with manufactures. It was matter of complaint among those at an early period interested in metallurgical pursuits in England, that our rich stores of zinc ores were sent out of this country as "ballast into foreign parts, in very great quantities, before it be wrought, so as the best brass beyond seas is made of our stone rather than their own, and the nation is aggrieved thereby," and thus Sir John Pettus, in his "Laws of Art and Nature in Knowing, Judging, Assaying, Fining, Refining, and Inlarging the Bodies of Confined Metals," published in 1683, expresses himself. The chief supplies of zinc appear, at an early period of the brass manufacture, to have been procured from Derbyshire, Flintshire, and Somersetshire ores. In 1796, the calamine raised in Derbyshire amounted to 1,500 tons, but it appears to have been of inferior quality, realising only 40*s.* per ton undressed, and dressed 120*s.* per ton; and was deemed inferior to that of Somersetshire, which realised from 65*s.* to 70*s.* undressed, and dressed 160*s.* per ton. Within the period of sixty years the quantity of zinc or calamine raised in Derbyshire had increased from 40 tons, in 1746, to 1,500, in 1796. If Bishop Watson was correct in his estimate of the Derbyshire returns in 1796, the quantity raised does not seem to have increased, as in 1859 the production was the same, *i.e.*, 1,500 tons. The returns of ores of zinc, given by the School of Mines in 1859, as being raised from English mines, amounted to 13,000 tons; Wales supplying about 5,500 tons; the Isle of Man, 2,500 tons; Cornwall, 2,400 tons; Derbyshire, 1,500 tons; and the remainder being made up by ores mined from Cumberland, Devonshire, and Ireland. The quantity of metallic zinc produced from the quantity of ore we have no account of; but, in 1864, the entire quantity of metallic zinc produced by all the mines in this country amounted only to 4,040 tons, while that consumed per annum in the making of brass in Birmingham alone exceeds 11,000 tons, from whence, then, comes the deficient 7,000 tons? The truth is, that we are indebted to foreign countries for our supplies; the Silesian and Vieille Montagne Companies and other foreign

zinc smelters help us out of our difficulties. Incidentally, it may be remarked, that the metallic zinc used in England was chiefly imported; in 1731, it is said to have been sold at £260 per ton, £13 per cwt., or 2*s.* 4¼*d.* per lb.; also between the years named and 1780 at £74 and £48 per ton; in 1738, Champion, of Bristol, obtained a patent for producing metallic zinc from English ores; up to 1750 he had succeeded in producing 200 tons only; owing to foreign competition, it fell in price; he petitioned for an extension of his patent, "as up to the time named he had been a very great loser." In order to show the price at which metallic zinc has been sold for the last twenty-five years, the average price in each year, from 1840 to 1865, and from 1856 to 1865, is a very near approximate estimated value introduced in the absence of authorised returns :—

AVERAGE PRICES OF METALLIC ZINC PER TON IN EACH YEAR, FROM 1840 TO 1865.

1840	1841	1842	1843	1844
£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
34 8 4	41 13 4	46 6 8	35 5 10	30 5 0
1845	**1846**	**1847**	**1848**	**1849**
£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
30 16 8	29 0 0	27 10 0	22 9 2	21 10 10
1850	**1851**	**1852**	**1853**	**1854**
£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
20 19 2	20 18 4	21 6 8	29 8 4	30 7 6
1855	***1856**	***1857**	***1858**	***1859**
£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
29 12 6	*26 10 0	*33 10 0	*27 10 0	*23 10 0
				***1864**
				£ *s.* *d.*
				*27 0 0
***1860**	***1861**	***1862**	***1863**	***1865**
£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*	£ *s.* *d.*
*23 0 0	*22 0 0	*22 10 0	*21 0 0	*24 10 0

The highest price realised in the twenty-five years, from 1840 to 1865 inclusive, for zinc or spelter, was from November, 1841, to June, 1862, when it brought £49 per ton; and the lowest sales effected were in November, 1850, when it was sold at £19 10s.

Another means of supply of metal for use in the brass-foundry trade of Birmingham is in the return of old metal to be remelted. This consists of old sheathing, bolts and nails,

worn-out locomotive and marine engine tubes, scrap metal collected in the country by hawkers; the filings, turnings, and dirt washings of casting shops, these several items from Birmingham brassfoundry establishments united together, with the old metal named, amount to not less than 8,000 tons. The largest establishments in Birmingham make their own brass; the smaller houses in the trade purchase the old metal revivified with new copper, cast in the form of ingots from metal dealers. Muntz's metal requires a large amount of copper to be added to it in order to bring it up to brass of ordinary quality. As, however, that kind of metal is usually taken back in exchange for new sheathing by the sheathing metal manufacturers, on payment, by the consumer, of a difference for reconverting it into new sheathing, it does not probably form an important supply to brassfounders generally. Locomotive tubes of Alston and Green's mixture contain a greater per centage of copper, approximating to the quality of best brass; they, therefore, are more available when remelted for brassfoundry purposes.

TIN OR BLOCK-TIN.

Though tin, as a metal, is comparatively little used, save in one department of the brassfoundry trade, viz., in bell founding, yet it enters into the composition of "gun metal," or the bronze of which Ordnance fittings are made. It forms a portion of the soft solder now but sparingly used (the less used the better) in "sweating" or attaching together certain parts of gas fittings, portions of stamped brassfoundry, &c., &c. It is occasionally used to mix with lead, to produce a harder metal, to make casting patterns from, when a small number of articles require to be cast, or where the patterns are large to save the value of brass which would be expended thereon. A passing allusion may be made as to the fact that tin appears to have been the means of establishing the earliest commercial relations between this and other countries; and that it was directly the means of producing our now advanced position as a nation, in science, art, and civilisation, may be gathered from the fact that 450 years before the Christian era, Herodotus describes the Tin islands of Britain under the name of the "Cassiterides;" this demonstrates that, as a market for tin, Cornwall was known long prior to the period when the historian wrote; and Diodorus Siculus tells how "the traders purchased the tin of

the natives;" wild fellows they were, with painted bodies, fierce countenances, and shaggy hair. From these the traders from other countries purchased the metallic tin in huge blocks, transported it into Gaul, travelling through which on foot in about 30 days, they carried their purchases on horseback to the mouth of the Rhine, whence it was distributed into the countries of Italy and Germany. It is no stretch of imagination to conceive that in all probability the bronzes of Egypt, Assyria, and Greece owed their enduring properties to English tin, as most assuredly did those of Etruria and Rome; and the metallic mirrors or "pateræ," in which Herculaneum and Pompeian beauties surveyed their charms, owed their brilliant reflective properties to Cornwall tin, which also entered into the composition of the bronze of the numerous Statuettes, Lamps, and Ornaments, disinterred from the ash-covered cities in the vicinity of Mount Vesuvius, which form the chief attractions of the Naples Museum.

To the early purchasers of Tin from other countries, is due the introduction, or production of the composite metal Bronze into England, converted by the aborigines into weapons of warfare, objects of use, ornament, and personal decoration.

It is calculated that in the production of bells, soft solder, bronze and mill bearings, about 200 tons of metallic tin is consumed annually in the brass trade; this is entirely distinct from other quantities consumed in coffin furniture, Britannia metal, medals, and coining, which consume extra about 600 tons annually in this town. The price of Tin is subject to variations like copper and zinc. Between the years 1840 and 1856, both inclusive, the highest or average year was in 1854, when it sold at £121. 18s. 4d., but in the first three months of that year it sold as high as £130. Its lowest limit was in August and October, 1843, when it declined to £60 per ton, and the lowest average throughout the entire year was also in 1843, viz., £62 per ton. In addition to the supply of tin by the Cornish mines, occasional importations of tin ores are received from Bohemia, Saxony, and Malacca, and the richest deposits of the metal known are said to be in the province of Tenasserim, on the east side of the Gulf of Martaban, in the Malayan peninsula; Sumatra, Siberia, and Bolivia have also mines of tin.

The property of tin imparting to copper when mixed therewith various degress of rigidity, up to the extreme limits of brittleness, is one of the curiosities of metallurgy. That two metals, each soft and ductile when apart, united together

in various proportions should produce bronze, rigid, yet tough, calculated to resist, for thousands of years, the ravages of time, atmosphere, and climate, and also be the means of transmitting down to our day the characteristic touches of ancient and mediæval artists; that a larger addition of tin should produce sonorous bells, hard and brittle; and that a further addition should increase the brittleness and add to the brilliant reflective properties of the alloy produced, forming in these latter days, the specula reflectors of the telescopes which Newton, Gregory, Herschel, Rosse, and Adams have directed to the firmament on high, penetrated the ethereal blue, and revealed the appearance of the surface of the sun and moon, and disclosed systems, planets, and stars until then unknown, is matter for wonder; and that two soft metals should produce a hard, is an anomaly curious alike to the initiated and to the tyro in metallurgical art.

THE OLD PROCESS OF BRASS MAKING.

As a new generation has arisen, when brass is not now made as formerly, the two methods of producing it will be here contrasted; the old method being first given, and the process is briefly described as follows:—The furnace used was dome-like in its interior, its bottom perforated with draft holes; round its inner circumference were ranged eight crucibles; in the centre stood a larger "king pot" or crucible; currents of air entered from below through the draft holes. The crucibles were made of fire clay; the charge consisted of calcined calamine ground fine, also of ground coal. These were mixed together, and thereafter levigated with water in the proportion of two gallons to 140lbs. of calamine and ground coal; 100lbs. of calamine and 40lbs. of ground coal, in a granulated state, were then passed through a sieve or riddle; this, in addition to 66lbs. of copper reduced to a state of bean or shot, completed the charge for the furnace named, and was distributed in the nine crucibles; the fuel, about 3cwt. of coal broken down to cubes about three inches square, was reduced by combustion to a coke state, the cinder or coke being carefully poked down between the pots, before the furnace was finally closed. To allow of the fusion of the copper, and interfusion of the calamine with it, ten or twelve hours were required to complete the melting of the charge. The "king pot" was first withdrawn, its contents stirred with

a flat-ended poker; the contents of the surrounding pots were then emptied into the "king pot" and it was replaced in the furnace. After being exposed to the heat of the furnace again, it was, after being skimmed, withdrawn, and its contents emptied into ingot moulds formed of iron. If for sheet metal, these were long and flat; if the metal was for re-melting or casting from, they were of the usual ingot shape. Boulton states, as a proportion for making brass, in his letter to the Directors of the New Birmingham Brass and Spelter Company, that two tons of copper and three tons of prepared calamine should produce three tons of brass; and the brasshouse at Forest Works' calculation, quoted by Dr. Percy, shows that 9cwt. 1qr. 20lbs. of shot copper and 14cwt. 0qr. 16lbs. of calamine produced 14cwt. 0qr. 16lbs. of good brass, and an additional 10lbs. of "skimmings" or "settlings." The copper was estimated to increase 50 per cent. in weight. Watson says, at most of the English brass works 45lbs. of copper and 60lbs. of calamine obtains from 60 to 70lbs. of brass. The German makers obtained from 64lbs. of copper and 46lbs. of calamine and charcoal 90lbs. of brass, and the brass produced was equal in weight to the calamine used. In plain words, the metallic zinc was liberated from the calamine or zinc ore and united with the copper; the product was called Calamine Brass.

Another method of producing sheet brass of very great malleability was accomplished by placing alternate sheets of copper and layers of calamine, and in that position placing them in a suitably constructed muffle; exposure to heat volatised the calamine, which entered into the structure of the copper, and converted them into sheets of brass alike ductile and malleable.

Dr. Percy quotes an instance, in his work on Metallurgy, in which a large firm recently applied to an establishment in Glamorganshire for calamine brass, under the impression that it was superior to the brass produced by direct mixture of metallic copper, and metallic zinc; and, on authority, he gives the experience of a practical brass worker in Birmingham, who positively maintained that he could distinguish the difference between calamine brass, and the brass now made by direct mixture, in the peculiar appearance of its polished surface. If the former is superior, it appears a matter worthy of investigation what property has the calamine in its crude state, which is lost in distillation, or in its conversion into metallic zinc? We are accustomed to consider that all dis-

tilled products are the purest, and hence good copper and pure metallic zinc should produce, at least, equally good if not superior brass to the calamine brass of days gone by. If the latter is superior, surely the advanced metallurgical knowledge of to-day could settle the matter and tell us wherein its superiority consisted?

THE MODERN PROCESS OF BRASS MAKING.

The modern method of brassmaking, by the direct mixture of copper and metallic zinc, and by which brass is now produced, is practised as follows:—The furnace, built with fire-bricks, is ten or twelve inches square, and about twenty-four inches deep—the bottom is formed of iron bars—a space between each is left sufficient to admit of a draft of air. The fuel is coke—that produced in gas-house retorts, and called soft coke, is commonly used in Birmingham. The crucibles are formed of Stourbridge clay. An attempt has recently been made to introduce Plumbago crucibles, but, with the exception of one or two houses in the trade, they have not found favour. The furnace being lighted, the crucibles toasted, so as to deprive them of any moisture, are placed in the furnace, and then packed round with coke—the ingot or tile copper is introduced, when melted the zinc is cautiously dropped in, and its intermixture with the copper facilitated by means of stirring with an iron rod or poker. After remaining a limited period to facilitate the complete mixture of the two metals, the crucible is withdrawn, and its contents poured into ingots, or moulds of sand. It will be understood that, by a series of limited mixings, there may be differences in colour in the articles produced at the different "heats" or pourings, and this, in large houses, is remedied by mixing a considerable quantity of metal, pouring it into ingots, and storing it for future use; the re-melting improving the homogenity of the mixture or brass. It may be remarked, that should the metal be too long exposed to the heat of the furnace, the zinc flies off in the form of minute white flakes; the peculiar light which illumines the interior of a brass casting shop when the pouring operation is going on, is caused by the combustion of the zinc—this causes a loss in the weight of metal produced, and an allowance is therefore made to the casters for loss of metal of from 4lb. to 6lb. per cwt. In thin ornamental castings, where the metal requires to be poured hot, in order to fill all the intricacies of the moulds, the loss is greater than

in heavy castings, when the metal does not require to be run into the moulds at so high a temperature.

Having entered into and discussed the early history of brass, the introduction of its manufacture into England, down to its localisation in Birmingham, noted the sources of supply of the raw material, and contrasted the Old and New processes of Brassmaking, the trade or manufacture as now conducted will be entered upon, and, as far as possible, the introduction of the improvements in manufacture, and the periods when these were introduced, with the rise and progress of the new separate divisions of the manufacture stated down to the present time. The earliest index or guide to the state of the brass trade is to be found in Pearson's Trade Directory of the year 1777; in which will be found only the general divisions, of Brass Founder, Bell and Cock Founder, and Brass Candlestick Maker. There is no doubt but the makers of all kinds of brass articles were designated Brass Founders, without regard to specialties. The divisions which now exist arose from the then manufacturers selecting some specialty which they considered they were most successful in producing, and which paid them best.

The increasing demand for brass articles, consequent on the advancing refinements of the period, the growing wants of society, and the practical application of scientific discovery—as in the introduction of lighting by gas—operated in extending old branches of the manufacture, and in originating new, until it reached the position it now holds as a special local industry with all its various ramifications. In some of the leading establishments of the present day General and Stamped Brassfoundry, the manufacture of Gas Fittings, Metal Rolling, Tube Making, and Wire Drawing are united; in others Cock Founding and the manufacture of Plumbers' Brassfoundry is practised. Cabinet Brass Founders are not unfrequently the manufacturers of General Brassfoundry. Stamped Brass Founders are Cornice Ring Makers, and unite also the production of Cornice Poles, all brass or partially covered. Metal manufacturers, in addition to the production of Sheet Brass, are not unfrequently Tube makers, and produce Brass and Copper Wire. Manufacturers of Yellow Metal Sheathing are producers of Ships' Bolts, Nails, and Brass Wire. Lamp makers of the past half century were also makers of Small Bronzes, or rather Bronzed articles; the original Lamp Manufacturers have been absorbed into or are now engaged in the manufacture of Gas Fittings. The divisions

of the brass trade will, however, be most satisfactorily dealt with as follows, under the heads of—

1. Brass Casters.
2. Cabinet, Bell, and General Brassfoundry.
3. Cock Making and Plumbers' Brassfoundry.
4. Stamped Brassfoundry, Finished and in the Rough.
5. Rolled Brass, Wire, and Sheathing.
6. Tube Making.
7. Lamp Making.
8. Gas Fittings.
9. Naval Brassfoundry.

Two processes involved in, and common to the majority of the departments of the finished brassfoundry manufacture require description, before entering on the consideration of the specialties of each division.

The first, that of Designing, Modelling, and Pattern making; the second, that of Casting; the former necessitating a knowledge of ornament, the power of representing in relief in plastic material the design produced on the paper by the designer, down to the reproduction of certain definite forms of portions of the design of a plain character, as round or square and other shapes, forming connections, the patterns for which can be produced by the lathe, or by means of files or other tools.

The process of Casting involves, on the contrary, no artistic skill, but simply care in ordinary works, and ingenuity in the production of the moulds for what are called "cored" castings, *i.e.*, relief and shadow is produced by undercuttings, as in figures, &c.; with these exceptions, casting is a simple mechanical operation.

The *modus operandi* in each is as follows:—

DESIGNING, MODELLING, AND PATTERN MAKING.

At the foundation of the production of all works of an ornamental kind in brass, lies the design, which should be pure in whatever style, fit for the purpose intended as regards use, and good in construction. In plain words, the ornamentation should grow out of the construction. Weight of metal is an important consideration in the cost of articles to be produced in great numbers, as in the staple brassfoundry of Birmingham. Where no work of an ornamental kind is introduced on an

article, the lathe, vice, and rasp, or file, will in general suffice to accomplish a first model, from which the crude pattern is produced. A cast is taken from the crude pattern, which is carefully turned or filed up, and a permanent pattern is made therefrom, which serves to produce thousands of casts. In patterns of an ornamental kind, the work is necessarily more complicated and difficult; it involves the taste of the Designer, the skill of the Modeller, and the careful and intelligent labour of the Repairer and Chaser. The designer having been put in possession of a knowledge of the article required, its style, dimensions, and the purposes it is destined to serve, proceeds to draw the design on paper of the work intended; if satisfactory, the structural parts of the work are made up, or should be, after which the modeller proceeds to model the ornamental parts, and this he does in plastic material, as wax, or pipe clay. French modellers prefer the latter material, as being more freely and expeditiously worked; the wax, or clay is worked upon with boxwood tools of various forms, and the details of leaves, flowers, and figures are produced thereby. From the wax, or clay model, a cast is taken in either lead or brass—which the "repairer" trims up or corrects—it is then passed into the hands of the "riffler," who carefully goes over all the surface with his small variously-shaped and bent riffles or files; all corrections being made, the chaser imparts texture with his chasing tools, as mattings, the veins of leaves, the centres of flowers, the hair on figures, where introduced, and the other details. All patterns of this kind are made of brass, the metal being hard is better suited to preserve the minute details already named. Such patterns are exceedingly valuable, and the stock of these of an ornamental kind in the pattern rooms of the leading manufactories in the lamp, gas fitting, and ornamental brassfoundry trade, in many instances, in value, may be estimated at from £1,000 to £5,000, the amounts named imperfectly and inadequately represent their value. The cost of a set of patterns for an ordinary wrought, or cast gas pendant or chandelier will reach not less than from £15 to £25, others, more expensive, to £50, and even more. Other patterns cost less, or more, in proportion to the greater or less amount of work introduced. In the production of such patterns, there is a considerable amount of risk, as some objects in the best taste in design are rejected for others more flashy and attractive. It is, however, satisfactory to record that there is evidence of the growth of a refined taste among English purchasers, and that such articles

as show purity of design are more certain of sale now than they were some fifteen or twenty years ago. Designers and modellers realise various salaries or wages, from £2 to £5 per week, and higher according to ability.

A class of artists now exists, unconnected with establishments, who design and model for brassfounders, &c., who do not keep designers or modellers on their premises; the class alluded to receive the instructions of the manufacturer, make the design, and supply the models at a fixed sum. Chasers and repairers realise from 30*s.* to 50*s.* per week. Pattern makers, who prepare the patterns for the caster, and make plain patterns of the connecting portions, produced in the lathe, or by means of file and vice, are well paid—their wages vary from 30*s.* to 60*s.* per week. Good pattern making lies at the root of the successful manufacturing of Brassfoundry of whatever kind.

Following the natural order of the production of articles in brass, the process of Casting will now be briefly described, and the special processes which distinguish the several departments of the trade will be described under their respective sections or divisions.

PROCESS OF CASTING, BRASS CASTERS, AND CASTERS FOR HIRE.

In the various manufactures of the brass trade, after the preparation of the patterns, the most important is that of the caster. Of Brass Casters and Casters for Hire, who may be called Brass Castings Manufacturers, there are not fewer than forty-two in the town (totally independent of manufacturers or manufactories of finished brassfoundry), who practise casting as a separate department of the brass trade. They either supply the castings at so much per hundredweight, if the metal is supplied, or the castings at so much extra, including the price of the metal. The patterns are supplied by the smaller brassfounders, who do not keep casters and who require the castings. The price for casting varies per hundredweight according to the character of the patterns. 1st, from ordinary patterns, which can be readily cast, are easily removed from the sand, and are distinguished by the title of Common Castings; 2nd, from patterns which are called wrought, *i.e*, of an ornamental character, as foliage and scroll work, the mould faced on one side only, the metal of superior quality, the sand impressions or moulds from which are "faced" or dusted with charcoal powder (wood charcoal),

in order to secure detail, and are distinguished as Single-faced Common Fine Castings; 3rd, to castings of a similar kind, but with work on both sides, which requires both halves of the mould to be faced; and 4th, Cored castings, the patterns of which are so undercut as to require a number of what are called "false cores," or pieces of sand built up or made to be easily removed from the mould, in order to get out the pattern, which cores are replaceable thereafter in the mould. This kind of moulding involves skill on the part of the moulder, and its complicated character will be best understood by the examination of an uncleansed cast of a plaster figure where all the markings show the several pieces of the mould not scraped off, and would indicate what are "false cores" in a brass casting.

The operation of Casting and Moulding may be briefly described as follows. The appliances are, a sand trough, free, good, and fine sand, cast iron or wood moulding frames or boxes, fitted together in two parts, moulding boards, clamps to hold the boxes together when closed, furnaces, Stourbridge clay or plumbago crucibles, and ovens to dry cores. The process of moulding consists in filling the first half of the box with sand; when filled, the patterns, if flat, are simply laid on the surface; if circular, they are driven in to half their diameter; dry parting sand is dusted all over the surface of the first half of the box; this is in order to separate the two halves of the box more readily; the upper half of the box is then dropt on, and is held there by dowels. The sand is then filled in and beaten down; a moulding board is placed on the back, the box separated (which is easily done owing to the parting sand); the patterns lifted out, "gets," or connections are formed, by cutting away the sand and connecting these with the appertures of the box provided for the introduction of the metal. The mould is then dusted over with "bean" flour, dried when necessary, the two parts or halves of the box closed together, and held in that position by clamps; the melted metal is poured in, and a perfect copy of the original pattern or model is produced. In fine casting, the mould is dusted over with "loam" or fine sand, thereafter with wood charcoal powder; it is then placed over the pattern again and beaten; the fine sand and charcoal powder copies sharply all the detail of chasing and minute markings in the pattern. Cored casting is a more complicated operation, as it will be readily understood that where draperies with their folds and undercuttings are introduced, on the attempted removal of

the pattern or model, the portions of sand which fill these would be torn away; this must be dealt with and prevented. In order to avoid the breaking away of the sand, the moulder has to form small pieces of sand into portions or cores, which he can remove; a great number of "false cores" have to be made in some castings. These, as has already been stated, require to be so formed that they can be removed before the model is withdrawn, and require to be replaced before closing the mould or box. As the looseness of any one of these "cores" would spoil the casting, the cores require great skill in formation and placing. Moulding from an ordinary process is in this kind of moulding elevated into the confines of art, and is consequently an expensive operation; thus, while common castings, metal included, at present can be purchased at 11*d.* per lb., single and double-faced castings 1*s.* 3*d.* to 1*s.* 4*d.* per lb., cored castings cannot be had for less than from 2*s.* 6*d.* to 3*s.* per lb., and then not of the most complicated character; but the extra cost of "core" castings is more than compensated for by the shadows produced from the undercuttings, and the artistic character in consequence imparted to the work, if the model has been artistically executed. The metal used for articles of common brassfoundry is of an inferior kind, made from various kinds of scrap brass collected, re-melted, and poured into ingots. A higher class of metal for better class articles is made from copper, two parts; zinc, one part. The best work is produced from a mixture of three parts copper and one of zinc. The rich red metal of which best gas fittings and other works of an ornamental character have been made recently, contains a greater proportion of copper of "best selected" quality in proportion to the zinc. A very small proportion of lead improves brass for working by turning or filing.

Immense quantities of a species of money, known as "Manillas," were at one time produced in Birmingham by casting. It closely resembled an object figured in Knight's Pictorial England (a species of ring money), and was exported to the Spanish settlements on the New and Old Calabar, and the Bonny Rivers in Africa. In addition to that produced in this town, it was largely manufactured by the Bristol house of Harfords, and by the Cheadle Company, and was cast of a metal composed of copper, with a very large proportion of lead as an alloy, and hardened by arsenic. In an evil hour, however, a very sharp trader, not a little unscrupulous, animated by the desire to get speedily rich, conceived the brilliant

idea of producing these objects in cast iron, and coppering them over by the electro deposit process. On their arrival at their destination the deception was at once detected, the "Manilla" rejected, and they now lie bulked up by the side of the African river where they were disembarked, are "taboo" to the Africans, and remain a standing monument, not to the honour and probity of the exporter by whom they were sent out. This gave the quietus to the manufacture of "Manilla" money in Birmingham until very recently, when the manufacture has been recommenced by Mr. Thomas Horne, in consequence of orders received for limited quantities. Once taken in, however, the "darkies" were not to be done a second time; with the order came the sable "mint master" of the tribe, who examined every example, rejecting those which were not satisfactory. No mean idea of the quick perception of these semi-savages will be gathered from the fact, that a few examples, slightly different in composition (which a Birmingham man would have passed over), and which, externally, formed no contrast to the bulk accepted, were at once thrown to one side, with an expressive "Ugh!" from the examiner. "Manillas," after being cast, were simply "shaken" in a revolving barrel, in order to remove the sand from the exterior, and to give an approximate degree of brightness, by a process generally adopted to brighten iron chain. Two other kinds of cast money were also made in the town, the destination of which was not clearly known; the one called "Cock Money," from the figure of a chanticleer being introduced on one side; the other a coin also with a square hole in the centre, and with Chinese characters surrounding it.

The specialties which distinguish the several divisions of the brassfoundry manufacture will now be discussed.

2.—CABINET, BELL, AND GENERAL BRASSFOUNDRY.

The manufactures of Cabinet, Bell, and general Brassfoundry, in the larger houses engaged in the production of brass work of the varieties named, are frequently produced unitedly in one establishment. Cabinet brassfoundry embraces the manufacture of all such articles in brass as are used by cabinet makers and carpenters in works executed by them. These articles may be indicated by the following condensed enumeration:—Castors, hinges, bolts, table fastenings, latches, handles of all kinds, door knobs and knockers, hat and coat hooks, pulleys of various kinds, blind mountings, blind racks,

sash lifts, window fastenings, tassel and Venetian blind hooks, picture rings, sconces, lamp, gun, and other hooks, and an infinitude of articles in use for furniture and carpentry purposes made of brass.

In Bell Furniture Brassfoundry all appliances are included which are used in bell hangings, as levers, slides, quadrants, sunk, push, and other pulls, to give motion to the wires, and communicate with the bells; also common cranks, which drive into the wall with spikes, and others of a more expensive character on plates to suit internal and external angles; also mortise, pillar, wheel and chain, and spring purchase cranks. The latter varieties were more in fashion when the descending ribbon or rope was used, when the wires were seen, than now, when they are concealed in tubes inserted in the wall. The bell carriages to which the bells are fitted are made, and all the etceteras used in bell hanging, with the exception of the wire and tubes already named, which it is not the province of this department of the trade to produce.

General Brassfoundry may be said to embrace all articles in brass not included in the above, nor in the other departments of the trade to be hereafter treated of. The articles which may properly be enumerated as forming the staple articles of general brassfoundry, are railings of various kinds, as those for desks, balustrades for staircases, picture and hat rods, screen poles, banner arms, fireguards, window guards, window fittings for drapery purposes, and other articles of a special kind, made in small quantities, and for special purposes. The production of the latter class of work involves the employment of a better class of workmen.

As it is believed that the manufacture of articles of cabinet brassfoundry lay at the root of the brass trade in Birmingham, a glance will be taken at a few of the leading improvements therein. It may be affirmed that all articles produced at an early period of the introduction of the manufacture were much more substantial and heavier than they now are, and the patterns of a less ornamental character. Competition has reduced the prices, improved the external appearance, but, as a consequence, has rendered them, as a rule, less able to resist ordinary wear and tear. The tendency, however, is now towards articles of a better kind, if we except such as are supplied for the "slaughter" furniture trade of London. In lock furniture, shutter latches, and cupboard turns, the knobs of these were originally cast. They are now, and have been for upwards of forty years, raised from flat discs of sheet metal

the conversion from a flat disc of metal being effected by means of raising tools worked in a press, which gradually renders the flat disc more convex, until it reaches the knob-like form. The partially formed knob is then placed in a tool in connection with the cast neck, round which a groove has been turned. The action of the press and tool compresses the metal of the partially formed knob into the groove of the cast neck, when it is complete and ready to be finished in the ordinary way. Recently, some excellent cast ornamental door knobs have been introduced of a very substantial kind since the taste for china and glass mortise furniture has sensibly declined.

The adaptation of China in connection with brass, to the purposes named, appears to have been introduced in 1844, by Harcourt Brothers; the china was procured from manufacturers of china and earthenware in the Potteries, and mounted by the brassfounders. This mounting suggested various ingenious methods for adapting and securing the knobs to the spindles, and regulating them to the thickness of doors—which, up to the period of the introduction of the china knobs, appears to have been but little thought of, or attended to. The application of china as Roses and Knobs to Bell Levers, followed as a consequence. It was then applied to form the terminal knobs or ornaments of Hat and Coat Hooks, and for various purposes for which it was, and was *not* fitted. So great appeared the demand for china fittings in connection with brass, that one firm in the cabinet brassfoundry trade (Messrs. Whitehouse) started the manufacture of china and earthenware in this town with special reference to articles of the class named; (in all probability the china bowl or wheeled castor, invented by J. B. Geithner, and popularly known as Cope and Collinson's, was suggested in consequence of the general use of china in brassfoundry). Glass, for the purposes named, *i.e.*, door fittings and bell fittings, never reached the demand of china and earthenware—this arose, in all probability, from its cost and difficulty in mounting it.

With the more general extension of the process of tube-drawing and solid stair rod making, the manufacture of coat and hat hooks, considerably changed from being cast, and are now chiefly made of tube, or their stems, if straight, were formed of iron, with brass cover, or of the same material as ordinary cased stair rods. When of bent or curved form, the tube is easily converted into the approved shape; and the ease with which tube, whether plain, twisted, or ornamental,

can now be procured, gives the articles in connection with ornamental back-plates and knobs a very much more attractive character as regards appearance, while they may be said to be equally useful, always providing that the tube is not too light, and the solderings or attachment of the tube to the back-plate are good, while the price is proportionately lower than the former solid-cast articles—some of which, however, are still made, of a more ornamental kind, for the better class of buyers. One leading manufacturer, in his pattern book, has engraved 120 different patterns of hat and coat hooks. Within the last few years, a class of articles has been introduced, viz., portable wardrobe hooks or yokes, which have deservedly commanded a large sale; they are used, as the name indicates, for the suspension of dresses in wardrobes, or against the walls of dressing-rooms, &c.—the frames of these are chiefly made of tube, plain or ornamental; the arms which project when in use, are cast, and terminate with china or ornamental cast brass knobs. Very attractive long-grip door handles are also produced by the introduction of ornamental tube, associated with ornamental cast back-plates. Various ingenious mechanical arrangements have also been applied to blind mountings, for attachment to rollers of wood; but in point of cheapness, without reference to durability, the roller blind mounting of Loach and Clarke, made out of sheet metal, with iron pins to move in the brackets, rivetted in, commanded a very large sale; and the principle of the wedge, as applied to rack pulleys, introduced by the same manufacturers, was recognised on its introduction by an equally extensive demand.

In this article of rack pulleys, a considerable amount of small inventive skill has been expended. The moveable frame or carriage into which the pulley for the cord is fitted, has been worked in a variety of ways, in order to tighten the cord. It has been held by springs, moving down a straight ratchet or rack on each side; it has been attached to a strip of metal, and passed through a staple and held in its place by a thumb-screw; it has been mounted on a frame, which was raised and depressed by turning the knob or button attached to a screw, as it revolved, the carriage with the pulley being moved up and down the screw; the pulley has been worked by being attached to a rod, which worked in a cylinder, containing a spiral spring, and operated on the piston-like arrangement to which the pulley was attached, intended to keep the cord of the blind tense. While there were various methods of

production tried, up to the year 1823 all were cast. In that year, Mr. Thomas Horne, sen., patented a method of making rack pulleys from sheet metal – on which the ratchet teeth were rolled in, or indented, in the process of rolling the metal. In this variety, the teeth were placed in the centre of the back, and one spring only was required to be attached to the back of the pulley carriage; then followed a host of rack pullies, produced by stamping, in 1844; the production of certain parts of rack pulleys, by means of the draw bench, being introduced by the Messrs. Harcourts.

A very clever application of ball and socket, to looking glass movements, was made by J. B. Geithner; it has the merit of working smoothly, and has quite taken the place of screw pins, which strip and refuse just when they are wanted to retain the glass at the desired angle; this arrangement has been applied extensively and successfully to other purposes.

The making of castors for furniture purposes absorbs a considerable amount of labour in the cabinet brassfoundry trade; formerly, these were of a more obtrusive character than they now are. In the old days of pillar and claw tables and curved out sofa legs, castors were prominent objects and decorations of the pieces of furniture in which they were introduced. As, however, fashions change in furniture as in other things, this form of castor has gone out, and even representations of them have been withdrawn from the pattern books of cabinet brassfounders, with one or two exceptions, as leading articles of manufacture. The sockets of the castors named projected out horizontally; ornamental examples of this form of castor represented lions' paws, Corinthian leafage, &c., &c.; in others, they simply bore the moulding, worked on the wood of the claw, and served as its termination; the horn and bowl worked below.

Of the ordinary round or now rarely asked for square socket castor, the former, particularly, are still made in large quantities. The present taste, however, in best furniture is to conceal the castors as much as possible, and hence a demand arose for Cabriollete castors, which are attached to the leg of the piece of furniture by means of a long screw; pivot and plate castors are also manufactured in large quantities. All the three varieties of castors last-named admit of concealment to a greater extent than the more securely fixed socket varieties. If there has been ingenuity practised in other departments of the Cabinet Brassfoundry trade, this specialty is no exception, and the various ingenious devices attempted

in order to diminish friction and secure easy motion, have been numberless. The "pons asinorum" of the castor trade has been to invent a castor, the moving or bearing point of which is directly under the point of pressure. In order to secure this, spherical balls have been tried, to facilitate the easy moving of these spheres or balls, friction wheels and smaller balls have been introduced as cushions to help the action or movement of the larger sphere. All such arrangements have, however, resulted in the production of a "stand-still motion" only. In the limbo of unsuccessful patents, there are not a few having for their object ball or perpendicular castors. There would have been more failures, but the construction of the intended ball castor was changed within the six months allowed for specifying. In 1819, Mr. James Harcourt patented an improvement in the construction of castors, which consisted in a sunk chamber, divided from the superior part of the socket, by a diaphragm of brass; in this a flat disc with one small friction wheel was introduced, and, in addition, two small balls; the bottom of the horn was round turned true; when it was in its place it rotated on the balls and friction wheel. There were two claimants for the invention of the first conical pin castor, the one patented it, and the other, in defiance, made, and continued to make it. The improvement reduced the weight of the casting of the arms or horn in which the bowl rotates, and considerably diminished the friction of the horn on the pin attached to the socket. To Mr. Horne is due the introduction of the pivot principle. Mr. David Harcourt, in 1839, invented a castor on the same principle, but with a long pin and socket, which were introduced up the interior of the legs of the furniture on which the castors were fitted; the horn and bowl could be readily withdrawn from the socket named. Then followed Lewty's introduction of an external cast iron covering to the ordinary pin in the horn in which the bowl works; the covering was turned with the socket of the castor in the process of making. The pin head is formed with a round nut-shaped head, which served the purpose of the washer in castors of ordinary construction. On the horn and bowl being placed in the cast iron bearing, the pin is dropped down the centre of the cast iron covering till it projects considerably into the interior of the socket, and is held there by setting down; the extra length of the pin is inserted into the wood, on the exterior of which the socket of the castor is fitted, and improves the attachment to the leg. Castors with double or waggon wheels,

had double sockets, the internal one of which was screwed to the leg, the outer one cast with the horn or arrangement for holding the wheel or bowl in one piece; the external socket moved freely on a pivot attached to the internal socket, and carried with it the horn and wheel. This arrangement was introduced by an engineer named McCalken, about the year 1839. No doubt there are, or may be other mechanical arrangements in castors which have escaped notice. As regards material, it remains to be stated that the wheels or bowls were at first made of discs of leather united together, on an internal bearing of brass drilled through to accommodate the iron pin on which the bowl rotated. Hard wood was also used, and brass bowls associated with brass sockets and horns were the rule, not the exception, until some fifteen years ago, when J. B. Geithner introduced earthenware as a material of which to form the bowls or wheels. These, associated with brass castors, commanded an almost unlimited sale, which will be largely increased, as the period of protection having lapsed, the monopoly is at an end. It remains to be stated that vulcanite has been tried as a material out of which to make bowls or wheels for castors, but abandoned as too expensive. It is more than probable that the new material "Parkesine," the invention of our townsman, Mr. Alexander Parkes, will eventually, no doubt, be pressed into the service of the castor for the same purpose.

In a decorative sense, the growing taste for metal-mounted decorated furniture, consisting of elaborate mouldings, ornamental handles, escutcheons, leafage, and terminations in metal associated with buhl and marqueterie in tables, cabinets, clocks, &c., will operate in raising the character and taste of the buhl cabinet brassfoundry. Some very excellent examples of this "Gouthière"* brass gilt mountings were executed for Messrs. Crace, of London, by Messrs. Cope and Collinson, and exhibited in the Paris Exhibition of 1855.

The demand for sconces of an attractive kind, consequent on the more general study of music (a result of the spread of taste and means of gratifying it), afforded by a reduction in price of musical instruments, as pianos, has largely operated in improving the bald, unattractive, clumsy appliances formerly in use for holding lights to be attached to the instruments named. The result has been recently some very attractive articles of the

* So called to preserve the name of the celebrated French maker of brass mountings for furniture.

kind named, tasteful, neat, elegant and cheap. As regards hinges, they, as a matter of necessity, continue to be produced in immense numbers. Within the last few years, additional varieties have been manufactured of a more expensive character, but cheap in proportion to former examples; made in order to permit of the rising and self-shutting of the door to which these hinges are attached. The more general, almost universal, introduction of bells has considerably diminished the production of door knockers, though they still form an object of manufacture. As regards bell furniture, it is probable that in no sub-division of the cabinet and bellfounder's trade has any of the articles been so much improved as levers, pulls, and other internal metallic fittings, of a decorative kind in connection with bell hanging. An attempt is now made to approximate the style of these to the decoration of the rooms in which they are fixed, and at times with success; even without reference to special examples, ordinary stock articles of the kind are better and more tasteful. Call bells, which formerly were deficient in ornament, have also been improved; they have been placed on ornamental stands, and the pressure of a button releasing the hammer produces sound, while the bell remains in its stationary position on the table. Architecture has not been without its influence in connection with the spread of knowledge of the advantages arising to health by the free admission of pure air, and has resulted in a demand for bolts to close French casements, and also quadrants and stays, to regulate and retain the window open, in the desired position.

The approximation of articles of brassfoundry, formerly of the baldest character imaginable, to those for a similar purpose of an ornamental kind, is a feature of the cabinet brassfoundry of the present day. But while the growth of taste requires ornament, the skill and sleight of modern housebreakers and "area sneaks," require to be met by ingenuity, invention, and substantiality. In this direction, various improvements have been introduced in window and other fastenings made by cabinet brassfounders, with the intention of preventing or rendering as difficult as possible the intention of such uninvited and unwelcome visitors.

As will readily be understood, with the two divisions of the brassfoundry trade already dealt with, General Brassfoundry, in its specialties, has kept pace. A greater desire to render shops attractive externally has largely increased the number of brass sash bars and name-plates made. The desire to display the goods for sale, attractively, has encouraged the production of

handsome brackets to support glass shelves; and of perpendicular rods, with moveable projecting arms, on which to hang drapery articles, or to sustain trays, on which the jeweller displays the products of the goldsmith's labours; or they serve to support the results of the potter's lathe, or those of the Parian statuette artist. Engravings and oil paintings, water-colour drawings, or chromo-lithographs, now hang, not from nails driven into the wall, but are suspended from metal mouldings or picture rods, thereby greatly increasing the demand for these articles. Chains are now used to suspend pictures instead of cords, and an arrangement of strips of metal depending from the rod, and sockets with hooks attached moving in the strips, permits of elevating or lowering the picture, and altering its inclination to the light, or the reverse. This improvement was introduced by Mr. Thomas Pemberton. In public rooms, hat rods with supporting brackets have superseded the old coat and hat hook arrangement, and hollow stair mouldings, and ornamental tube rods of a massive and decorated character, have taken the place of the former solid iron rod, cased with brass of so meagre looking and poverty stricken an appearance. The introduction of the Penny Postage by Rowland Hill operated on this branch of trade materially—how it did so is strange, but true. Immediately on its coming into effect, came the demand for letter weighing machines, which were made in immense quantities, and letter box plates were introduced, made, and continue to be made, in very considerable numbers. The revived art of needlework, or embroidery, by which queens and ladies of the olden time wiled away the time in the absence of their lords, engaged in the sterner pursuits of war at home or abroad, has not been without its influence in the production of tasteful fire-screen banner stands, and banner arms to attach to mantelpieces, from which to suspend embroidered banners, worked by skilful and delicate fingers. The production of these has recently been very large. Even female fashion, on the introduction of irrepressible crinoline, aided the general brassfounder: for with crinoline came the necessity for protecting the steel-distended and expanded skirts, in which girl, maid, matron, and widow were, and still are attired, from the dangers arising from fire. The number of fire-guards of a superior class produced in consequence, on a moderate calculation, numbered upwards of 20,000. One manufacturer produced 4,500. These guards varied in price, from 15*s.* up to £3 each, and therefore formed no mean addition to the return of these

manufacturers. The number given is independent of other and cheaper articles of the kind produced by wireworkers in iron and brass wire.

In the processes of manufacture in connection with Cabinet, Bell, and General brassfoundry, there has been little change, so far as regards manipulation, with the exception of the application of steam power to the turning of the lathes. One establishment only, that of Messrs. W. Tonks and Son, has used a machine invented and patented by Mr. Thomas Potts, but improved upon by them, for "floating" tube. The machine is automatic in its operation; the tube to be floated is attached to the horizontal bed; the floats, of which there are five, move parallel and longitudinally in their action; they each pass a little way into the space previously floated, but the juncture is perfect, and free from the peculiar indications, which marks the stroke of the "float" where it joins, when the tube is "floated" by hand labour. The tube operated upon is turned also by the machine, and exposes a new portion of surface to be operated upon, until it is floated in its entire length. It is singular to think that of the millions of feet of tube in a straight form, as picture, hat, stair, and other rods, with finished tube, "for cutting to length," and tube cornice poles sent out annually, that until within the last ten years it was floated, and still is, with the exception named, by manual labour only. That workmen exist who have spent their lives in an operation, which realises Monsieur Mantallini's idea of the "demd horrid grind," the genuflexions of a bowing dervish, or those of a "pit sawyer," is, in this age of invention and progress, matter for wonder and remark.

The curiosities and oddities of the manufactures form one of the topics to which the attention of the writers of these reports on Local Industries is directed. The examples which follow are, it is thought, worthy of record. While the bodies of the rulers of Egypt—the Pharoahs, Ptolemies, and Cheops—reposed in huge sarcophagi of stone or granite, and the great ones of Greece in those formed of marble, storied over with incidents in their lives cut by the sculptors of that period; and graceful urns, produced in the clay of the potter, accommodated the ashes of the dead Etruscan; in more recent times coffins of lead, oak, mahogany, and other woods have been used for our dead, down to elm or blackened deal, which forms the parish case, or box to contain the body of the "pauper whom nobody owns." Now modern invention has also given us coffins of glass, of iron, and of zinc, and even in-

serted in the last, plates of glass directly over the countenance, in order to enable friends to survey the ravages of the destroyer on the visage of the silent tenant; but none of the materials named were grand enough to form the mortuary chests destined to contain the remains of two palm oil potentates, who ruled, or rule, on the South Coast of Africa, and bore, or still bear, the euphonious titles of "King I Am," and "Egbo Jack." They desired their coffins to be made of brass; they were then alive, and wanted to see them before they were permanently used. Of brass the coffins were accordingly made; each coffin was 6ft. 10in. in length, 3ft. in depth, and 2ft. 3in. wide at the widest part. The whole was polished, lacquered, and richly decorated with cast ornaments, and had substantial handles. A shield with emblazonings surmounted the lid of each; but the most singular feature which marked these objects was the introduction of four padlocks in and on each, two of which were attached to the interior, and two to the exterior. The interior padlocks had their hasps, and could only be locked from the inside. Report stated that the coffins during life were intended to serve the purpose of an oratory, or private cell, into which the proprietor retired for devotional purposes, locking himself in during his spiritual exercises; each coffin weighed 600 pounds. A more prosaic reading of their use will be found, it is thought, in their owners using them as receptacles for their treasure during life, and after death to be buried in the coffin with it, as is the custom in that country of Gold Dust, Elephants' Tusks, Palm Oil, and Vegetable Gums.

It would have been satisfactory to have been able to have instituted a comparison as to the reduction in price of articles of Cabinet Brassfoundry and Bell Furniture made at a former period with the same class of articles produced now; this, however, is scarcely possible. While gross prices in the old suites of patterns remain the same, discounts have been changed, and new suites have been introduced or substituted, in some cases the articles are lighter, in others the same articles have been improved upon in external appearance.

In General Brassfoundry a like conclusion is arrived at: better and more attractive work is now produced, and sold at a comparatively moderate rate. The difference in cost now does not entirely consist in the weight of the article being diminished: division of labour, and competition, have united to produce the reduction in price.

In these united sections of the brassfoundry trade treated of it is assumed that at least one-third of the workmen employed in the brass trade are engaged. There exist two modes of payment of wages. Men who head shops and pay their assistants by the piece—such men realise from 35*s.* to 50*s.* per week at best work; good workmen, paid by the week, average from 25*s.* to 30*s.*; secondary workmen, according to ability, from 15*s.* to 25*s.* Juvenile labour can accomplish a good deal in the preparatory operations, and useful lads get from 7*s.* 6*d.* to 10*s.*; boys from 3*s.* 6*d.* to 7*s.* Female labour is but little taken advantage of in these departments, and is confined to lacquering and wrapping up only. Good lacquerers realise 10*s.* per week; inferior 8*s.*; and girls 3*s.* to 5*s.* per week; wrappers-up, 8*s.* to 10*s.*

3.—COCK FOUNDING, PLUMBERS', AND ENGINEERING BRASSFOUNDRY.

The manufacture of the first-named class of articles appears in the earliest directories, 1773, as a distinct and separate branch of the brassfoundry trade; but in the year 1780 we find six cock founders named, who appear to have specially directed their attention to the production of this universally useful form of metal work. In all probability the manufacture of taps is identified with the introduction of the brass trade into the town, and formed among the earliest examples of its productions in the metal named; though it must be admitted that the metal out of which these were produced, until recently, could scarce be called brass, its composition being as follows:—

	lbs.
Copper	6
Lead	7
Turnings or filings of cocks in process of finish	10
Old cocks	7
Tin	1
	31

This composition was designated "pot metal," a superior quality of which was used when the necessity for hot water cocks in order to supply the demand for kitchen boilers, and the modern luxury of baths were introduced. The metal of which these were made was composed of—

	lbs.
Copper	2
Lead	1
Tin	1
	4

The more general application of steam has not been without an influence in the cock trade, the immense pressure it exerts calling for a special metal to resist its pressure, the heat also is another element which calls for a change in the composition of metal, of which the cocks used for steam are made. On the same authority as has been already quoted, the metal of which steam cocks are at present made is composed of a "bronze" or "gun metal," consisting of—

	lbs.	oz.
Copper	14	0
Brass	4	0
Tin	0	14
	18 $\frac{14}{16}$	lbs.

While, however, the old "pot metal" is occasionally used for low-priced articles for export purposes, cold liquids, &c., it is stated, though the quantity produced has not sensibly diminished, the demand for cocks of a superior quality of metal consequent on the introduction of water into towns, has proportionably increased; these are known in the trade as "yellow metal cocks," and are composed of—

	lbs.
Copper	28
Zinc	7
Lead	7
Tin	1
	43

The appearance of "pot metal" cocks when first cast is by no means attractive, in the common examples they exhibit a leaden coloured exterior, and if the metal has not been properly mixed, and a union of its component parts effected in the melting, globules of lead may be detected on the surface. The pattern making for the manufacture of cocks involves no small degree of skill and knowledge, and the making of the core boxes, by which the entire barrel of the cocks is cast hollow for the passage of the fluid, and for the plug, involves very great nicety of workmanship in order that the requisite thickness of metal may be preserved throughout. Into the core, supports of thin wire are introduced in order to strengthen the sand of which the "core" is made. The mould being made as in other kinds of brass casting, the core is laid in the spaces indicated by "prints" in the model, or casting pattern, and the space left between the core and im-

pression of the pattern is taken possession of by the fluid metal, when the moulding box is closed and the metal is poured in. Several of the varieties of cocks, as regards form adapted for special purposes, are of a very complicated character, and the patterns for these and core boxes are correspondingly complicated. In their primitive form cocks were constructed on the simplest principle, viz., with a plug, which allowed the liquid to pass through an aperture in it when presented to the orifice of the barrel, the keys or plugs were held in by being rivetted, after fitting sufficiently tight to keep the plug in its place, and to permit of its being turned easily round by its cross head. It will at once be understood that by this arrangement any internal obstruction could not be removed which would interfere with the action of the tap; as grit, which cuts the plug, and renders the working imperfect, resulting in the escape of the liquid the tap was intended to conserve. It was therefore a very great improvement when the screw and washer took the place of the old rivetted mode of securing the plug, as the plug could be readily withdrawn for examination. The washers, from a simple perforated disc with square hole in the centre, assumed, in the hands of some manufacturers, that of a helical spring, the pressure of which was regulated by a screw also. Others mortising the bottom of the key introduced a "cotter" pin; the "cotter" also was increased in its action by a screw. Springs were also introduced in a variety of cocks designated "lock cocks," specially devised with the intention of preventing the surreptitious abstraction of the liquor. In this variety a key, which could be withdrawn, and which fitted on to a corresponding piece of metal projecting from or into an aperture, sank into the upper end of the plug. The plug was protected from being tampered with by being covered with a cup, the aperture on the top of which was cut into a form to permit of the introduction of the portable key with which the plug was turned, and egress of the liquor procured. In this variety the spring was introduced on the upper surface of the plug, and, consequently, pressed it down into the barrel. In some examples the taper of the plug was reversed, its thickest part being at the bottom of the barrel, and it was forced up into its seat by a thick screw, which fitted into an internal thread cut in the bottom of the barrel, the friction of the key plug being regulated by a thick plug screw.

A what was called "Syphon" construction was then introduced; this consisted in perforating the plug at right angles,

so as to permit of the escape of the fluid from the bottom of the plug, the projecting curved end, from which the liquor is drawn in the common examples, by this arrangement being entirely dispensed with. In the cocks hitherto named, the material was entirely metal, the key or plug worked against metal, but an innovation took place; a cork chamber, ferrule, or lining, was introduced in the interior of the barrel, formed of metal externally, and in this cork ferrule the metal plug worked, the elastic nature of cork adapting itself to the unyielding nature of the metal of which the plug was composed. The other constructions of cocks refer chiefly to what may be called "screw down," and those in which the apertures are closed by valve-formed stoppers, operated upon by screws, to which motion is given by turning the cross-head of the external key, and thereby operating upon and pressing down the conical-formed piece of metal which stops the passage for the water. Diaphragm cocks are now also largely made in Birmingham, since the expiration of Lambert's patent, which may be said to have been the most successful and most universally adopted new construction over all others.* In that variety of cock the aperture is closed by vulcanised Indian rubber, operated upon by a screw which is attached to a diaphragm or elastic disc of rubber held round its upper and under outer circumference between brass flanges by four brass screws; on turning the external cross head, the screw brings up along with it the central portion of the rubber disc, elevating and raising it from its bearing, opening thereby the passage for the fluid, or in moving the screw by turning the key in the reverse direction the disc is pressed down, and the orifice closed to prevent the escape of the fluid, and stop the passage.

Any further attempt to describe the minute distinctions or difference in the construction of the articles treated of, without the aid of woodcuts, would simply confuse; suffice it to say, that in this as in other sections of the brass trades there have been numerous patents taken out involving a greater or less amount of mechanical ingenuity; withal, however, no great attempt has been made to change the mode of manufacture from "manual production" to that by which the same class of objects can be partially if not entirely produced by machinery. The "tighted" department of the trade, *i.e.*, that wherein

* The introduction of the cork barrel cock is attributable to Martineau and Rudder, and to the first named the patent globe cork, with half cork plug; also an improved shaped syphon cock. "The screw-down variety of cocks were introduced by Guest and Chrimes, of Rotherham, and the India rubber diaphragm cock by Lambert's, of London and Walsall."

metal "plugs" are fitted and tighted into metal "barrels." So far as regards the artisans engaged therein, the majority still support their special "trades union" as members of which they do not encourage the introduction of any new appliances to aid them in their labours; probably the increase of the "screwed down" element may induce them to listen to reason, and cause them to abandon a combination which depends for its very existence on the retention of the present crude methods of working. The baneful effect of unions has never been more forcibly shown than in that of the file makers of Sheffield. Ignoring the steadily improving character of file-cutting machinery they struck—the result has been rendered painfully apparent and costly to the workmen.*

One thing is certain, that the first manufacturer who takes advantage of ingeniously constructed machinery for the production of "tighted" taps, &c., as is now done in the manufacture of the component parts of gas fittings, before him must the union, or any combination fall. The total number of workmen engaged in the manufacture of "tighted" taps, or cocks, may be estimated as reaching nearly 300; of these 160 may be calculated as belonging to the union.

It is not possible to estimate correctly the number employed in the "screwed down" manufacture.

The designations of the various kinds of cocks made are as follow:—Patent Globe, Syphon, Range, Bottling, Racking, Beer machine, Wine, Spirit, Bib, Ball Valve, and Cannon ended; large examples for distillery boilers, and other purposes. To these, chiefly used for the purposes named, may now be added, produced in gun metal, for Engineering purposes Lubricating Cups for machinery, Grease Cups and Taps, Steam stop cocks, Steam whistles, and Steam gauges, to be attached to boilers. The manufacture of these has been added to the trade of the manufacturers of cocks within a few years, and is consequent on the large increase in demand for machinery, hot water and steam heating apparatus, and a growing recognition of the importance of the division of labour, the engineers finding out that it is more economical to buy such taps, &c., than manufacture them by their

* The Sheffield correspondent of the *Leeds Mercury* says:—The result is an unconditional surrender on the part of the men. The pecuniary loss in the struggle has been immense. The unions have incurred a vast amount of debt, and it is calculated that there has been a loss of £70,000 or £80,000 in wages alone. The masters have suffered heavily, and several of the weaker firms have got into the *Gazette;* but the triumph of the masters, as a body, has been complete. It should be added that machines have already been erected, and with their aid the masters hope to be able to retain the pre-eminence that Sheffield has hitherto enjoyed in the file trade.—*Daily Post*, June 19th, 1866.

own workmen, the very change of tools for one object to be produced materially adding to its cost; and practice in the making of taps enables even the tap workmen of Birmingham, with their simple and crude tools, to make the articles at a cheaper rate than they can be made by engineers on their own premises. Cock making is a good illustration of cheapening consequent on the division of labour, or rather expedition arrived at by confining the manipulation to one particular object or class of objects. The production of taps, or valves, to resist the force of steam successfully necessitates superior and skilful workmanship—the bearings of the plug perfect throughout the entire length of barrel. In a tap exposed only to the weight of a fluid, as the water, beer, &c., in a cask, the plug may only be a comparative fit, and, well doctored with tallow or wax, may not at first show its defects; try the same tap on a water pipe, with the ordinary pressure used in water works, or place it on a steam pipe, its defects are rendered apparent in an instant, and the difference between good and bad work is speedily revealed. In the same manner steam valves require to be well seated, and every portion of the two surfaces of the valve and seat should be in the closest possible contact. The certainty and ease with which a valve cock can be closed, and the valve held *in situ*, has within the last few years increased the demand for this form of cock.

The intention, in alluding to the particulars last introduced, is to show that the importance of really good work involves good and expert workmen, who are paid much better wages than those of the same class are in other departments of the brassfoundry trade.

An intelligent manufacturer in the cock-founding trade states the wages of workmen who make best articles as from 42*s.* to 45*s.* per week, after paying his assistants and helps. It is probable that in no department of the brass trade has there been less change in tools and appliances for working than in that which attention has now been directed to. The old process of boring-out is retained, the square steel borer and wood splint operated upon by a "dwang," the borer pressed down by a perpendicular pressure screw; even the oldest form of lathe known—that of the pole lathe, is still used in cock barrel finishing. As, though very old, its very existence may be new to our readers, a description of it is introduced:—It consists of a pretty stiff, springy ash pole, six or seven feet in length; one end of it is fastened to the ceiling or beam; the other end is

left free; to the free end is attached a gut band; a maundril, or arbour of wood, works on two centres, between wooden supports. Round the end of the arbour the band is wound, and its extremity is connected with the treddle. The cock barrel to be part turned is passed on to the arbour; the workman applies his foot to the treddle, and, by long practice, gives the arbour such an amount of revolution as exposes just so much of the barrel of the cock as requires to be turned to the action of the tool; in this manner all the barrel is turned that can be; the remainder is finished by filing. The "jiggle," "jiggle" action of the machine is ludicrous, and suggests, could not modern machine making ingenuity invent a substitute? be this, however, as it may, the production of cocks of common forms or kinds, will ultimately be by Machinery.

Why the manufacture of Cocks and Bells should be allied together, and produced in the same establishment appears difficult to explain, as does also the union of Bells and Candlesticks. In all probability, however, the production of bells filled up the spare time of the caster engaged. The connection between Cockfounding and Plumbers' Brassfoundry seems more natural, and as such readily accounts for the manufacture of the last-named in connection with the former.

Plumbers' brassfoundry includes among its productions the manufacture of the smaller kinds of Hydraulic Machines, as Lifting and Forcing Pumps, Garden Engines, Beer Engines, Fire Engine Couplings, Washers and Wastes, Washers and Plugs for Washhand Basins, Valves of various kinds for Cisterns, and other purposes, as Baths &c., &c.

The more general recognition of Sanitary principles, their adoption and incorporation in the legislative enactments connected with the health of towns, have materially operated in increasing the united trade of the cock and plumbers' brassfounder, and given it an impetus and an importance commensurate with the benefits resulting from the introduction of measures calculated to improve the health of communities where plentiful supplies of pure water and a comparatively perfect system of drainage have been introduced, and have taken the place of vicarious or limited supplies and imperfect systems of drainage, equivalent to no system at all.

4.—STAMPED BRASSFOUNDRY, FINISHED AND IN THE ROUGH, PIERCING, CORNICE POLE, AND RING MAKING, ETC.

The writer was led to identify the introduction of this division of the brass trade with the period of the introduction of the manufacture of coffin furniture into Birmingham; on investigation he finds his conjectures confirmed. The germ of the stamped brassfoundry is not due to local talent, but is the invention of John Pickering, of London, a jeweller, or gilt toy maker, who, on March 7th, 1769, patented "a new method of performing that kind of work called chasing, for gold, silver, brass, tin, and other metals, but more especially to be used in the production of coffin furniture; also ornaments for coaches, chariots, cabinet brass work, and domestic furniture." The stamp is described as with two upright rods, a falling hammer to which "the force" is attached, the position which the "die" occupies on the bed of the stamp, and how it is held; and the inventor winds up his description by modestly saying "that thereby work is executed in a much more expeditious manner, and far superior in beauty and elegance to anything of the kind (not being actual chasing) ever yet performed by any other method." A few months thereafter, on August 7, 1769, we find a Richard Ford, of Birmingham, adopting stamping as a means of raising scales, sauce, and warming-pans, basins, and kettles. In 1777 the invention of the London jeweller or toy maker had evidently reached Birmingham, and some clever patent agent of the day drew a patent for John Marston, a brassfounder, and Samuel Bellamy, a die sinker, both of Birmingham, patenting the stamping *(not of brass)* but of rolled gilt and plated metals, into hat and cloak pins, all kinds of figures, decorations, ornaments, and other devices for cabinet and lock furniture, with the introduction of colours into the same. The colours were introduced behind perforations. Metallic foils were occasionally used, *i.e.*, such as are still employed by jewellers to place behind the settings of stones to enhance and give depth to their brilliancy and colour. The lacquer used is stated to have been made from gum sandrach dissolved in spirits of wine. Articles not plated or gilt might be left of the natural colour of the metal, and lacquered with a varnish composed of seed lac dissolved in spirits of wine coloured with annatto. The initiated will have no difficulty in recognising in the patents of Pickering, Ford, Marston, and Bellamy the germ of the present Stamped Brassfoundry trade, as it now exists and is practised.

For the information of nonpractical readers, it will be proper to state that stamped brassfoundry differs from cast, in so far that its raw material is sheet brass, produced by rolling cast ingots or strips of Brass into thin sheets in the manner hereafter to be described under the head of metal rolling, &c.

That the introduction of Stamped Brassfoundry was regarded as something very important may be gathered by reference to a work published in Birmingham, in the year 1780. It is amusing in these days, when every newspaper has its critic of art and manufactures, to observe the laudatory strain in which the then writer announces the introduction of the new process in the Brassfoundry Trade. After alluding to the prejudice which existed in favour of "town made articles," *i.e.*, London made—he says, "though artists of unrivalled excellence exist in London, every Londoner is not an artist, and they did not carry everything to the perfection of which it was capable," a striking example of which will be found by the comparison he makes as to the superiority of the stamped brasswork produced in Birmingham. These consisted, even at that early period, of mouldings for rooms, furniture ornaments, girandoles, picture and looking glass frames, and he proceeds to say that "the old process of casting is utterly laid aside and a more cheap and expeditious method is substituted. Artists of inventive minds and unwearied application have called in the aid of dies, presses, and stamps, and one man can, in the same space of time, produce what, on the old principle, would have required ten to perform, and by this improvement beauty and elegance may be obtained without incurring the enormous expense which has hitherto accompanied them."

Two firms appear to have monopolised the stamped brassfoundry demand of the period, 1783, viz., Jones and Barker, and Gee and Eginton, who represent themselves as manufacturers "of coffin furniture, in best white metal, silvered on Britannia metal; looking glasses and pictures in gilt metal, or burnished gold frames, bordering, and ornaments for rooms, in stamped paper or gilt metal." The firm who more particularly achieved success in this department of the brass trade was that known as Yates, Hamper, and Co., now extinct. The writer of this paper had in his possession, until recently, a curious pattern book of the house named. The designs, though of the semi-classic period then fashionable, indicated aspiration after a better style of ornament. He has also recently examined examples of the works themselves; though dimmed in lustre after the lapse of sixty-five years' exposure to the

atmosphere, the impression of the die (though the dies were shallow) was sharp and well brought up, and the finish, where the lacquer was not removed, would amply justify the opinion of the critic alluded to, *i.e.*, "that many of the articles, particularly the picture frames, were so richly gilt that they pass with very good judges for burnished gold."

Increased familiarity arising from the practice of the stamping process led to bolder attempts to produce ornament in greater relief. The dies from which the articles were stamped were sunk deeper, as experience was gained that by annealing the ductility of the metal was restored. Many articles then made in stamped metal are now but seldom asked for, and have almost ceased to be represented in the pattern books of stamped brassfounders, as for example, Curtain, Hat, Cloak, and Looking-glass Pins, Bed Caps, Drawer Knobs, Handles, the shields of which were stamped and represented lion heads, &c., &c., grasping rings of tube; lion and bird claws, grasping balls of sheet metal, used as feet for tea caddies and workboxes; Key-Hole Escutcheons, Bell Pulls, with stamped ornament to attach to the ribbons, used to ring bells, before levers were introduced, and upholstery decorations of a now obsolete kind; but while the articles named have fallen before change of fashion, they have been more than compensated for by an immense demand for articles in another direction for uses in trade undreamt of by early manufacturers of stamped brassfoundry. Finger plates, at first cast some 40 years ago, began to be stamped; they then realised 30*s.* per dozen. The first stamped finger plate was made by Mr. Thomas Horne. A similar article is now sold at 12*s.* per dozen. Cornice pole ends, originally carved in wood and gilt, began to be made of cast brass; eventually they were and are now stamped, the pattern selected for the first experiment being a cast brass example of the knob or projecting-out kind, made by Messrs. Abercombie, brassfounders, of Soho Street, London. The first departure from the form named is due also to Mr. Thomas Horne, who designed and introduced an end which returned, and displayed a rosette, blossom, or flower in front. To the same manufacturer is due the introduction of the drop or pendant end, brought out in 1844, which may be said to have been the great hit in the cornice end manufacture. "The Fuchsia," on its earliest introduction, from its novelty, attracted attention, and the demand for it for some time almost exceeded the means of supply. The inventor, however, had had the good fortune to register

his design; the result was other manufacturers who had slightly altered the design and gone into the market as competitors were compelled to acknowledge their obligations by payment of a royalty. 16,000 pairs of this Cornice end were made by the inventor during the five years his registration lasted; since then, at least double the number have been made. The idea once suggested of a pendant end, it has been the progenitor of a host of Grape, Plumb, Apple, Filbert, Rose, Chesnut, and other ends, which hang from the ends of cornice poles and form their terminations.

Glass in the form of blossoms, fruit, leaves, &c., associated with stamped brassfoundry, and introduced by the writer of this in the year 1846, marks another era in the stamped brass-Foundry Trade. As in the case already alluded to, the demand at first for cornice ends and curtain bands of the Lily and Fuchsia pattern, (the lily and fuchsia flowers being of opal or other coloured glass, the leaves of metal,) was with difficulty supplied. In the space of 14 years, to which the patent extended, the sale reached upwards of 90,000 pairs.

Change of fashion obliterated the old method of sustaining the drapery window curtains, by means of what were called Curtain Pins, and Curtain Bands took their place; these, on their first introduction, were made of sheet metal about $\frac{1}{8}$ of an inch thick by $2\frac{1}{2}$ or 3 inches wide, or were cast; if of sheet metal, they were ornamented by "milling" or "cording" tools, *i.e.*, small circular tools, which revolve on a pin, the external diameter of which tool or roller bore an impression or design. The tool, when held or pressed against the revolving metal in the lathe, communicated to the metal the counterpart impression. The metal was soldered on to a hoop and turned on a chuck in the lathe, the milling tool applied and held against the hoop until the desired impression was produced, the hoop was then sawn open, the milled strip bent into form, and thereafter dipped, burnished, and lacquered, &c. This, of course, was too good an opportunity to be lost. An article to serve the same purpose was produced by stamping, very much lighter and cheaper, which, in the end, drove the cast heavy sheet metal varieties out of the field. The sale of these articles (curtain bands) still continues, though now somewhat limited by recent changes in taste, and the substitution of cords and tassels. Novelty rather than good taste would seem to have presided over the design of the ornamentation of many of these curtain bands. While some of the designs have been chaste and elegant, the majority have bee

just the reverse; as for example—(and novelty would seem to have operated in no small degree some years ago)—during the agitation of the movement for the purchase of Shakespere's House, at Stratford-on-Avon, a manufacturer introduced curtain bands and cornice ends *en suite*, the ends a swan, *i.e.*, that of Avon, from the beak of which dangled a portrait of Shakespere in stamped brass; the curtain band had a medallion portrait of the dramatist introduced, surmounted by the bird already named. The rage for "polking" also resulted in a Polka Curtain Band.

Some thirty or thirty-five years ago, Window Cornices, till then formed of wood carved and then gilt, or of wood structurally, and compo ornament superficially, also gilt, begun to be made of thin stamped sheet brass, were effective, and possessed the advantage of being readily restored by cleansing and relacquering at a much cheaper rate than their former representatives could be gilt. The trade in these grew, and was very considerable, until it received a check by extensive importations of French and Prussian examples, the style and beauty of which even the most ardent sticklers in favour of English brass cornices must admit; the colour is remarkably fine, the burnishing exceedingly brilliant, even on the tinselly metal from which they are made, while the lacquer or varnish with which they are protected from oxidation or tarnish is extremely transparent, but does not stand so well as English lacquer. In several of the examples imported, there is an opportunity for comparison as to price, arising from the patterns of Birmingham manufacturers having been copied either by cast iron dies, produced by casting from the originals, or by having dies sunk from them in steel. Admitting that in strength of material the balance was in favour of the original articles of Birmingham manufacture, still there was such a marked difference of price in favour of those of continental production as to be startling, and led to the enquiry if these could be sold by a retailer at the prices marked, at what price were they produced by the manufacturers at Paris and Isherlon? While every attempt to deteriorate the substantial character of English manufactures is to be deplored, in this age of competition, the importation of foreign metal manufactures must be met.

On the introduction of the Continental Stamped Cornices, there was the usual howl on the part of the local manufacturers; chaos had come again; the trade was done for in England. A little further reflection, however, led to an attempt to try

if the imported examples could not be met by an article of local manufacture equally light and cheap. The effort was made, the result satisfactory, as regards reduction of price. In Birmingham are now produced stamped cornices equally light, and as cheap as those of Prussian manufacture, with the exception that the latter, as regards burnishing, exhibit less "rivelling," in all probability arising from a more careful preparation of the "forces," or internal support, or solid convex copy of the cornice on which the burnishing is effected, and a delicacy and lightness of touch, which distinguishes the manipulation of continental artisans, attributable to vegetable diet, light wine, and very small beer. On the contrary, English beef and beer give muscular force and power, difficult to restrain, and unconsciously demonstrated in opposition to will. The difference lies there; but if the proposition is reversed, it is equally difficult for the continental workman to impart to solid cast work the deep rich burnish recognisable in the kind of work last-named produced by Englishmen. As regards the "dipping" of the foreign examples, while the metal is evidently lighter in colour, apart from the colour of the varnish or lacquer used to protect the metal from oxidation, their surface displays a delightfully uniform, speckless, delicately "dead" effect, in all probability arising from a superior knowledge of chemistry and its practical application. With these exceptions, the English competitive examples are up to the mark, and may fairly take their place side by side. As has been already stated, many of the foreign examples are copies of Birmingham cornice makers' patterns, affording a means of comparison as to price; and it may be instructive to compare Birmingham prices of the year 1856 with the prices of the same articles produced after the introduction of the imported varieties, at the same time contrasting the value of the English against the German, premising, however, that in the last-named comparison the articles of English make were heavier, but by no means of such a weight as to account for the very great and apparent dissimilarity in price between the examples—metal only, no woodwork—price per foot:—

	Birmingham, 1856.		1866.		English.		German.	
	s. d.		s. d.		s. d.		s. d.	
4½-in. Cornice	1 1	...	0 6	... 4½-in.	1 1	...	0 8	per foot.
6-in. „	2 1	...	0 10	... 8-in.	4 4	...	2 4½	„
10-in. „	4 2	...	1 9	... 8½-in.	2 10	...	1 8	„

Manufacturers of finished Stamped Brassfoundry for Upholstery purposes are also makers of Brass Tube Cornice Poles; they are also makers of brass (three-fourths, and half covered on

wood) poles, in which articles an equally great reduction in price has been made as in stamped window cornices. A two-and-a-half inch cornice pole, three-fourths covered, which originally cost 2*s.* 6*d.* a foot in 1840, can now be purchased at considerably less than half that amount. The metal is lighter, but the difference in the value of the metal does not account for the very great reduction in price, thus:—

	2in.	2¼in.	2½in.
	s. *d.*	*s.* *d.*	*s.* *d.*
1840	1 9 ...	2 2 ...	2 6
1866	0 11½ ...	1 1 ...	1 2

The same manufacturers make also Cornice Pole Rings at a great reduction in price from the old prices in the year named.

	2¼in.	2½in.	3in.
	s. *d.*	*s.* *d.*	*s.* *d.*
1840	4 1 ...	5 0 ...	6 0 per doz.
1846	2 10 ...	3 0 ...	3 9 „

The three-fourths covered poles have the metal drawn on by the drawing process, similar to that to be described in tube drawing. A wood core or centre is laid in a strip of brass, rendered concave by passing through rolls. In this state it is taken to the draw-bench, the wood and brass drawn through a tool, the "tange" of the brass and wood being caught by the pliers of the draw-bench, and dragged in its entire length through the tool, the result is, the brass is made to cling to the wood. The brass is thereafter "floated," with floats, *i.e.*, files, with the teeth cut in one direction, the surface scoured with pounded pot, the pole is thereafter burnished with long steel burnishers; lacquering concludes the finish, and completes the pole. All brass poles are finished in the same way; but occasionally they are polished and lacquered. Cornice Pole Rings are made from tube, the ring form is given by winding the tube round an iron mandrill; the entire length of tube forms about one dozen rings. The oil is then sawn through longitudinally, which separates the rings, the joints of which are soldered, and the rings finished by turning and burnishing, the loops for the curtain hook rivetted in, and the rings are thereafter lacquered. Broad or flat rings for the same purpose are made from sheet metal, and raised convex by press tools. Stamped ornamental rings are also made for the same purpose. The first ring of the former variety was made by Mr. Thomas Horne. In making ordinary tube cornice rings, where the tube is made of thin sheet brass, the tube requires to be filled with sand in order to retain its cylindrical form in "winding," and to prevent the appearance of "puckering."

As *Dipping* is the universally adopted method of finish in Stamped Brassfoundry, the process will now be described. In connection with this department of brass manufacture, we have to record a curious incident which revolutionised this style of finish, and has extended itself into all other departments of the the finished brass trade. Previously, the operation of dipping or acid finish consisted in "pickling" the brass in weak acid, and thereafter passing the work through strong-dipping aquafortis, the result was a bright surface. The "dead dipped" process, which gives such a contrast to brilliant burnishing where introduced, arose originally from the negligence of the workman, whose special duty it was to "dip" the article. In the year 1832, a "dipper" in the employ of Mr. David Malins left throughout the night a quantity of articles in the cleansing solution, or pickle; the result was, that on attempting to produce the bright "dip" by immersing or passing the articles through the strong acid, they presented a dull frosted yellow surface or hue; charmed with the effect, certain portions were operated upon with the burnisher, and lacquered. Acting on the accidental hint, "dead dipping" was thus originated, and has now become the recognised and generally practised mode of finish where acid is employed.

The operation of "dipping" is practised as follows:—The shop is, or should be, a well-ventilated, high-roofed apartment, with abundant provision for the escape of the fumes of the acid. It is built round interiorly with brickwork, on which to place the tubs which contain the water to kill the acid, and the "jowls" or earthenware vessels in which the various strengths of acid are contained. There should also be a muffle in which to anneal the work, and a horizontal plate of iron with provision to heat it, in order to keep the box-wood receptacle or sheet-iron pan and its contents at a moderate temperature. This shop should be in connection with a space or yard in which to place the pickle troughs, and there should be ample provision for the supply of clean cold water; if soft water, so much the better; also a set boiler in which to keep hot a supply of ley or alkaline solution, as potash or soda. The materials employed are aquafortis of various strengths, pure water, and argol, *i.e.*, the refuse or sediment of wine casks, or crude tartar in the form of a powder. After annealing, the work is immersed in a weak solution of pickle, to "scale it," or remove the external skin. After rinsing it out, it is brushed with sand, to remove the more firmly adherent scales. Again pickled, if uniformly clean, it is then in a condition to receive

a final finish, if bright dipped; and, if dead dipped, to be subjected to the "deadening" process, which is conducted as follows:—The aquafortis is reduced from its dipping strength by means of water, or a special variety is used and designated by the name of "deadening aqua." A quantity of either the former or latter is poured into a "jowl," or brown earthenware open-mouthed vessel. The articles are placed therein, and the jowl agitated till a creamy coating is observable over their entire surface; they are then removed and washed out in water. After they are cooled and the acid "killed" they are passed through the strong aquafortis, rinsed out in three several tubs of water, and then dried out in warm box-sawdust contained in the sheet-iron pan already alluded to. Any acid which may have accidentally insinuated itself into defects in the work is neutralised by immersion in the "ley" or alkaline solution contained in the boiler. After the articles are dried out they are then plunged into a tub containing pure water, on the surface of which is strewed a small quantity of argol, or tartar. In this condition the workman holds them in his vice, or, if round or globular, places them on the chuck in his lathe.

The operation of dipping is considerably dependent on temperature. It is retarded by cold, and accelerated by a moderate heat; in exceedingly hot weather it is with great difficulty accomplished, and is rarely satisfactory, as the work becomes speckled or irregular in the "deadening." The success of the operation of dipping is greatly dependent on the mixture of the metal, and not a little on the aquafortis, its strength and purity. Up to the present time practice has been the only guide to English "dippers;" the recurrence of certain phenomena they obviate by experience, by rule of thumb or experiment; and these experiments are not on all occasions successful in removing the difficulties which present themselves. Science, to be useful, should deal with the rationale of the operations and processes employed in manufactures; but no scientific work has yet explained the "why and because" which regulates the failure or success of "dead dipping."

To dipping follows burnishing, the process of which will now be described.

Burnishing, which furnishes a contrast to other portions of dead dipped work, is effected by means of steel burnishers, or tools of steel, varying in form according to the nature of the work and surfaces of the portions to be burnished. For ordinary flat work, or tubes and the edges of cast work,

the burnishers are from twelve to fifteen inches long, of oval shape, and tapering to a point. Other varieties of burnishers, as for lathe burnishing, are made with variously formed terminations; others are hooked, and of various breadths and thicknesses; all are blunt, and after being hardened are polished up to the highest degree of brilliancy on the portion used for burnishing. The article to be burnished is held in a vice, if cast; if stamped, it is laid on a "force" or solid metal convex brass or lead cast of the stamped article; this furnishes an internal support to the thin metal, and prevents its sinking under the pressure of the burnisher. The surface to be burnished is operated upon with the steel burnisher, dipped in "ox gall." This lubricates the burnisher, and prevents scratching. The work, when it gets dry, is dipped into the argol water. When the article has been burnished on all the portions intended, it is passed through "sharp water," *i.e.*, water in which a small quantity of acid has been mixed, thereafter it is rinsed out in pure water, and finally dried out in warm box-sawdust; it is then lacquered to protect it from oxidation or tarnish.

As Stamped Brassfoundry is always lacquered, a description of the process of lacquering is here introduced.

Lacquering, or the covering of finished brass work, with transparent varnish to preserve the surface and finish of the articles from ordinary and extraordinary atmospheric and other influences, may be said to complete the manipulatory operations in the manufacture of objects in brass. The lacquering room, in the best regulated manufactories, is a lofty, well-aired apartment, with counters round, on which to lay the finished articles. In it are erected, on brick basements, with cast iron top or plate placed horizontally like an ordinary hot-hearth, one or more stoves. Ordinary cast-iron frames and doors are inserted in front to allow of the introduction of the fuel. A series of flues running under the surface of the iron plate secures the diffusion of heat generally on its upper surface. On this plate are laid the articles to be lacquered. The Lacquer or varnish is composed of spirits of wine, in which has been dissolved seed lac. In appearance it presents that of pale French brandy, verging, where coloured, into that of the brown variety of the spirit already named. Turmeric, dragon's blood, or sandal wood, will impart various shades of colour if dissolved in the mixture of spirits of wine and lac already named. The brass articles having been coated over when cold with the lacquer, are laid on the hot iron plate, and when

sufficiently heated are again coated with lacquer applied with large round camel hair brushes, of sizes varying from five-eight inches to one inch diameter. Delicate and skilful application, and the perfection of lacquering, consist in a uniform coating. Careless lacquering is indicated by smearing or irregular depths of shade, and consequently impaired brilliancy of effect. Too much heat frizzles the lacquer; if too cold the articles will be dull. The spirit of wine is simply a solvent for the gum, and when the lacquer is applied evaporates or flies off, leaving the gum on the surface of the brass, and protects its surface completely for years from ordinary exhalations or other influences. Sea-air, the noxious fumes of chemicals or tobacco, the deposits of flies, damp, &c., however, act upon it, and corrode through the lacquer, impairing its brilliancy and protective properties. The idea that lacquering brightens up brass work, apart from finish, is an error too frequently entertained; unless there is previous finish, lacquer being transparent serves only to render more apparent the existing defects on the surface of the object on which it is applied.

Attempts have been made to introduce steam-heated lacquering plates, or a hollow iron box into which the steam passes. Heat in steam, however, indicates pressure, and no ordinary engine boiler valve could be so loaded as to stand the pressure to get up the required degree of heat equal to that produced by fuel introduced immediately under a cast-iron plate.

Steam has, however, been successfully applied to the lacquering of tubes and other hollow articles as follows:—a steam pipe is conducted from the boiler of the engine connected with the works, this pipe is led into the lacquering room, and placed horizontally about three feet or three feet six inches from the floor. In this horizontal tube is inserted, at regular distances, a number of good, well made gun-metal taps; these are fitted with lever keys, easily removed after the steam has been turned on or off. The taps have tapering ends, which are inserted into the end of the pipe or tube to be lacquered. The opposite end of the tube is supported on a stand, the steam is turned on, passes through the interior of the tube, and speedily heats it to a sufficient temperature for lacquering. The lacquer is then applied as already described. For the purpose of lacquering such articles as have been named, the steam method alluded to has no equal. The heat of the tube, or hollow article to be operated upon, can be increased or diminished at will by simply turning on more, or checking the admission of the steam.

Contrast this with the tedious process of heating a twelve or eighteen feet tube, or hollow cornice pole, on a cast-iron plate. The utmost length which could be properly heated at one time would not extend beyond eighteen inches or two feet. We have thus at least twelve separate heatings; removed from the hot plate the article speedily cools, and we have nine or twelve separate joinings of lacquer; the lacquerer must be careful and skilful indeed who is able to conceal the junctions of the several points of contact. If this is contrasted with the tube regularly heated by steam, the superiority of the steam process will at once be recognised.

STAMPERS IN THE ROUGH, AND FOR HIRE.

Having hitherto dealt chiefly with finished stamped Brassfoundry for sale to upholsterers and decorators, another equally important department of the stamped trade remains to be treated of, viz., the class of articles produced and consumed by manufacturers of cabinet brassfoundry, gas fittings, and brass bedstead makers, who either have not dies or stamps wherewith to produce stampings, or who desire to vary their patterns by the infusion of a little variety, which are supplied by "Manufacturers of Stampings in the Rough." There is yet another section of the stamped trade, viz., that of "Stampers for Hire;" these do not possess dies of their own, though they have all the appliances for stamping. In the latter, the dies and metal are sent by the manufacturer; after the stampings are completed, they are returned with the scrap and dies, the stampings being charged at so much per gross or per dozen. The former class sell their work at so much per gross or dozen, the price of the metal included. In the condition in which the Stampings are sold they are unfinished, being left without the oxide or skin on their surface being removed after annealing, and from the last blow of the stamp. For gas fitting purposes, Balance Weights, Vases, Bodies, Arms or Branches, Ceiling Plates, Chain Links, &c., are produced. These are converted or fitted up into chandeliers, by the manufacturer, workmen adding the structural parts, introducing the tubes which conduct the gas to the burners, and forming the necessary attachment to connect the stampings with the other portions of the chandelier, &c. The article is then taken to pieces and finished by lacquering or bronzing as may be desired. Recently, a considerable improvement has been made in the "stamped rough trade" by manufacturers engaged in it

sinking entire sets of dies to produce chandeliers, &c., *en suite;* formerly they simply produced only incongruous parts, and the consequence was an article in which a mixture of styles was too apparent. Admitting the effect of stamped work never can be compared to good honest casting, in so far as substantiality, and light and shadow, consequent on undercutting, are concerned, still a very near approximation to the effect of cast work may be arrived at by the attachment of leaves, ornaments, or portions of ornaments stamped separately, and soldered with hard solder to the other parts of the stamping it is intended to enrich. The present demand for articles good in form, decorated with ornament in low relief, is favourable to the stamping process, in so far, that while the die in which the article or portion of the article to be stamped is more easily sunk, the stamping of the metal is accomplished with greater facility if attention is paid to the "force," owing to the ease with which the "force" is withdrawn by the stamper after the blow has been struck. The conditions involved in the preparation of a die for stamping, necessitate that it should be so cut or tapered in the work, in order that the metal can be easily withdrawn after it has been struck into the die. If undercut, the metal would be driven into the undercut portion of the die and held there. Every incision or depression in the die must therefore be tapered outwards towards the top of the die, so that if a cast in plaster was taken from the die, the cast would readily drop out on reversing the die. It is the necessity for attending to this condition which lies at the bottom of want of effect in stamped work of all kinds, and makes it contrast so unfavourably with "beaten works," which there is no doubt stamping was intended to imitate.

Within the last few years very large ceiling ornaments, made in brass, have been introduced instead of "plaster," "papier maché," and "compo," for the decoration of centres of ceilings of rooms, &c. These are produced by stamping in separate leaves, and uniting the several portions together. The stamped work produced for bedstead makers consists of vases to surmount the pillars, capitals, and bases, centre husks for pillars, rosettes, and other portions for the decoration of head and foot rails.

The process of stamping will now be briefly described. The mechanical requisites are a stamp formed of a heavy mass of cast iron, which is sunk into the ground. From this, two cast-iron uprights or pillars rise. On the top of these is a transverse piece of metal, with an aperture in the centre, over which

a pulley works. Over this pulley, with a groove in it, a rope works; to one end of the rope is attached a hammer or "ram," which slides between the pillars, which act as guides; the other end of the rope is left free, and is used to raise the hammer. The die is attached to the bed of the stamp and held there by four screws; to the pulling hammer a "force" or convex copy of the die is attached. The piece of sheet metal to be stamped is laid on the die, the hammer is elevated by pulling the rope, it is then allowed to descend; the consequence of the blow is, that the metal assumes the approximate form of the concavity sunk in the die. If the reader imagined that the production of a stamped article was effected by one blow, he would labour under a mistaken impression; even an article in low relief requires seven or eight blows, and a corresponding change of "forces," increasing in convexity and in the amount of detail, until the entire design in the die is brought up. While seven or eight blows have been named, certain articles require as many as twenty or twenty-five blows to bring them up with all the details perfect. If expedited by diminishing the number of blows, the chances are, that the metal operated upon would tear, crack, or "fly," in the process of stamping. In the process, the metal is repeatedly annealed to restore its ductility. The last blows are given from brass "forces," with all the details perfect, the "taking down" being effected by lead, tin, or softer metal forces. If the description given of the process of stamping has been understood, the idea of the difficulty of producing globular articles, as the balance weights of chandeliers and certain varieties of cornice ends, will naturally suggest itself. Such are, however, stamped in two or more parts; the two parts which form an object are then made to fit each other, and bound together with binding wire. Borax and solder being applied, the union is effected by the action of a soldering stove or a hearth, the fire of which is operated upon with bellows, or the gas blow-pipe effects a similar result. The surplus metal and solder is then trimmed off, and the balance weight or portion of the cornice end is in a condition to be passed into the hands of the fitter and finisher.

A recent introduction of improved appliances for the production of large-sized vessels by stamping in metals, as copper, &c., has been made by Mr. Daniel J. Fleetwood, and merits attention. In it the united power of water and steam, &c., is taken advantage of for the production of purely cylindrical forms by the forcing down, or out of the flat discs of metal, cylinders of various depths with flat flanges or

vessels with ornamental mouldings on top and bottom, dish-covers, &c. The upper and lower dies are moveable, the upper operated upon by steam, the lower by the equally irresistible force of hydraulic pressure, and a ring partaking of the character of the external ornamental form of the vessel which is akin to the "force" in ordinary stamping. This steel force is operated upon by a piston-like die, or hammer, which it surrounds annularly, (it is a collar, in fact). The down blow of the piston-like upper die strikes on the surface of this force, which in turn operates on the copper disc, and it gradually impresses on it the contour of the mouldings. No annealings are required, and the advantage is, that the metal of the vessel is formed uniform throughout, and not as in that process in which the disc is held, and the metal drawn, or forced down by pressure, in which case the sides of the vessel must be thinner. In the Fleetwood process, each blow takes in a little more metal, and the metal is drawn in or "swaged down," not forced down, thus preserving a greater thickness on the sides of the vessel than can possibly be done by "the cam" operation method. By the new process, the "dies" or "anvils" can be withdrawn, and the stamping taken out. If two sets of dies are being worked, as they can be, two workmen may be employed, as a clever arrangement of a railway permits of dies being withdrawn, one workman dislodging—withdrawing his die—and taking out the stamping, while the other, having placed his die under the stamp, the operation of stamping is proceeded with, and no time is lost. This method of stamping effectually does away with "repeated" annealings, changing "forces;" and work which could only be produced by a great number of successive operations, and at a great expenditure of time, is now reduced to a minimum as regards time and cost. For large objects, cylindrical in form, with ornamental mouldings on the upper surface, as large cooking vessels for the Turkish army, of which immense quantities have been made in Birmingham; for dish covers, &c., the process is invaluable. The application of two forces to effect one operation is original, viz., the hydraulic force which impels up the lower die, and the pulsative force of steam which operates on the upper die or hammer which strikes the blow on the collar or annular die, and produces, in semi-ornamental work, the mouldings. Of course it will be readily understood this process is confined to the production of such work as has been named.

All stamped articles have surplus metal attached to them after the stamping process has been completed, which is got

rid of, where the number of the articles is not very great, by means of thin chisels. When the stamping is laid in the die, removed from the stamp, where articles are numerous, "clipping tools" are made of the exact contour of the outline of the die, the bed placed in the press and held there, the punch is attached to the screw of the press, the lever gives motion to the screw, causes the punch to descend, and cuts away the surplus metal by one operation.

The process of stamping, when conducted by manual labour alone, is a laborious one, involving in the raising of the "ram" or falling hammer, frequently 112 lbs. or more in weight, the unnecessary expenditure of muscular labour. The application of steam "power" to the process, while it has been taken advantage of by the manufacturers of stamped tea tray blanks, dish covers, and large articles to be electro-plated, by tin-plate workers, and by manufacturers engaged in the production of large copper goods, with one or two exceptions, has not yet been generally adopted by stampers engaged in the production of stamped brass goods. The steam hammer of Nasmyth, with its immense power, capable of such delicate adjustment, certainly furnished the hint; and one manufacturer, Mr. Joseph Hill, of Broad Street, patented a steam hammer with certain improvements which fitted it for brass stamping. One or two other manufacturers have adopted methods by which the "ram" is lifted by belts passing over pulleys attached to a shaft set in motion by steam, but the great majority of the trade continue to use manual labour only. They are slow to recognise the waste of nervous energy and muscular strength in a process which can be better accomplished by the inanimate and untiring power of steam. By retaining the old method of working, they ignore the science of the nineteenth century; this, advancing intelligence repudiates, and humanity deplores. One diligent manufacturer of stamped brassfoundry in the rough informs us that the labour, by the pulley-revolving-by-machinery process, is diminished by one-third; what was done by the stamper and two "pullers" is now done by the "stamper" himself. He elevates the "ram" with ease himself; in another stamp worked by one man, the pull is effected with the use of the arm only. A little prejudice existed on the introduction of the process by the workmen or *stampers*, but this has now been dissipated, and the process is preferred.

In connection with stamping in the rough, that of "Piercing" is also practised. This process consists, in addi-

tion to that of cutting away the surplus metal from the stampings already described, in perforating various apertures n work already stamped, as for example, the border which surrounds an Argand burner, or the coronas which have been recently introduced to surmount shades in connection with terra cotta tops. These perforations are all made by cutting out and "piercing" from sheet metal with "beds" and "punches." In cutting out such coronas, &c., frequently there are several sets of tools and corresponding punches required to produce one pattern. The best and most familiar illustration of the process of "piercing" which can be given is that of the ordinary paraffin burner, *i.e.*, that part of a paraffin lamp which is attached to the receptacle which contains the hydrocarbon oil, and through which the wick rises. Such burners are made entirely out of sheet brass. Each burner requires, in some examples, the operation of thirty-five different pairs of tools to complete it, involving thirty-five distinct changes of tools, and a corresponding number of manipulations. A somewhat similar process was practised in the early days of the manufacture of finger plates, in their transition stage between casting and stamping; and when they were made by casting, before stamping was introduced, they were then perforated; but as brass cast is by no means so solid as brass rolled, the perforations were cut out as described in the process of piercing. As, however, the latter were entirely formed of flat sheet brass, the pattern was produced by a process now but seldom used, viz., that of "book piercing." In this case the bed had the entire design cut in it; to it was attached a thin plate, as the boards of a book; this was also a copy of the "bed." To each of the perforations a piece of steel was fitted, corresponding to the apertures in the beds. The operation was performed thus:—The piece of rolled or sheet metal to form the finger plate was laid on the bed, the perforated cover was dropped over the sheet metal, and the several punches or formed pieces of steel arranged in their corresponding spaces. These punches projected above the surface of the board when arranged. The bed, metal, and cover were placed under a press, the handle turned; the operation of the screw compressed the heads of the punches, forced them through the metal, and the perforations were completed. The same routine followed until the quantity of articles desired were completed. The same method is followed in perforating ornamental strips of metal for letting into wood furniture, for decorative purposes, as that now known as

"buhl work," and associated with tortoise-shell and various kinds of ornamental woodwork. It was also used in fender making, to produce the ornamental perforations which at one period formed their decorative enrichments.

Among the curiosities in stamping and piercing, the writer of this has to record that some years ago he had placed before him for reproduction a number of patterns of head ornaments in brass, made by a native African worker in metal (no doubt cut out at a vast expenditure of time, by means of small chisels, and ornamented by numberless blows from punches), which in a very singular manner confirmed the peculiarity of the ornamentation of savage tribes, so well illustrated in the work of Mr. Owen Jones. The whole of these patterns were decorated on the principle of geometric figures, as circles, squares, and combinations of angles—save one example, in which coral was taken advantage of as a type; but it was conventionalised into a graceful and harmonious arrangement, perfectly balanced and symmetrical. The only surface ornamentation was a series of externally elevated dots punched up from behind, which followed and displayed the lines of the perforations, thereby illustrating the intuitive perception of ornament in the mind of the savage. The complicated and involved forms in the originals, necessitated for their reproduction the making of a large number of cutting-out or press tools. These once made, the process of reproduction was reduced to the minimum of time and cost, the dotting being produced all over the surface by one blow of the stamp, thus furnishing the Banyan importer on the coast of Africa with new examples of decorative enrichments for purposes of sale, or barter, with the natives from the interior, with which the investigations, consequent on the travels of Burton, Speke, Livingstone, and Baker, are daily rendering us more and more familiar.

In the stamping and piercing trade a very considerable amount of female labour is taken advantage of. The tools are fitted into the press by tool makers, who also attend to the condition of the tools in cutting out the larger examples of stamped work from the scrap which surrounds the stampings. Women work even the large presses, leaving to girls the cutting out of smaller examples of work, as chain-links, blanks for rollers, &c. Frequently the cutting out of the large examples alluded to is very laborious, involving a considerable amount of strength, which renders it questionable whether the occupation is one quite in unison with the employment of female labour.

The labour in the stamped trade is performed by stampers, who realise, according to ability, from 20*s.* to 25*s.* Experienced stampers of ability get, by the piece, from 30*s.* to 40*s.* per week; men, who simply raise the ram of the press, 15*s.* to 18*s.* per week; lads, from 7*s.* 6*d.* to 10*s.* per week; boys, who, "cob" the work, brush off the scales, place it together, and do small stampings, 3*s.* 6*d.* to 5*s.* 6*d.* per week; annealers of the work in process of stamping, who attend to the muffle, 15*s.* to 18*s.*; fitters together of the work, to prepare it for dipping, and burnish it, from 20*s.* to 30*s.*; dippers, from 20*s.* to 25*s.*; lacquerers (women), 8*s.* to 10*s.*; girls, from 3*s.* 6*d.* to 5*s.*

In "piercing" and cutting out, where women and girls are generally employed, and where the progress of the work is superintended by a workman or tool maker, he gets from 30*s.* to 40*s.* per week. In addition to making tools, he sharpens and sets the tools in use. Women get from 8*s.* to 12*s.*; advanced girls, 6*s.* to 8*s.*; young girls, 3*s.* 6*d.* to 5*s* 6*d.* As regards the payment of women, some of them take out the work by piece occasionally, and realise more money than is named.

Rolled Metal, Wire, and Tube Making will next engage our attention. In the manufacture, the consumption of raw material, *i.e.*, copper and spelter, is very considerable; the united results form no inconsiderable item in the exports of the United Kingdom, especially as regards yellow metal sheathing.

5.—THE MANUFACTURE OF ROLLED SHEET BRASS, BRASS AND COPPER WIRE.

Sheet brass is the "latten" of the older writers, a term constantly used in archæological treatises. It was in this form that the metal brass was chiefly imported into this country from the continent in early times, and until the manufacture of brass was established in England, and was produced by the Battery Works. Some of the slabs, chiefly for ornamental purposes, especially those imported from the middle of the twelfth century down to the fifteenth, were, however, cast, or cast and hammered, as an examination of them shows. The Chinese still continue to cast their plates, or slabs of thin brass, their patience united to their skill, serving them for the rolling mill of the "barbarians" of the new world. It should be understood, that in order to produce a thin plate of brass, even so thick as $\frac{1}{8}$ or $\frac{1}{4}$ of an inch of say 4 feet by 3 feet, a

surface of sand, or sand mould of such a size could not be expected to stand the requisite pressure, but becomes convex in the middle. The consequence is, that the plate when cast is unequal in thickness, thin in the centre, or the metal becomes congealed owing to its want of body, and the slab or plate when cast is deficient in solidity, in so much that the most skilful hammerman could neither hammer it solid, flat, or equal in thickness. If the difficulty exists in reference to the production of metal of the thickness named, how much is it increased when sheet metal of the lower gauges, some of which is scarcely so thick as ordinary writing paper, is required, as it is for many of the Birmingham trades. It is here the great importance and value of the rolling mill is shown, the "strip caster," and the irresistible power of huge rolls set in motion by the mighty power of steam. Without the rolling mill, the Birmingham brass trade would be small indeed. Rolled brass is the semi-raw material on which the stamped brassfounder entirely depends; without it, ordinary soldered brass tube, patent cased tube, or cased stair rods could not be made. It largely enters into the productions of the cabinet brassfounder, of the door, shutter knob, and cupboard-turn maker, of the drawn and pressed brass hinge maker, and brass covered cornice pole maker; in truth, it would be extremely difficult to state in what department of the brass trade it is not consumed. Immense quantities of rolled metals are required in the manufacture of the domes and mouldings of locomotive engines, and for other engineering, useful, and decorative purposes. Not the least attractive features of the shops of our large cities and provincial towns are derived from the brass plates on which are engraved the names and businesses of the proprietors, and the brilliancy of the plate glass of their windows is increased by the brass-covered sash bars with which it is associated. Even writing paper, so smooth and glossy of surface (as much of it now is), receives its finish from bright rolled brass plates; and lastly, in imitation of "brass" and "slab" of the olden time, on enduring brass we commemorate the memory of departed friends, of genius, talent, and public usefulness, gone from among us.

The processes involved in the production of sheet brass differ from those of cast brass very considerably, in so far as the moulds in which the strips of brass are cast, afterwards to be rolled. These are not formed of sand, but of cast iron for the ordinary purposes of Birmingham manufacture. Larger ingots for sheets of greater dimensions, are formed of slabs of granite.

In either case, before pouring in the metal the interior of the ingot moulds is coated with oil and charcoal powder. The ingot mould in form resembles a shallow oblong iron box, with lid, and after the operation of coating (as described) has been gone through, the lid or cover is placed on, and the two parts of the mould held in their position by one or more iron clamps. The ingot mould is placed perpendicularly, and one end of the mould being left open, is that into which the melted metal or brass is poured. Considerable skill and experience is required in the formation of the ingot mould; if either too hollow or too convex in the centre, the strip produced fails to roll satisfactorily. The ingot being cast and found solid, is presented to the first pair of rolls, technically, "breaking down rolls." In Birmingham, these are set in motion by steam, and in their revolution pinch and drag the strip through, considerably reducing it in thickness and increasing its length. This operation is repeated until the strip has become so hard as to require annealing to restore its ductility. The annealing operation is conducted in huge reverberatory furnaces or muffles, which the heat of the fuel raises internally into a vivid red heat; these are closed by an iron door. On the introduction of the metal, the door is closed, and after a few minutes is opened, the strip has become of a blood-red heat, the annealing has been effected, the ductility of the metal has been restored, and the strip is carefully withdrawn. After being allowed to cool it is again passed through the rolls, and the operation of annealing repeated, until the requisite thickness or gauge has been nearly arrived at. The elongated strip, which is now twenty or thirty times its original length, but which has not increased in breadth, is immersed in cleansing pickle, or a solution of sulphuric acid, it is then rinsed out in clean water, dried, and if desired of bright smooth surface, is finally passed through bright polished rolls. "Spilly" metal occurs when thin portions rise up on the surface in process of working, or slight convex elevations appear—these imperfections arise from the imperfect casting of the "strips." Two qualities of sheet brass are made, one in which the metal approaches to the quality of "common fine" or dipping metal, and will solder; another but cheaper variety which will not solder, or, as it is technically said, will not stand the fire, *i.e.*, its melting point is below that of ordinary spelter solder. Such metal is fitted for work that does not require jointing or uniting, except by means of hard solder, which runs at a low temperature, but which, when run, will not permit of being hammered in connection with the pieces of the metal it partially unites.

YELLOW METAL SHEATHING, BOLTS, NAILS, AND WIRE.

Next to the solid tube trade, but superior to it in the amount of copper and zinc, or spelter, consumed in its manufacture, is the yellow metal trade, or the manufacture of Yellow Metal Sheathing, Bolts, Nails, and Wire, for ship-building purposes. The late George Frederick Muntz, Esq., M.P., has hitherto enjoyed the reputation of being the inventor of this mixture; at all events he has been considered the discoverer of this now important branch of brass industry, by which copper, largely alloyed with zinc, has superseded the application of sheet copper for the protection of ships below the water line. If, however, the merit of introducing a large percentage of zinc with copper for the purpose is to be regarded as forming a claim to protection, Mr. Muntz's claim to be considered as an original inventor is of the most shadowy character imaginable. So far back as 1779, a Mr. James Keir patented a metal, "capable of being forged or wrought when red *hot* or cold, and more fit for making bolts, nails, and sheathing for ships, than any other metals previously applied for the purpose." Its component parts were one hundred parts of copper, seventy-five parts of zinc, and ten parts of iron. The copper and iron were first melted and mixed with charcoal and pounded glass, and the zinc then added. In 1800, a Mr. William Collins obtained a patent, which claimed three alloys of metals for ship sheathing, *i.e.*, red, yellow, and white; the yellow, consisting of *one hundred* parts of copper and *eighty* parts of zinc, producing a metal which could be rolled at a *low red heat*. It will be seen by comparison that the mixture of Muntz's sheathing is a wide one, varying from *fifty* up to *sixty-three* per cent. of best-selected copper, with *fifty* down to *thirty-seven* per cent. of zinc. Keir's sheathing metal mixture, if divided by half, gives *fifty* copper, *thirty-seven* and a half zinc, and five iron; and Collins's, *fifty* copper, and *forty* zinc. The merits of Mr. Muntz are therefore reducible to the resuscitation of a dead process, or mixture only.

At the meeting of the British Association in Birmingham, in 1849, Captain James, R.E., of Portsmouth, detailed a series of experiments he had entered into, as regards an infusion of phosphorus into copper for sheathing purposes, prepared for him by Dr. Percy, in 1848, which he showed resisted the action of sea water in a greater degree than pure copper. Messrs. Alexander and Henry Parkes had, however, in the year 1848, protected the incorporation of phosphorus with metals, for the

purpose of improving their density, solidity, and adhesive properties. In 1857 they patented for ship sheathing, copper and its alloys with zinc, in combination with phosphorus, or metal manganese, to enable, as they state, the sheets *to be rolled hot.* The last named quality, it will be observed, is no new feature, as the sheathings of Keir, Collins, and Muntz, were all capable of being rolled hot. The proportions of the mixtures of Messrs. Parkes were six ounces of phosphorus, one hundred pounds of copper; or four ounces of phosphorus, sixty pounds copper and forty pounds zinc; or four to six ounces of manganese, and one hundred pounds copper. The flux used to melt the manganese with the copper is carbonaceous matter or charcoal. Advanced chemical science has hitherto failed to show in what way the phosphorus acts; whether as a superior flux only, or whether it enters into combination with, and imparts the quality to the metal which is claimed for it. Dr. Percy maintains it does not resist the action of the sea water better than sheathing of the ordinary composition.

It may afford some idea of the importance in which the manufacture of Yellow Metal Sheathing is held, commercially, when it is stated that after the death of Mr. Muntz, the trade and works were purchased from his son, G. F. Muntz, Esq., by a Joint Stock Company Limited, and upwards of £40,000 paid for the goodwill alone! But it was one of the great prizes drawn in the lottery of patents. How it resisted the crucial test of Courts of Law, to which, in common with some other patents, it was subjected, is matter for wonder; and equally so that a renewal of the patent should have been asked for, after the sum of at least £68,000 had been realised thereby. The remuneration was surely ample; for it is impossible to believe that either mental labour, pecuniary means, or protracted experiments were involved therein. The writer of this heard Mr. Muntz—at a dinner got up to celebrate the inauguration of the New Patent Law, in 1852—declare, as a set-off against the cost stated by a speaker as consequent on experiments preparatory to taking out certain patents, that the preliminary expenses incurred by him on his ship-sheathing patent, cost him the munificent sum of 8*d.*! It is doubtful with Collins's specification before us, even to assign it the dignity of a "new manufacture." It was one of those patents which may be placed among the categories of Patent Law enigmas, which have been the means of originating opposition to a law conceived for the protection of inventions and inventors. Such patents indicate the necessity for a special Court for the trial

of such cases, composed of scientifically educated legal men, aided by practical men or "experts." By such means only can doubtful patents be tested. As the reviver of an old patent Mr. Muntz is entitled to consideration, and on these grounds only. Now, with the printed specifications for consultation, such a patent could not have stood the test of a Court of Law, and no patent agent would have been justified in taking it out.

The large quantity of zinc in proportion to the copper, and the property of the mixture permitting its being rolled hot, are so many elements which enable the yellow metal sheathing to be sold at a cheap rate, in proportion to the price of copper sheathing. When partially decayed, it is received back and exchanged for new, an allowance being made for the old sheathing. Tough cake copper being £86 per ton, the price of yellow metal sheathing is as follows:—Sheathing and bolts, 8½*d.* per lb.; nails, 10½*d.* per lb. In exchange, old metal taken back—metal and bolts, 2*d.* per lb.; nails, 4¾*d.* per lb. But its price varies with that of copper and zinc at the time the sheathing is sold. The production of sheathing, ship bolts, nails, and wire, made of the Muntz's mixture, amounts to 11,000 tons per annum in Birmingham alone; the value of which may be roughly estimated at £800,000, produced by the five manufacturers engaged in this town. Yellow Metal Sheathing is also produced in South Wales.

The processes involved in the production of Yellow Metal sheathing, &c., are very simple, and consist in melting the copper and spelter in a reverberatory furnace. Very generally, old sheathing forms a part of the mixture. Before pouring, tests are instituted which are necessary, as the too great heat of the furnace may have led to the volatilisation of the zinc. When found correct, the metal is drawn off by means of iron ladles, coated internally with clay, the contents of these are emptied into large ingots of cast iron, or "strip" ingots as they are called, the strip casts are then rolled out hot; this being a quality which yellow metal possesses over ordinary sheet brass, (which is rolled cold), and materially reduces its cost. Immense and ponderous rolls compress and elongate the semi-plastic ingots into the thickness required, the bolts are cut from thick strips and drawn or rolled. Wire of this metal, of which considerable quantities are exported, is made by the process already described in wire drawing. Bolts, nails, and wire are subjected to immersion in sulphuric acid pickle, from time to time, and being washed out in pure water, and then dried, the operation is complete. A very large amount of yellow metal sheathing,

sheet brass, and wire, is exported to India, amounting to 15,764 tons in 1864, and to 9,453 tons in 1865. A considerable amount of this metal must be consumed in making brass cups which serve the purposes of gloves, and Memorial cards, in England. The funeral of every Hindoo, we are told, increases the consumption of brass, according to his station, the relatives of the deceased giving a brass cup to every Brahmin present at the funeral, so that various numbers of cups, from five up to a thousand, and sometimes the last number multiplied by ten, are distributed on such occasions, according to the rank and standing of the departed.

Between three and four hundred workmen, it is calculated, are employed in the metal rolling trade. Head rollers take out the cast strip and roll it at so much per cwt. They realise from 40*s.* to 50*s.* per week; reducers of the metal get from 20*s.* to 22*s.*; finishers of the metal, 24*s.*, 26*s.*, and 30*s.* per week; mufflemen, 8*s.* to 10*s.*per week; lads, according to age and ability; Casters of strips are paid per cwt., and realise good wages.

The manufacture of Copper and Brass Wire merits a brief allusion, in so far as the consumption and manufacture of both are very considerable in these days of telegraphic communication. The former is of the utmost importance, and some idea of the productive power of the Birmingham brass and copper wire drawers will be gathered by reference to the Atlantic cable, attempted to be laid in August, 1865. The copper wire used in its construction was produced by two houses engaged in the manufacture, *i.e.*, Messrs. Bolton and Sons, and Messrs. Wilkes and Sons. The central core or conducting part of the cable consisted of seven copper wires of 18 W.G. thickness—these were twisted together into a strand of 10 W.G. The copper consumed in making the wire for the cable shipped, which in length was 2,300 nautical miles, weighed upwards of 690,000lbs., or 308 tons. 0 cwt. 2 qrs. 24 lbs. The seven united wires which formed the strand in the centre of the cable, if placed end to end, would have reached to a distance equal to 16,100 miles. If we add a little more than half the quantity named, it equals the circumference of the earth (25,000 miles). Wheatstone calculated the speed of electricity as 192,000 miles per second, and the rate at which information can be transmitted as from thirty-five to forty-two words per minute. Did Shakespere, 300 years ago, when he made Puck say, "I'll put a girdle round the earth in forty minutes," anticipate the coming of the time when time and

space should be all but annihilated by means of the Electric Telegraph? The possibility of producing the material for the girdle is amply demonstrated, granted the accomplishment of the laying of such girdle, and Puck's forty minutes would be reduced to one minute! While we write, cable No. 3 is being deposited in the waters of the Atlantic. The copper wire in this, as in the former cable, has been produced by Messrs. Bolton and Sons, and Messrs. Wilkes and Sons.

In the manufacture of copper and brass wire, for the former, the raw material is purchased from the copper merchants in the form of a partially rolled copper strip of considerable length, of $\frac{3}{8}$ or $\frac{1}{2}$-in. in thickness, which is then rolled down to the thickness suitable to produce the wire, then slit by means of what are called slitting rolls, *i.e.*, by means of a series of steel discs, which operate as revolving cutters. A pair of these slitting rolls are so constructed that the discs of one roll fit into the corresponding spaces of the other. These rolls are set in motion by power, and on the rolled strip being presented to them, it is dragged in, and slit longitudinally into as many "strands" of equal breadth as there are revolving discs or cutters; the "strands" are, of course, square. These are converted into round wire, by being drawn through a succcession of draw plates, or holes of various sizes, diminishing in diameter. This is effected as follows:—Attached to a long shaft operated upon by power, are a series of bevelled pinions or wheels. In connection with these, and working horizontally, are a number of cast-iron drums, corresponding to the pinions which are made to revolve by means of corresponding bevelled pinions. The drums alluded to have on their upper surface a small clamp operated upon by a screw. The "strand" is reduced at the end by filing, so as to enter and pass through the hole of the draw-plate. A pair of pincers, operated upon by power, draw the end of the strip sufficiently through, and in length sufficient to permit of its being attached to the clamp. The end of the "strand" is presented to the clamp, the screw is turned; the "strand" attached; the draw-plate is placed behind the two "snags" or pieces of iron which stand perpendicularly on the draw bench, the strand being placed on a reel. The drum is thrown into "gear," revolves, dragging through the strand, and converting it from a square into a round wire. The operation of drawing hardens the wire, and in the process of reduction it is repeatedly annealed. It is necessary to remark that if brass wire were drawn and forthwith subjected to the operation of the heat in the muffles, the

result would be that it would fly or break into thousands of pieces. Before, therefore, it is placed in the muffle, the drawn coil is taken up in both hands by the assistant wire drawer, and struck violently on a wooden block. This operation expands the outer particles of the brass on the surface of the wire, and allows for the expansion of the interior particles.

Engineering experience has demonstrated that iron, subjected to vibration, is changed from a fibrous to a crystalline texture; and the same alteration or phenomenon is observable in common brass wire, which becomes disintegrated by exposure to action of the atmosphere. The brass wire guard crumbles; the brass wire chain in use in common gas-fittings, to suspend the balance weights, &c., frequently gives way without notice, and, if no injury is done, is, at least, productive of serious inconvenience.

Brass wire, like sheet metal, is made of two qualities, one which will stand the fire, with a greater per centage of copper, and a second quality which will not, the proportion of zinc in its composition being greater. Brass wire, in its earlier stage of manufacture, is produced not from strips purchased out, but from strips cast in the manufactory where the wire is drawn. The strip is rolled out, and slit into strands, as already described. In drawing both copper and brass wire, the strands are lubricated with grease or oil, to prevent their cutting. The final operation, in both cases, is to clean the wire by immersion in acid, and then to rinse it out in clean water. If for soft wire, the acid finish is left; if for bright, the wire is again drawn through the tool, which imparts to it the bright appearance it presents, and with which we are familiar.

There is no doubt that in the early stage of wire manufacture, it was drawn out by means of the hammer; afterwards came the operation of drawing or pulling through the tool by hand. Rudolf of Nuremberg, somewhere about the middle of the fourteenth century, was the first to introduce the present system of wire drawing. Readers familiar with the processes of ornamentation, will recollect the advantage taken of wire in precious metals for decorative purposes, as in the production of filagree work. The art of wire drawing by machinery, as regards brass and iron, was eventually introduced into England by Christopher Shutz, about the seventh year of the reign of Queen Elizabeth. "Previous to that period all English wire was made and drawn by men's strength." In the seventh year of the reign of Charles the Second, English brass wire was sold at £8. 8*s*. per cwt., and

Swedish brass wire at £5 5*s.* per cwt. The latter price, it is said, was quoted in order to destroy the English trade. Swedish wire was eventually prohibited from being sold in England by special enactment. At present Brass wire is sold as follows :— Brass wire used in making pins, £4 11*s.* per cwt.* Ordinary brass wire, £4 15*s.* 8*d.* Soldering brass wire, £5 9*s.* 8*d.* per cwt.

A considerable quantity of the brass wire made in Birmingham finds its way to the Gold Coast, to Old Calabar, in the form of what are called "guinea rods," one hundred of which, each three feet in length, of Nos. 4 and 5 gauge in thickness, packed up in deal cases, and being at their destination, sold in exchange for palm oil, &c., are used as the "circulating medium" by the natives, and at the death of the possessor are interred with the body. An influential Birmingham merchant states the orders from that country frequently amount to from five to twenty tons each. Large numbers of rings made of solid brass wire, about seven-sixteenths thick and three-and-a-quarter inches diameter, made of wire, are also sent to the Gold Coast. A smaller size of brass wire (a little thicker than ordinary pin wire) is converted by being wound round spits into spirals like an ordinary check bell spring, and is also exported to the locality named for purposes of ornament and personal decoration. To the west coast of Africa the wire is sent in rods or straight lengths, and to the east cast in rings or coils, where its purchase is monopolised by the Banyan or Arab merchants immediately on its importation—Zanzibar being the chief depôt. Wire of the No. 4 and 5 gauge is generally preferred. When sent into the interior, the large 50 lb. coils are sold at prices varying from 50*s.* to 67*s.*, and are divided into three or four rings called, "khata," for convenience of carriage, and attachment to the "banghy" or carrying pole. Native artisans at Unyanyembe convert the wire into the coil bracelets, a "khata," or ring of wire being sufficient to form two or three of these ornaments, each of which weighs about 3 lbs. The "katinda," or coil bracelet is sold, when made, for one dollar (4*s.* 2*d.*) each. The katinda bracelets were formerly made of copper wire, but its cost has been the means of introducing brass wire instead. Though the east African can draw *fine* brass wire, they import it from Zanzibar into the interior. The gauges preferred are from No. 22 to 25; this they convert into a variety of ornaments.

* 15,000,000 pins are said to be daily called for in this country, in the manufacture of which 2,727 lbs. of brass wire is consumed. Some idea of the consumption of brass wire in the manufacture of pins may be gathered from the fact, that one firm in Birmingham consumes 150 tons per annum, or 336,000 lbs.

The very general use of brass wire as ornaments among the tribes of Africa is well illustrated as follows, from the pages of Burton's travels in Africa :—

"The costume in brass, worn by the Wanyamwezi, are brass 'bangles,' or massive brass rings, frequently weighing 4½lbs each, on the wrists. The forearm bears 'katinda' or coil bracelets; the waist is girt by a coil of wire twisted round a rope or fibre; and the ankles are covered with a profusion of iron bells, thin rings of brass and copper wire."

"The wives of the chiefs of the Wabwari wear a lot of brass ornaments."

"The ornaments of the Wusagara, in addition to beads, are the 'katinda' (their weight is the test of wealth and respectability), extending from elbow to wrist. Others wear little chains or thick 'bangles' of copper, brass, and zinc; and those of more ample means twist a few circles of brass under the knee in addition."

"The sultan of Insene eschews and despises beads, preferring coils of copper or brass wire."

"Even the porters, of which great numbers are attached to each caravan on its journey to and from the interior, in addition to massive ivory bracelets, wore heavy 'bangles' of brass or copper, and thin circles or discs of the same metals."

Livingstone, in his travels to the Zambesi, still further illustrates the use of brass wire, and brass in Africa, by describing a Makololo woman attired not in a costume supplied by a Parisian "modiste," but in that of Dame Nature, aided by a Birmingham brass wire manufacturer. He says :—

"Sebituane's sister, the head lady of Sesheke, wore eighteen solid brass rings, as thick as one's finger, on each leg, and three of copper under each knee; nineteen brass rings on her left arm, and eight of brass and copper on her right; also a large ivory ring above each elbow. She had a pretty bead necklace, and a bead sash encircled her waist. The weight of the bright brass rings round her legs impeded her walking, and chafed her ankles; but, as it was the fashion, she did not mind the inconvenience, and guarded against the pain by putting soft rag round the lower rings."

In addition to rings of brass wire, or of cast brass, very large quantities of Armlet and Anklet rings, made of tube, and varying in size from 2¾ up to 3½ and 4 inches internal diameter, are made in Birmingham, and sent out to Africa. These weigh from 2½ oz. up to 4 oz. each, are similar to cornice rings, but have no loop. Neither are they united at the junction with solder, in order to admit of their being opened the more readily, to allow of their being placed on the arm and leg of the wearer. These rings are ornamented by "milling tools," finished by burnishing and lacquering, and are used by merchants on the Gold Coast for payments of debts and exchanges with the natives, who bring down palm

oil and other natural products, receiving the rings in barter. These rings form the decorations of the natives, their number indicating the wealth and position of the wearer. Some idea will be gathered of the extent of Birmingham orders for this commodity from the fact that some three years ago one order executed in this town extended to 20,000 dozen, or 240,000 rings, 3½-in. diameter, the weight of brass consumed in their manufacture amounting to nearly 23½ tons.

6.—BRASS AND COPPER TUBE MANUFACTURE, SOLDERED, SOLID, AND ORNAMENTAL.

There is an immense consumption of brass in the form of tubes in Birmingham manufactures, inferior only to that in the manufacture of locomotive and marine engine boilers. This important branch of the brass trade we now propose to consider. No doubt all tubes were formerly hand-made, and produced by cutting a strip or ribbon from a sheet of rolled metal, turning up the strip over an iron rod of the size of the interior of the tube required, binding the edges of the partially formed tube together with rings of wire, placing solder and borax along the seam or joint, and fusing the solder by means of an ordinary forge fire; then, after removing the wire and surplus solder, the crude tube was hammered round on the iron rod over which it had been bent up. Tubes so produced were necessarily imperfect, unequal in diameter, and unfitted thereby for purposes where accuracy was required. The inventor of the draw bench is not known; but Sir Edward Thomason certainly introduced some important improvements therein, which, no doubt, operated very materially in developing the brass tube trade.

The manufacture of ordinary soldered tube is now practised as follows:—From sheets or rolls of metal, strips are cut of the requisite breadth by means of revolving or circular shears propelled by machinery. If these strips are of strong metal, or for large tubes, they are rendered concave in their entire length, by passing through rolls, one of which is concave, the other convex. The end of the strip is converted into a tange by two blows with a hammer. The drawing tool being placed *in situ* on the draw bench, the tange is passed through it. It is then connected with the draw-tongs attached to to the chain, which are moved along the horizontal surface of the draw bench. The wheels and pinions which drag the chain along are placed "in gear;" the tongs compressing

the tange of the strip of metal, are dragged along, and with them the strip of metal, which in its passage through the tool is converted into a cylinder, with a seam down its entire length. In this condition the partially formed tube is passed to the "wirer"—usually a girl—who binds the edges together with iron wire at intervals of two inches apart. It is then passed to the "charger," who places along the seam a granulated brass solder, mixed to the consistency of clay with borax. In this condition the tube is handed to the "solderer," who passes the tube into a soldering stove; it becomes gradually heated to a red heat, when the solder melts, and unites the two edges together; the tube is now a perfect one. On cooling, the wires are untwisted and taken off, the surplus solder removed by filing, the tube immersed in oil of vitriol pickle, then washed out in water. The concluding operation consists in passing the tube again through the tool in the draw bench. If an ordinary tube, it is considered as finished; if mandrill-drawn as for pump cylinders, telescopes, or for purposes where great accuracy is required, a steel rod or mandrill is placed or passed in or down the interior of the tube, and in this position it is drawn through the tool, which compresses the brass tube on its internal steel support, and produces, on the withdrawal of the mandrill, a tube parallel in its internal and external surface.

Admitting the difficulty of pointing out when tube making was introduced into this town, or the inventor who first created appliances which facilitated its production by power, that wire drawing suggested tube drawing appears a self-evident result. Draw benches were familiarly spoken of in 1782; they had, therefore, been in use long prior to that year; but while the period of the introduction of brass tube making cannot be determined, that of one of its most important branches can; the invention and inventor of patent or cased tube being clearly defined. In the "Memoirs of Half a Century," by Sir Edward Thomason, he modestly tells us, "During the year 1803, I put up a complete machine for drawing tubes in a new and peculiar way. The radius of the winch connected with and governing a series of wheels gave the machine great power." "This mode of drawing tubes led to much novelty of invention, and eventually to that of sliding hearth brushes. In watching the operation of drawing brass and copper tubes upon the mandrill, I found it required as much power to slide off the hollow tube from the mandrill as was required to draw it on. Reasoning from the adhesion of the brass

tube to the steel mandrill, I found by experiment that the union of copper and iron, or brass and iron, could be firmly attached by pressure, and conceived that such an application would be useful for making of copper bolts for shipping, solid brass rods for stair carpets, solid brass to go round the top of a room, to suspend pictures, as curtain rods for drawing rooms, and as balustrades for stair-cases." "This mode of manufacture led to the brass bars or railing at the front of the London shop windows. It gave strength and the appearance of solidity, when, at the same time, the whole was only of sheet iron, except the thin casing of brass drawn over it by pressure." Thomason, at an early period, fitted-up "many splendid stair-cases," among others, for the Queen of Wurtemburg, the Marquis of Westmeath, Lord Forester, and that of the Plough Hotel, at Cheltenham. Some eight years after, in 1811, Benjamin Cook, (who was one of the earliest makers of metallic bedsteads, &c.,) obtained a patent for combining and connecting together different kinds of metals, and also metals and wood, in such a way as to make combinations thereof. The former was essentially Thomason's invention; the latter was original, and is familiarly known as the process by which wood brass covered poles were, and are now produced. Thomason had no difficulty in proving the right of "user, as he had sold articles made similar to those patented" years before Cook had thought of the method. The difficulty was, however, got over by Thomason getting a letter of license to sell whatever he chose during the term of the patent. Thomason, therefore, (and not Cook, as has been generally understood,) is entitled to be considered the inventor of the now familiarly known patent, or iron brass-cased tube, and also of solid iron stair rods cased with brass. The quantity of patent tube now made and consumed in the manufacture of picture rods, bedsteads, railings, and hollow stair rods is almost incredible. One leading firm engaged in the manufacture states that its production of the Patent Tube exceeds 100,000 feet per annum. The process of patent tube making has not been improved in any particular since the days of Thomason, saving that recently, instead of cutting the iron from charcoal sheet, Mr. Thomas Potts has substituted hoop iron of proper widths for the cut strip; the consequence is a slight reduction in price. The *modus operandi* of manufacture practised in the making of patent tube is simple. The centre cylinder or tube of iron is drawn, as already described in the operation of brass tube making.

The brass or outer case is made in a similar manner, and soldered, but made so much larger that it slides easily over the iron tube it envelopes—over which it is slipped—the two tubes being permanently united together by being drawn through a tool, and the brass case being compressed on the iron interior tube an iron tube, with an exterior brass covering, is the result. When patent tube is intended for bending, it is customary to solder the seam of the interior or iron tube also. For ordinary purposes, or when the tube is used in straight lengths, as picture rods, &c., it is unnecessary to do so.

Attention will now be directed to the manufacture of a class of tubes, which cannot be produced by the ordinary processes in use in the tube trade. It may, here, however, be incidentally remarked that, so long as the tube is parallel, its ornamentation, so far as regards external longitudinal decoration, can be accomplished by the ordinary drawbench and tool, thus :—A round, square, diamond, triangular, octagonal, sexagonal, convex, or concave reeded tube, is simply produced by substituting a form of tool, the internal surface of which is shaped in accordance with the external surface of the tube which it is intended to draw. Taper tubes, on the contrary, require a special provision for their manufacture, and the invention of tools for their production has attracted the attention of not a few ingenious minds. It will be readily understood that in order to draw a taper tube, an expanding tool is required, in order to adapt itself to the gradually increasing diameter of the taper to be drawn. Some clever combinations of springs operating on segments of steel, intended to produce taper tubes of various forms in external diameter, have been produced from time to time, but such may be classed among the mechanical failures of the past. In 1813, Mr. Henry Osborn succeeded in producing tapering cylinders by means of a pair of rolls, with tapering grooves cut in their external surface. The same process was claimed as an invention by Dr. Church and Mr. Jonathan Harlow in 1841. Taper tubes, however, of diameter corresponding only to the groove in the rolls could be produced, and any variation necessitated sinking or cutting new rolls specially. The most ingenious and universally applicable process for producing tubes of varying tapers, whether reeded, fluted, twisted, or many-sided in their external form, was that invented by Mr. John Ward, now of the Birmingham Tube Works, Digbeth, in the year 1848, who introduced, instead of rolls, an expanding tool formed of block tin. The process being

as follows:—The soldered-up taper cylinder or tube is slipped on to a steel or iron mandrill of the form corresponding to the desired tube; in this condition the end of the mandrill and tube is caught by the tongs of the drawbench, and is pulled through the soft metal tool, which reluctantly expands, but still clings to and compresses the sheet metal case into the form of the mandrill by which it is internally supported. The beautiful simplicity of this application is not its least recommendation; the tool is economical in cost of production, as the metal of which it is cast can be re-melted and re-cast into tools after it is used; economy and variety are thus united together. By no other process in use in the tube trade could the same amount of structural ornamentation be given at the minimum of expenditure.

In the production of twisted tube, the tool which imparts the twist, or spiral, is simply a revolving nut, held firmly in a suitable frame. When set in motion it acts as a screw plate, and threads the tube in its passage through. Diapered or diamond-pattern tube is produced by a similar tool and in a similar manner, only it is twice passed through—first, through a right-hand threaded tool, and second, through a left-hand threaded tool. Considerable quantities of this variety of tube are consumed in the construction of mediæval brassfoundry, gas fittings, &c.

An ornamental variety of brass tube was introduced in 1852, consequent on the invention of the ornamentation of metal by pressure* by the late Mr. Richard Ford Sturges.

* The reader may be reminded that this process in all probability was that which gave rise to the art of Nature-Printing, for which the Austrians take credit, and for which the late Mr. Henry Bradbury received an amount of praise by no means deserved. It remains to be proved where the Austrians got their idea; but it is certain that Mr. H. B. got his from the Austrian Printing Office, in which he was employed at Vienna. Dr. Branston, then of Sheffield, in 1849, printed with casts taken by gutta percha from natural objects in the year 1849, having, however, first taken a cast from some in brass. In 1852, the writer of this, in experimenting on the ornamentation of metal by pressure, used natural objects, as feathers, leaves, &c. It occurred to him that he had procured an impression in metal which could be printed from. He therefore at once took the metal plates (formed of Britannia metal) to a copper-plate printer, Mr. Martin Billing—had them inked and printed from. The result was a perfect impression of the object used, *i.e.*, a feather, even to the down which surrounds the quill. The writer of this read a paper before the London Society of Arts, February 15th, 1854, in which he challenged alike the Austrian patent and the claims of Mr. Bradbury. Mr. Bradbury was present at the meeting, but remained silent. Mr. Bradbury and the Austrians arrived at their conclusion by a roundabout process of taking an impression on lead, and from the lead a copy by electro deposition, and a second plate by deposition, which formed that printed from; but the writer used Britannia metal, which is harder than lead, and printed from it direct, thereby securing details which are lost in taking two electro deposition plates. By using Mons. Joubert's acieraging, or steel deposit process, the Britannia metal plate is rendered equal in endurance to a steel plate. As it is, 500 impressions of feathers and leaves have been taken from one Britannia metal plate. The writer has still the plates in his possession. It is worthy of remark that the Austrian patent for copying *lace* was taken out between May and October, 1852, but Mr. Sturges had printed from *lace* in August, 1851. A Mr. W. Taylor, of Nottingham, exhibited in the Exhibition of 1851 examples of *lace and tambour* work printed in some way from impressions taken from the objects represented. Sturges' patent for ornamenting metals by pressure from *lace, wire work, and paper*

This ornamentation was effected, by placing between two sheets of metal, perforated paper, thread lace, or perforated zinc. On passing the metal through the rolls, the pattern of the paper, zinc, or lace, was indented in the brass; the brass so ornamented was made up into tube, of which considerable quantities were sold.

By far the most successful system devised for the ornamentation of brass tube was that provisionally protected and patented by Mr. Fearn, of Vittoria Street, Birmingham, in 1852, by which the tube, after being made, was ornamented by means of plain rollers arranged in a frame to form a tool similar to that used in the production of the solid seamless brass tubes—hereafter to be described—with this difference that on the outer concave surface of the groove of the rollers was cut the design or portion of the design which it was intended to indent on the surface of the tube to be ornamented. The plain tube, with an internal support or mandrill of steel, was introduced into the tool and drawn through; the rollers revolved, and in their revolution impressed the design on the external surface of the plain tube presented for ornamentation. The limit of this style of tube decoration is only bounded by the power of the designer and the skill of the die sinker. The patent was allowed to lapse at the end of the third year; it then became public property, and as such, from the ornamentation of pencil cases and small tubes, it has been applied extensively for the general decoration of all sizes of brass tubes to be converted into gas fittings, bedstead pillars, and articles of cabinet brassfoundry, fire and window guards, &c., and, so applied, adds very greatly to the attractive features of the objects of which it forms a part. It is to be regretted that in the hands of the inventor the process failed to realise its true measure of usefulness and profit.

With the introduction of phosphorus or metal magnanese into the alloy of copper and zinc of which tubes are made—

was sealed on the 24th January, 1852. Of course the specification was immediately printed, and the details open to investigation. Where, then, are the claims of Austria—of Mr. H. Bradbury? *Lace* is not a natural production. Natural objects were soon copied, but the writer believes that the Austrian claim is worthless, and that the first natural objects were printed from in Birmingham; but while admiring works produced by a National Treasury, as in Austria, and those produced by Mr. H. Bradbury, he declines to recognise a claim for originality where it is not due, and unsupported by better evidence than has yet been adduced. There is, however, a certain Peter Kyhl, a Danish goldsmith, who appears to have done something in Nature-Printing, in the way of copying natural objects, so far back as 1833. His work is stated to be in MS., and reposes in dust in the archives of a museum in Copenhagen. He also appears to have ornamented silver wares; this information, though stated, has not been proved, and must be taken for what it is worth. The writer adheres to his opinion that Nature-Printing owes its recent successful progress to Birmingham.

a plan said to improve the purity of the metal, its cohesive properties, and its solidity, and which is due to the result of the investigations of Messrs. Alexander and Henry Parkes, the *chief* features of the improvements and advances in the manufacture of tube, more particularly brass and copper, have been alluded to; if we except certain preliminary processes, as the casting of the billets and appliances by which it is intended to render the billets more solid in texture, or the formation of billets by forcing these by pressure out of flat discs of sheet metal. As these are matters of detail only, and do not materially affect the increase or facilitate the production of such tubes, they may be passed over without additional comment.

SOLID OR SEAMLESS BRASS TUBES FOR LOCOMOTIVE OR MARINE ENGINE BOILERS.

Brass tube making appears to have had no improvements introduced into its mode of manufacture of any importance until the year 1838, previous to which year it was produced as already described, *i.e.* the tubes had seams along their entire length, which were united by soldering. Tubes of lead or block tin had been produced seamless, the former by hydraulic pressure, the latter by drawing down (through a succession of tools diminishing in internal diameter till the size desired was reached) a thick cast cylinder of tin, the interior of which was filled with a "spit" or "mandrill" of the internal diameter of the tube required, which was afterwards withdrawn. The necessities of modern travel, however, had rendered the production of brass tubes wherewith to fill the boilers of Locomotive and Marine engines of the utmost importance, as the steam was more easily evolved by their introduction. Iron tubes are corroded by the water from which the vapour is generated, hence the necessity for substituting another metal not liable to rust or oxydation. The soldered joints of the tubes made of copper or brass not unfrequently showed weakness, or leaked, owing to imperfect soldering, and the production of seamless or solid brass tubes, as they are now called, became a desideratum, which was supplied in June, 1838, by Mr. Charles Green, who, by aid of machinery proportionably more powerful and in unison with the more unyielding material to be drawn, converted thick and short cylinders of brass into elongated tubes suitable for the purpose intended. The drawing tool in Green's method is not, as in

ordinary tube making, a hole punched out from a bar of steel, but is formed by four steel rollers, the concave surfaces of which, when united together *in situ*, formed a circular tool, which in concavity corresponded to the external diameter of the tube to be produced; the reducing, or drawing down process, being facilitated by repeated annealings of the tube in progress of manufacture. This method of tube making was accepted as satisfactory by engineers; the consequence was an increased and increasing demand for brass tubes for the purposes named. The progress of solid tube making was not, however, destined to remain stationary. In May, 1852, Mr. George Frederick Muntz, jun., patented, along with an alloy of 60 per cent. copper and 38 parts of zinc for making seamless tubes, a new and ingenious method of making such tubes. His billets were cast oval, not cylindrical; they were rolled out or elongated when the metal was at a red heat, and the cylindrical form was given in the last operation. The history of solid tube making would be incomplete as regards brass and copper were no allusion made to the patent taken out in 1850 by the late Mr. Thomas Attwood for the production of seamless copper tubes from the worn-out rollers of calico printers, when abandoned by them as useless. The rib or slot, which held the roller on its axis, being removed, the copper billet, as it may be called, (*i.e.*, worn-out roller,) is rolled, or drawn down to the diameter required.

Some idea as to the immense demand for brass solid and copper tube—more particularly the former—will be arrived at if it is considered that, by the last computation of railway statistics which is complete, that of 1864, it is shown that in England there are in working order 8,890 miles of railroad; in Scotland, 2,105 miles; in Ireland, 1,794. In England, the proportion of locomotives is 64 to every hundred miles; in Scotland, 55; in Ireland, 27; giving a total of 7,337 locomotives in use in the railways of the United Kingdom. On competent authority it is said that two-thirds, or sixty-six and two-thirds per cent. of the number of locomotives named, are fitted up with solid seamless brass tubes; this gives 4,893 engines. As the average number of tubes in each locomotive boiler may be taken at 150, and each tube is at least twenty-five pounds weight, the total weight of brass tube in the service of the various railway companies cannot be less, at the present time, than 8,500 tons. Marine boilers also require seamless brass tubes, the diameters of which are larger, *i.e.*, from two-and-a-half to three-and-a-quarter inches each tube, from six feet to eight feet in

length, and weigh from fifteen up to thirty pounds. A set of boilers for one steam ship requires from two to three thousand tubes, the weight of such tubes amounting to about twenty-five tons. Taking 2,500 tubes of 22½ lbs. each as an average number and weight, admitting that the marine tubes in use amounted to half the quantity of the locomotives, gives the weight of solid brass tube in use for locomotive and steam-boat purposes in England, as equal to nearly 13,000 tons; and at eighty-five per cent., about 18,300 tons.* These tubes, it is understood, are replaced once in three years; and as the number of locomotives is increasing, as also steam ships for the navy and for the merchant marine service, this suggests that the solid brass tube trade is destined to be an increasing and permanent manufacture. Boiler tubes, in brass, are replaced at an average every three years. A competent authority consulted states that the quantity produced by the six Birmingham houses in the trade is 4,500 tons for locomotives, and 2,000 tons for marine engines, or 6,500 tons annually. In the manufacture, 5,000 tons of best-selected copper is consumed, and 1,700 tons of spelter; the wages paid, about £27,000 per annum. Locomotive tubes are also made by Newton, Keates, and Co., Liverpool, and the Broughton Copper Company, of Manchester. Some few are also made in Newcastle.

The contracts issued by the London and North-Western Railway Company, for tubes alone, amount to 300 tons annually. As the estimates referring to the brass tubes in use on the railways of the United Kingdom may be considered problematical, another example is given on authority which can be vouched for.—On the railway which traverses the East Indies, extending from Calcutta to Delhi, a distance of 1,100 miles, there are now working 310 locomotive engines, containing from 150 to 170 tubes in each boiler. Assuming 160 tubes as an average number, and the weight of the solid brass tubes at twenty-one pounds each, the total weight of the tubes at work on that railway *alone* would amount to 465 tons, 9,300 hundredweights, or 1,041,600 lbs. As however, 120 engines in addition are being built, 180 tons will be added thereto, which will give a total of 645 tons of solid brass tubes in use on this railway,

* The writer being anxious not to overstate the percentage of engines in which brass tubes were used, an enquiry was made of an eminent engineer, who replied as follows—"The brass tubes in locomotives in England, I think, are about eighty-five per cent. of the whole quantity of tubes used; a friend familiar with locomotives thinks the same. The mercantile marine use some iron tubes, probably over fifty per cent. of the whole; but then the Government use decidedly less iron tubes. I should say off-hand they use seventy per cent. of Brass, and I am not sure whether they have not decided to use all brass."

so important to the trade and commerce of Central India, which has reduced a journey which occupied three months into the short space of two-and-a-half days!

It is interesting to know that the first introduction of tubes into steam-engine boilers, as a means of increasing the heating surface, and more speedily "getting up the steam"—now so very generally and universally adopted in the boilers of locomotive engines, &c., the production of which tubes has operated so beneficially on the solid brass tube trade of the town—may be said to be due, and is shown by Mr. Smiles in his recent admirable "Lives of Boulton and Watt," to have originated with the former. In connection with experiments on the best forms to be adopted in the boilers for engines then being made at the Soho, he found, by experiment, the water more speedily converted into steam by the introduction of tubes through the entire length of the boiler. In 1780 he wrote to Watt, then resident in Cornwall, on the subject, suggesting the application of tubes in boilers, and that the tubes should be made of iron. To the material Watt objected, but the application of tubes for the purpose intended he did not oppose. Boulton then suggested tubes of copper, to which his partner assented. He then carried out his suggestion by introducing four copper tubes, 20 inches in diameter, and 26 feet long, into the boilers of the Wheal Busy Mine engine, the fire passing through two of these and returning through the other two. He thus anticipated the present form of many-tubed boilers. It is no mean tribute to the genius of Boulton that the requirements of modern locomotion and navigation should have recognised in the tubular boiler that which is best fitted to give life, vitality, and motion to the locomotives, and which drag their freight of human beings, &c., over the network of railways extending to 12,700 miles in the United Kingdom alone, and also into the boilers of the steam ships which plough the surface of every ocean. Trevithick, in 1815, meditated the introduction of tubes to locomotive boilers, and he introduced them perpendicularly. Gurney, Summers, and Ogle, worked in the direction of the application of steam locomotion on common roads, and used tubes also in connection with their boilers. It was reserved for George Stephenson to realise in the old "Rocket" Engine, produced in 1829, the form of tubular boiler, as now used, with slight modifications, in locomotives. In the engine named he introduced twenty-five copper tubes, each three inches in diameter; the fastening-in of these tubes is an amusing incident in the life of his son Robert.

These tubes were fitted into the boiler with brass flanges and nuts; leakage resulted. The son wrote to the father in great grief and tribulation; he replied, "bore out clean holes in the boiler ends; fit in the copper tubes as tightly as possible; solder up, and then raise the steam." The plan succeeded perfectly, the expansion of the copper tubes completely filling up all interstices. No solder is used now, but the end of the tube is simply turned over with a suitably formed punch or drift. Copper tubes were eventually changed into brass. To Matthew Boulton and George Stephenson, therefore, the tube manufacturers of Birmingham owe their solid locomotive and brass tube trade.

The production of brass and copper tube in Birmingham may be estimated at not less than from 8,000 to 9,000 tons per annum, of which between 6,000 and 7,000 tons are solid or seamless, and the remainder is made by the ordinary process of drawing from flat strips of metal, and soldering up the joints.

In the manufacture of the seamless tube the labour of adults is more generally employed than in tube making of the ordinary kind. The average wages of the workman may be stated as 30*s.* per week; labourers who attend to the annealing and pickling of the tube in process of manufacture receive from 15*s.* to 18*s.* per week. In the soldered tube trade, as the processes are more numerous, there is a greater scope for the employment of female and juvenile labour; not unfrequently a foreman undertakes to produce the tube at a certain rate per cwt. or ton, in which case he pays the workpeople under him. Good workmen earn from 20*s.* to 30*s.* or 35*s.* per week; lads who assist in carrying the strips about and assisting generally, from 4*s.* 6*d.* to 10*s.*, according to age and ability. Women employed as solderers are paid from 10*s.* to 12*s.* per week; and girls who wire, or bind the tubes with wire preparatory to their being soldered, and remove the wires after the soldering operation has been completed, earn from 4*s.* to 8*s.* per week. Payment, however, is dependent on the amount of skill and expedition displayed.

7.—LAMP MAKING, LUSTRES, CHANDELIERS FOR OIL AND CANDLES, AND SMALL BRONZED ORNAMENTS.

Lamp, Lustre, and Chandelier manufacturers were, as will be readily understood, a very much more important body in the brass trade than they are at present. Formerly, tallow or wax candles and oil supplied the only sources of artificial light, these materials are now only exceptionally used; consequently, some

thirty or forty years ago the trade of lamp making, &c., was a very much more important one than it is at present, or ever will be again in time to come. Gas has given the quietus to lamp making, if we except those for paraffin, and the chief manufacturers of lamps have been absorbed into the manufacture of Gas Fittings. But the trade is one which has claims to consideration, in so far as while the mechanical construction of the oil lamp employed and kept alive a superior class of workmen, it developed and encouraged the art of design and modelling, (imitative certainly,) in which portions of the remains of classic mouldings, copied from Stuart's Athens and Piranesi, were used, and in which the pillars Corinthian, Ionic, Composite, &c., in character, supported lamps, or Caryatide figures bent under the imaginary weight of the lamp head they were supposed to sustain. One design represented "Atlas supporting an improved brass Liverpool lamp," with arms extended, hands pressed on stomach, the lamp apparently balanced on his head, conveyed the unpleasant impression that the head of the lamp would speedily roll off. Hanging lamps were of equally strange design. Imitations of the Warwick Vase formed the receptacle for the oil; the arms to which were attached the burners concealed below by heavy cast "boats," or bodies; bearded philosophers or ivy-crowned satyr masks grinned down on the possessor of the lamp who stood below, and honeysuckles, vine leaves, fruit, &c., made up the component parts of an incongruous whole. These articles were then accepted in the days when art and taste was the exception rather than the rule, as examples of supereminent art applied to industry. Probably nothing more instructive as to progress in the direction of applied design can possibly be gathered, than by turning over the pages of the pattern books of the Messengers and Timothy Smiths of a by-gone period. We learn therein the traditions on which ornament was founded, and following these traditions, we see how much originality was sacrificed on the altar of antiquity, fitness never for one moment being taken into consideration; and hence, the misapplication of forms, abstractly good in themselves, imperfectly reproduced for purposes for which they were totally inapplicable. Nor at this period were these reproduced by inferior artists or modellers. Flaxman, whose graceful, elegant, and poetic fancy illustrated so beautifully passages in Homer and Dante, whose sculpture charms from its chaste and pure, yet simple dignity, modelled for the Messengers, as did also Francis Chantrey; and Wyon, a progenitor of the now-distinguished mint medallist,

when in connection with the Soho, lent his artistic powers to the designing of decorations for the lamp work produced in that establishment, in addition to his avocation as a medallist. The various drawing masters in the town were also pressed into the service as "designers." The imperfect understanding which prevailed as to construction, or rather "that ornament should be designed without reference to construction," does not appear to have been understood at the period, or if understood, was ignored; still, however, these gropings in the dark are entitled to respect, as the harbingers of a better time coming which has now arrived, or to which we are rapidly approximating.

In the introduction we have referred to the construction of lamps. In the older and more primitive examples, the wick was then a solid one, which communicated with the oil directly, and combustion took place only at the point where the atmospheric air was in contact with the flame. In the hands of the ancient Greek and Etruscan metal workers, the vessel which contained the oil assumed very elegant forms; but the principle of the lamp produced was crude to a degree, and differed not one whit from that adopted by savage nations, wherein the wick is simply placed in a crude earthenware or metal vessel. The wick was drawn up when consumed, by pins or other rude contrivances. Of lamps made on this principle, great quantities were produced in Birmingham previous to the year 1780, though slightly modified in external form, and by no means so elegant as their classical prototypes. In the year 1789 a great change took place by Mons. Argand inventing an arrangement consisting of a circular wick and a passage for air up the centre of the flame. By this arrangement the flame was surrounded by two concentric currents of air by the addition of a chimney, at first made of iron, but eventually of glass. This chimney, supported on a holder outside the burner, imparted steadiness to the flame, the air being introduced between the outside of the flame through apertures of the glass holder and up the interior of the circular wick; the combustion was therefore more equal and rapid. (The form of the Argand burner for oil was at an early period adopted as the model for gas burners.) The introduction of Argand's improvement in lamps into those of Birmingham manufacture is due to James Watt, the great improver of the steam engine; who in correspondence with Argand, while learning all the French inventor had accomplished, made various ingenious suggestions on the subject of improved reading lamps, which, when produced, (according

to his biographer, Patrick Muirhead,) "gave a light, surpassing both in steadiness of flame and brilliancy anything of the kind that had appeared in those comparatively dark ages." It is more than probable the suggestion of the glass chimney, and its change of form from that of a cylinder of equal diameter throughout to one which is contracted above the flame, is due to James Watt. The chimneys of the lamps first produced by Mons. Argand were formed of sheet iron. Among the multifarious manufactures which issued from the Soho Manufactory, lamps of various kinds were included, and formed no unimportant part of its productions. In Argand's lamps the wick was raised by means of a spiral thread cut in a tube, the wick holder, with wick attached, being operated upon by a longitudinal slit tube—the wick holder internal pin rising on the spiral thread by means of another pin attached also to the wick holder, but outside, which worked up the slit of the tube already alluded to. The slit tube was connected to the glass holder, on turning which the wick rose in order to allow of its being trimmed. From the year 1800 to 1820, great quantities of what were called "Liverpool" lamps were made. These were on the Argand principle, but a button or disc was introduced, which rose from the centre of the tube up which the air passed, and by impinging on the flame caused it to expand. In order to accommodate the direction of the flame, the chimneys were globular at the bottom, and terminated in a cylindrical form at the top. These chimneys were held on by means of two pins and a screw or thumb bit. Immense quantities of *Astral Lamps* (called French) were also made, in which the magazine or receptacle for the oil was a circular rim, so formed that but little shadow was cast by the burner, which stood in the centre of the circular rim, and was supplied with oil by two tubes connected with the burner and the rim, which contained the oil. These lamp heads were fitted to pillars or stands, the design of which has been alluded to in the introductory remarks. *Lamps for burning Tallow* were at one time made extensively in Birmingham, and numberless burners for the combustion of Naphtha, and lamps for the same purpose, were also produced. The disagreeable odour of the coal tar from which the naphtha was made, however, speedily operated in terminating the manufacture of these lamps, and naphtha, as a means of illumination, is now confined to lighting up booths and caravans at country fairs. Occasionally the lamp trade, after the introduction of gas, showed signs of revival, as on

the introduction of *Palmer's Candle Lamp*. This variety of lamp, it is almost unnecessary to state, consisted of a tube to hold a candle or candles of various diameters, with a spiral spring in a tube, or barrel, which forced the candle as it was consumed up against the under surface of the cone-formed cap. These were made in all styles of ornament, from the most elaborate down to the simplest form of a tube to contain the candle, and a bottom on which to fasten the tube, as in an ordinary candlestick. China and glass highly decorated pillars were occasionally introduced in some of the more expensive varieties. The light of the candle lamps formed, however, a very inferior substitute for gas, and they are now very seldom sold, but representations of them are still found in the pattern books of lamp makers. Then followed the era of Camphine, which operated materially on the lamp trade of the time. As a means of illumination, when the spirit is pure, it is not inferior to gas; but the proper supply of air, in order to secure complete combustion, can only be arrived at by the nicest experiment. If due adjustment of the quantity of air is not attended to in the construction of the burner, then follows the escape of an unconsumed carbon in the form of flakes of a black snow, which was facetiously termed by *Punch* "an invasion of the blacks." The same distinguished authority compared the light and smoke of the lamp named to that of "a couple of farthing candles, and the smoke of six kitchen chimneys." Carefully attended to, all conditions being equal, the light was brilliant and colourless. The objections alluded to, the care required, imperfectly purified camphine, and an explosion or two arising from carelessness, in the course of a few years speedily terminated the demand for camphine lamps.

Moderator lamps were introduced from the Continent about the year 1850, and a few manufacturers in Birmingham directed their attention to their production. It may, however, be questioned if their manufacture ever was successfully naturalised in this town; the movements of the lamps, or their internal fittings, were alone made. The ornamental cases, many of which were very elegant, were imported from France; the demand there for this class of lamp, being very great, induced the French manufacturers to sink an immense variety of dies for the purpose of producing these cases or external ornamental coverings. The stands also, being chiefly made of zinc and cast in metal moulds, afterwards skilfully bronzed or gilt, were also produced by and purchased from the French manufacturers of moderator lamps. At present

the demand for these lamps in this country has so declined that it is doubtful whether any manufacturer in Birmingham is engaged in what may be called their "manufacture" in the true meaning of the term.

How science affects and adds to the prosperity of manufactures is well exemplified in the recent demand for immense quantities of lamps and burners for the combustion of "paraffin" oil. Liebig, so far back as the year 1841, demonstrated by experiment that paraffin is merely the solid and liquid form of "olefiant gas," which is obtained from the distillation of coal and peat. This idea having been started, Mr. James Young, then of Manchester, observing that the oil from which paraffin is procured, being connected with the coal formation, might be produced from coal by distillation, his experiments were confirmatory. In the Exhibition of 1851, paraffin in a solid form was represented by a solitary example in *one* paraffin candle, in the exhibition of 1862 a solid block of paraffin was shown, which weighed upwards of half a ton, and its purity was demonstrated by its colourless, inodorous, tasteless, and beautifully translucent appearance. It is, however, in the condition of oil that we have chiefly to view this product and its influence on metallic industry. The first use of the oil was as a "lubricant;" eventually, it took its place as an illuminating agent. The bituminous coal of Wemyss, Torbanehill, Boghead, Wigan, Newcastle, &c., on being distilled at a low red heat produce large quantities of the oil named. In the year 1860, the manufacture of paraffin oil in this country had reached the quantity of 2,300,000 gallons. If to this is added the influence of the discovery within the last four or five years of the "hydro-carbon" oil springs of America and Canada,* also used for lubricating and illuminating purposes, we shall arrive at some idea of the demand for lamps to burn paraffin oil. With a properly regulated supply of air, these lamps produce a very much more brilliant light than can be obtained from the consumption of an equal quantity of whale, or vegetable oils. In 1860, a lamp manufacturer produced in one year 247,431 lamps for the consumption of oil manufactured by Mr. Young. In 1861, the same manufacturer was producing at the rate of 1,200 per day, or 375,000 per annum. At the first introduction of the paraffin oil, these lamps were produced by Scotch houses engaged in the brassfoundry trade; but in

* The yield of petroleum in the United States of America, during the last five years, has been as follows:—1861, 24,000,000; 1862, 40,000,000; 1863, 70,000,000; 1864, 87,000,000; 1865, 91,000,000 gallons.

1861 the trade was introduced into Birmingham, and four lamp manufacturers began the manufacture. To these a new establishment was added, and small manufacturers turned their attention to the production of burners. The Birmingham production of paraffin burners reaches 500,000 annually; and of complete lamps of all prices, certainly not less than 75,000. Lamps were produced at prices varying from 7*d.* to 50*s.* each. Great quantities of "heads," viz., the receptacle for the oil fitted with burners, were manufactured. These receptacles were formed of flint, opal, and other coloured glasses. Bracket, reading, and pendant lamps, were also made. In these, the form of the bracket and pendant varieties (with the exception of the head) was adopted from the gas-fitting types. While, however, except from home competition, the manufacture of the complete lamp has been left comparatively untouched, the competition in the article of "burners" only (or that portion which screws into the oil receptacle) has been materially increased by importations from America and Germany. The English burners, which sold in 1862 at 8½*d.* each, are now reduced to little more than one-half; and quantities introduced from America have been offered at a still lower price. It may be questioned whether, in any branch of the brassfoundry manufacture, the division of labour and the facilitation of production, have been more attended to. The maximum in number within a given time, and the minimum in cost and profit, may be said to have been reached. As these burners are entirely produced from sheet brass, by the processes involved in Stamping and Piercing (already described), it will at once be understood that the rate of production is very rapid. A leading firm in the trade has stated that in the manufacture of these burners they use thirty-five pair of tools. If to the making we add that of the processes of dipping, lacquering, and fitting together; in all, thirty-eight operations, and three ounces of metal manipulated, a burner is produced for a mere trifle of cost. If the *modus operandi* for the production of these burners is important, attention to the proper quantity of air admitted is much more so, as on this depends the perfection of the burner, and the excellence, or the reverse, of the resulting light, the entire consumption of the carboniferous particles or their partial consumption only, and consequent attendant inconveniences of smoke, smut, and smell. For some years the paraffin lamp trade promises to be, if not an increasing, at least a steady one; and paraffin lamps will be adopted and take the place of those fed by animal or vegetable oils, in

localities where gas has not been, or is not likely to be introduced.

The improvements of locomotion and the rapid increase of railways, and the regulations of the Admiralty as to the necessity for ships carrying lights, have had a great influence on the lamp manufacture. Of Signal Lamps for Stations, the lighting of the interior of Railway Carriages, and others for Marine purposes, great numbers of practically useful but prosaic-looking lamps and lanterns have been, and are constantly being, produced. The former and latter, when illuminated by their interior lamps, indicate by the white, red, blue, or green lenses exposed, signals of danger or safety, necessity for caution, or the existence of the object which carries the light. The manufacture of these is carried on by many of the establishments engaged formerly in the oil lamp manufacture, and one or two new establishments have been called into existence.

One special department of manufacture connected with and practised in common with lamp making by lamp manufacturers remains to be noticed, viz., the production of small articles, not in bronze, but bronzed, consisting of Inkstands, Vases, small Candlesticks, Girandoles, Pastile Burners, Paper Weights, Figures, Animals, and other objects smaller in size, with some pretensions to artistic design and execution, but often entirely deficient therein, and singularly so as contrasted with the same class of objects executed by French modellers and artisans—Barbédienne, Barbezat, Deniere, Miroy Brothers, and other French bronzists on their stalls at the International Exhibitions in 1851 and 1862. As a general rule, the class of works named produced by Birmingham manufacturers was inferior in every particular. They were badly modelled and badly chased. If a classic design was selected for imitation, it was utterly spoiled either in its adaptation to a purpose for which it was never intended, or the modeller deprived it of its beauty of line and elegant contour. Figures well modelled and selected for imitation were converted into grotesques (if the original was not cast from), and grotesque figures, if imitated when they had passed through the alembic of modeller, caster, chaser, &c., were simply malformations. The attempt was too ambitious, and the results could only be, or have been, tolerated by a generation which knew little of manufactures, and less of art. Can it therefore be wondered at that this branch of manufacture should almost have ceased to be cultivated in connection with the lamp manufacture? or that it should have passed away from among us to France, where the demand is greater, the modeller more intel-

ligent and familiar with good examples of art workmanship—the chaser understanding the way to produce texture, and able to penetrate the intention of the modeller—the bronzer equally able to produce the colour which gives value to the united labours of all? Where good "bronzes" of a small size have been produced in Birmingham (such as Elkington's, which are entirely exceptional examples), they have not been due to their former producers, and there is every reason to suppose that even the perfection of these owes something to the influence of French artisans. A somewhat greater infusion of this element into English work cannot be objected to. "Art grows upon what it feeds upon." The ornamental metallic art of France, as regards its bronze working, is due to the munificence of its monarchs in encouraging the great workers in bronze from Italy to reside in France, and leave an impress which operates even now in bronze making in that country. Succeeding French sculptors carried on the production of large works in bronze, but, while they did so, they lent their influence on small works in the same metal; the result has been the present high position of the bronze manufacturers of France, which only by long years of patient perseverance Birmingham manufacturers may hope to rival. The stride made by French bronzists in the space which elapsed between the years 1851 and 1862 clearly indicates that the task will be a difficult one.

In one particular, viz., the production of imitation bronzes, figures, &c., the French retain a field untouched by any other nation. Allusion has already been made to moderator lamp stands produced in metal moulds, and then bronzed, by means of a superficial deposit of brass or copper, and then coloured to represent true bronze. They are thus produced from a carefully prepared original model. Metal moulds are made, which take to pieces like the plaster moulds used by the Italian plaster figure makers; into the metal mould, when closed, zinc in a melted state is poured, and speedily congeals. The cast produced is then trimmed up, bronzed, and sold at one-sixth of the cost if cast in bronze. Though deficient, so far as it lacks the finish of the "riffler" and "chaser," the bronze effect is admirably imitated, and figures imitative of, and copies of reductions from celebrated originals, are thus placed within the reach of those purchasers whose limited means would preclude the possibility of procuring examples in real bronze.

The wages of the artisans engaged in the lamp trade were comparatively high. In the best days of the trade, skilled workmen were well paid, and others in proportion. Female

labour at an early period was not so common in manufactories as it now is; and, in the lamp trade, was confined to lacquering and wrapping-up. In the paraffin lamp burner trade, large numbers of press women and girls are employed to cut out, raise up, and perforate the several parts, which form a complete burner, out of sheet metal; and these are paid occasionally by the quantity, at other times by the week—girls realising from 5*s.* to 7*s.* 6*d.*, and women, 10*s.* and 12*s.* per week.

8.—GAS FITTINGS' MANUFACTURE.

That Birmingham should now be the grand centre for the manufacture of gas fittings, whether plain or ornamented, is not to be wondered at, when considered in connection with its industry in metals—particularly brass—and as also that the first practical application of gas for lighting purposes was due to William Murdock, of Soho, the trusted servant and valued friend of his employers, Matthew Boulton and James Watt. In 1792, Murdock, then superintendent of the engines erected by the firm named, in Cornwall, lighted up his offices and house at Redruth with gas; and, in 1802, on the occasion of the peace demonstration of that year, the "new light" illuminated and disclosed in dazzling brilliancy the exterior of Soho House, at Handsworth, then the dwelling of Boulton, still standing, and the long extended front of the manufactory, now, alas! numbered only with the memories of the past! Murdock had, however, previously demonstrated the advantage of the new light by lighting up the offices at Soho; and in 1803, the whole manufactory was supplied regularly with gas. In 1804, the manufactory of Philips and Lee, at Manchester, was "lit" up, and very speedily Gott and Son, at Leeds, followed their example. Although the genius and scientific knowledge of Sir Humphrey Davy failed to comprehend the practicability and application of gas to the lighting of towns, in 1812, it was introduced into London, and in 1815, into Paris. The imagination of Walter Scott failed to realise the possibility of lighting up towns or dwellings with "smoke," as he facetiously called it, but in a few years he became a convert, and fitted up Abbotsford with gas. Absurd notions prevailed as to what gas was, and this no doubt greatly retarded its more speedy introduction. It was supposed to be in a constant state of ignition in the interior of the pipes; its pressure was exaggerated, and its explosive powers magnified. In order to provide for this, even so far down as the year 1819, Mr.

Wetherly Phipson, of the Dog Pool Mills, patented a gas pipe formed of lead internally and copper externally. Thirty years afterwards, *i.e.*, in 1849, a double brass tube was patented by Mr. R. W. Winfield for greater security, and intended to be applied to the manufacture of gas fittings. Mrs. Partington's futile attempt to sweep out the tide of the Atlantic Ocean with her mop, was not more successful than attempts to oppose the general introduction of gas, which soon rose in favour, and from the lighting of streets was introduced into shops, and thence into private dwellings. At an early period, the best gas fittings were made in Edinburgh; and about the year 1810, the late Mr. Messenger, of Broad Street, procured a workman from Edinburgh (the late Mr. Saunderson), and commenced the manufacture of gas fittings in Birmingham, and Mr. Heaton (an old and respected superintendent of the Birmingham Gas Company), informs us, that when at work in London in 1812, he fitted up gas work, made by Mr. Benjamin Cook, of Birmingham. To the two establishments of Messenger and Cook may therefore be traced the beginning of one of the now most important departments of the brass trade in the town.

If any of the earlier examples of these fittings exist, their bald forms would call up a smile, and their imperfect fitting seriously affect our sense of smell. All the keys or plugs of swivel joints and taps then used for gas were rivetted like the keys or plugs of ordinary beer and spirit taps (the era of screw and washer not having arrived). The forms of the various fittings were crude, imperfect, and ungainly, and the higher class of chandeliers or gaseliers—(a new word now superseding the absurd term *gas* chandeliers)—consisted in the making use of the series of patterns which had done duty for an oil arrangement, the lights occupying a similar position to the oil burner with its wick. The manufacturers and public failed to observe that, while contracted arms were a necessity of the oil order of things, consequent on the receptacle which held the oil being required near the burner, the requirements of gas did not necessitate this, while economy of light and its diffusion were increased by an extension of these arms or branches. If the then state of artistic excellence had been equal to the emergency, these might have been clothed (as they now are) with graceful ornament. That demand increases supply; and competition among manufacturers is a healthful stimulus and productive of improvement alike in design and manufacture, the gas fitting manufacture among others is an illustration. The period at which it became a distinct and separate depart-

ment of the brass trade is not clearly known. In 1820, probably some few lamp makers made gas fittings. In 1833, five manufacturers of gas fittings appear in the directory. In 1847, they increased to seventeen. In 1865, they numbered twenty-five. With this extraordinary increase of producers there has been an extraordinarily increased demand for gas fittings. In every quarter of the globe where gas has been introduced, Birmingham manufacturers of gas fittings find a market; the substantial quality of their articles securing a preference, and being exported to various cities and towns in Russia, Austria, Prussia, Holland, Spain, Bavaria, Belgium, Brazil, Chili, Batavia, Java, China, Japan, and to the East and West Indies. With this extended field of operations abroad, and an increased and increasing home trade, the expansion and increase is readily accounted for. But for their substantiality and fair prices, these fittings in the foreign markets would wage only an unequal war against similar articles of tasteful design—the ornamentation executed in zinc, bronzed, or gilt, the parts held together with soft solder—produced by French artisans and manufacturers, or the tinsel fittings of the easily-fed light-working Germans, or those of America, turned out by facile and well adapted automatic machinery, for the invention of which the citizens of the United States are celebrated.

But while the external forms of ornamental fittings have been improved, and rendered more attractive, unity of style in one object is better preserved. Lightness and elegance, in connection with improved modes of finish, have followed as a consequence, though large quantities of stamped bodies, vases, arms, chain links, and other portions of ornament, are used up in the construction of the cheaper class of competitive work. The tendency is towards a superior class of fittings, in which light and elegant castings have taken the place of the ornaments alluded to as stamped. Improvements in tube making have not been without an influence, and Fearn's patent for ornamenting tube, extended in its application to the decoration of varied sizes of tubes, has placed in the hands of gas-fittings manufacturers the means of producing articles very much more attractive at a comparatively cheap rate. Even the removal of the fiscal duties on glass, by extending room for experiment in that material, has operated on the gas fittings' trade by the introduction of new forms of glasses to be placed over burners. A leader in this direction was Mr. John Hunt, now of the Hope Works, who introduced not only elegantly formed globes and shades of flint glass, but also others coated

with opaline, and semi-opaque coloured glass, as shades for flexible stand reading lights, billiard lights, &c. Some ten or twelve years ago large quantities of glass and china ornaments were introduced and associated with brass construction, as vases, arms, and flowers. The demand for fittings with such decorations has, however, sensibly diminished, and they are now seldom asked for, except by purchasers of peculiar tastes. Even electro-deposition and photography have been pressed into the service for the production of the decorative parts of gas fittings. It is satisfactory, however, to record that mere novelty, apart from fitness, reigns only for a brief space of time—the fashion of the hour; and that now unity of material in brass only, is generally preferred in gas fittings.

Having described the ornamental portions of gas fittings, construction will necessarily form a part of the subject matter. Allusion has been already made, to the imperfect construction of the early examples of fittings, on the introduction of gas. As will readily be understood, all chandeliers or pendants were formerly stationary, they could not be raised or lowered. The introduction of a mode of construction by which this could be effected, and the light brought down or raised up, engrossed the attention and inventive skill of gas fittings' manufacturers and workmen. Among the arrangements first tried to effect so great and desirable an improvement, were stuffing boxes through which the tube attached to the body of the chandelier or pendant was appended, which worked telescopically, but the surface of the tube which drew down was unseemly; and it also diffused in the apartment in which the fitting hung an unpleasant odour, and the imperfectly purified gas deposited matter thereon which prevented the action of the slide. Racks and pinions were applied to effect the desired end, arrangements of helical springs tried, the internal tube was converted into a screw exteriorly, and the nut attached to the tube of the body of the chandelier, on being turned, elevated or depressed the chandelier. Atmospheric pressure was tried, but that which would sustain the weight of the chandelier at a low temperature failed when the apartment became heated, and this method also resulted in failure, and the simple water-slide, with its balance weights, tried at a comparatively early period, continues, and will continue, to be the simplest, best, and most useful arrangement for the purpose it is intended to serve, viz., to elevate or draw down the fitting of which it forms a part. Objections were long made to the unseemly appearance of the balance weights and to the fragile nature

of the chain with which these were hung; the latter defect was partially met by the application of a hempen cord or gut string, externally covered with wire: this, however, failed also. The objection was eventually overcome by Mr. Isaac Clements, who produced a chain made of sheet brass, which may now be said to be introduced generally on all water-sliding gas fittings. The unseemly dangling character of the balance weights has also been in some examples got rid of by carrying the body of the chandelier up in the form of an ornamental sheath to the height of the external stalk. Between this sheath or ornamental cylinder and the internal tube or real stalk space is left, down which the weight, to counterbalance the weight of the chandelier, works. Externally, no counterpoise weight is seen, and the ornamental character of the chandelier is not interfered with. The internal arrangement of this object is on the stuffing-box principle, with means for lubricating the piston-like apparatus, which allows the gaselier to be elevated or drawn down. To Mr. John Hunt this arrangement is due. Considerable change has also been made in the construction of lobby lamps, which now take the form of elegantly cut globes or vases, apparently sustained by cords or rope-like tubes of metal, the central down rod being got rid of, the gas passing down one of the twisted tubes. This method of dispensing with the central tubes was suggested at an early period of the gas fittings manufacture by James Simpson, Esq., Advocate, of Edinburgh, more generally known as the author of the "Philosophy of Education." Flexible tubes for the conveyance of gas also gave rise to numerous modifications of table or reading stands. Mantelpiece lights are also now generally adopted in best houses where taste presides.

It may be interesting to know that since the introduction of gas, no fewer than ninety patents have been taken out for the improvement of burners only, and parts thereof. The accepted class of such articles may, however, be limited to very few. Jets with single flame are now rarely used, and "fish tails" or "Scotch jets" have taken their place. This class of burners, or "nibs," as they are called, are made of cast iron, and produced chiefly in and about Manchester. On the contrary, the great proportion of Argand burners (so called from their form resembling the circular wick lamp burner invented by Mons. Argand) are all or mostly made in Birmingham. This burner, taking into consideration the amount of light given, and its quality in proportion to the quantity of gas consumed, is certainly the most economical when skilfully

made. The holes being uniform in size from which the gas issues, in the improvement of this kind of burner, terra cotta perforated plates have been applied instead of perforated steel or iron plates—the corrosion from impure gas sensibly corroding the steel or iron top away. The body of the burner was, and is still occasionally, cast. In 1847, however, the chief portion of the burner and glass holder, united in one, was produced by means of the stamping process, and a button was introduced, which rose up in the centre, and caused the flame to curve outwards. A glass was devised with special reference to the curve of the flame and cap, formed of wire gauze, or of perforated metal, which, fitted on the top of the glass, elongated the flame by increasing the draught or more completely consuming the gas. A few years afterwards, for the cap already named, a terra cotta concave disc was introduced, which, becoming heated by the lighted gas, consumed the carboniferous particles and other products unconsumed by Argand's without the terra cotta arrangement, or ordinary fish-tail, bat-wing, and other burners; these last improvements were also originated by the inventor already twice named.

The most recent improvement in connection with the manufacture of gas fittings, is in the substitution of cast iron, for lead, in the filling of the external covering or shell which forms the balance weights of water-sliding gaseliers, or pendants. The brass shell to be filled is placed in water, and the molten iron poured in. The water prevents the shell from being melted, its temperature never rising above 212°. Iron shot had been previously used for filling. The improvement consists in pouring in the molten iron, and the cheapness of iron in comparison with lead; but the specific gravity of lead is greater than iron, and it may be questioned whether the increase of size of shell, in many instances rendered necessary by the lightness of the cast iron, is commensurate with the difference in price between the two metals used, *i.e.*, iron or lead, and all the more that in the dipping operation the iron is more operated upon by acid than lead, thereby increasing the difficulty in finishing; if polished, or bronzed, the same objection does not apply. This improvement is the invention of Mr. James Atkins, of the Cambridge Street Works.

In fitting together parts of gas fittings in process of manufacture, it is now customary to avoid the use of soft or tinman's solder; the best houses in the trade invariably use hard solder; and the primitive method of screwing tubes into joints and

stopcocks, trusting to white lead for tightness, even in brackets, branches, &c., is carefully avoided. The use of white lead, and leather, or card washers is reduced to an exception.

The Gas Fittings manufacture is one which has improved by competition as regards superior workmanship; and though leading articles may be somewhat lighter, they are better fitted, equally serviceable, very much cheaper, and better finished, than they were when they cost in some instances over one-third or a half more. These remarks apply to portions of fittings, as single and double brackets, and such articles as are used, of a plain character, in ordinary shops, bedrooms, and servants' apartments in houses, and also in public institutions. Where ornamental work is introduced in better class fittings, any comparison in price, of a satisfactory kind, cannot be made; but more and better work can now be had for a sum which, a few years ago, could only have purchased an article, the ornament on which was calculated to degrade rather than adorn. At the present period there is a greater demand for better and higher-priced articles than there was ever known before.

A new feature distinguished the gas fittings exhibited by Birmingham exhibitors in the International display of 1862, viz., the rich colour of the metal in which many of the chandeliers and more expensive articles were made. This was principally due to a greater preponderance of copper over the zinc used in the composition of the brass employed in their construction. If to this we add that the colour was rendered more brilliant after dipping in acid, by means of friction against brass wire brushes revolving in a lathe propelled by steam power or manual labour, (technically "scratch brushing)," and that then to say it rivalled the appearance of a more valuable metal, is no exaggeration. If to this is added the feature of a variety of many-hued bronzes over the limited range of colour in the bronzes or bronzings at the command of English metal workers previously, the advance is very marked as regards finish. One peculiar bronze, as applied to the class of work now under consideration, marked the year 1862; viz., the brilliant steely reflective black bronze produced from a solution of platinum (*i.e.*, the bichloride).*

* For the information of the uninitiated, it may not be out of place to state the expression "bronzing" must not be confounded with the metal called bronze, used for statuary purposes; and that bronzing, to be properly understood in connection with brass, does not consist in covering the surface of the metal to be bronzed with an opaque pigment applied with a brush. It is either the result of chemical action, by which the colour of the metal is changed, or a coating of another metal is thrown down on the metal to be bronzed. Thus the common black bronze, the only kind at the command of the Birmingham brassfounders for a long series of years, was produced by the immersion of the article in a solution of acid and

Until very recently the component parts of ordinary Gas Fittings, as Main Taps, Stop Taps, Swivels, and Couplings of various kinds, were produced entirely by hand labour, and the operation of "plugging," or fitting in the keys or plugs to the taps and swivels, was performed by hand labour, the lathes only in some instances being propelled by a steam power. The operation was performed thus:—the barrel was bored out with a taper "rimer" or "borer," the plug was fastened in the lathe by screw, or clams; it was then turned down to a taper form, corresponding to the interior taper of the barrel or socket. This was arrived at by placing the barrel on the key, and observing, while the key rotated and the barrel was held fast, that the friction of the two produced the indication of a general coincidence. If they did not do so, the turning tool was again applied to the plug, till the proper bearing or taper was arrived at. Barrel and key were then seated by grinding together with loam—the set-off for the washer turned down—the hole for the screw having previously been drilled and tapped. The completion of the various parts, afterwards, as the squares of the joints, the heads of the keys, the finishing of the screws and washers, the filing away of portions of the barrels, to convert taps into stop taps, was all done by hand labour; and the consequent irregularity and imperfection, or perfection of the work, was entirely dependent on the amount of skill possessed by the workman.

That no successful attempt should have been made to produce these parts of Gas Fittings, known as Main and Stop Cocks, Swing, Universal, Swivel, and Union Joints, Bracket Backs, and Pendant Tops, previous to the year 1859, is matter of wonder, but that it has now been done and

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salamoniac, or spirits of salt and arsenic, or the two last-named associated with smithy iron scales. In the case of the two last mixtures, the articles were partially heated before immersion in the liquid; on being withdrawn they were black or of steely hue. They were then brushed with blacklead, and eventually coated with lacquer of a deep transparent yellow colour, which produced the ordinary green bronze, now but seldom asked for, or preferred. A lacquer of a more transparent colour produced a blacker shade; on the contrary, the base of the red bronze, or Venetian, or Florentine, is the result of a thin coating of copper, its shade being partially obscured by blacklead also; it is coated for protection with lacquer. All the bronzed zinc figures imported from the continent, and now so common in this country, many of which are very excellent copies of celebrated original works, owe their beauty of colour to a superficial coating of copper, varied by the application of chemicals which alter their hues; even the impress of age, the verdigris florescence which is supposed to give evidence of "hoar antiquity," and the presence of which is accepted by archæologists and the dilettanti as denoting the *bona fide* antique origin of the specimen, can now to be produced in a few hours. In bronzing, continental metal workers are still our superiors; the new colours of bronze are due to them, their scientific knowledge being superior to that of English workmen, and affording another strong proof of the necessity of chemistry, as regards the metals, being more generally studied by English artisans. It may, after the explanations given, be unnecessary to state that the colour of the bronze produced, as in bronzed articles, is only skin deep, and that a scratch reveals the original metal, the surface of which has been bronzed as already described.

is being done by one intelligent manufacturer, is a matter of satisfaction. The machinery employed is automatic in its operation, and is worked by levers. The successful operation of the machines, however, requires careful and skilful grinding and setting of the tools and cutters employed to effect the desired end. The principle involved in the "plugging" process is essentially that of the slide rest. In boring the barrels, the borer is fixed on an iron chuck in the lathe, and the barrel to be bored in the slide rest, which is then worked, and propels the barrel against the borer till the sand marks of the core are obliterated. The plug, or key to be fitted is securely fixed in suitable clams or grips, and the tool set, in order to produce a taper the exact counterpart of the interior of the barrel which has been bored out as described. The lathe is set in motion, the slide rest operated upon, and the result is—a plug which fits air-tightly the barrel of tap or joint. This effected, and the slide rest tool withdrawn, a tool and drill is brought up against the end of the key or plug; the former makes the set-off for the washer to fit on, the latter drills the hole for the reception of the screw, which, in connection with the washer, allows the joint, key, or plug to turn freely in its barrel. The set-off for the washer is finally squared, or made into a D form, by the key or plug being held firmly in a grip; a circular cutter cuts away the metal and produces the flat of the washer if D in its perforation. If square is selected as the form of the perforation of the washer, the position of the key is changed four times, the cutter brought to bear, and a square produced. A somewhat similar cutter and operation cuts away that portion of the tap barrel which converts it into a stop cock or tap; and the hole for the insertion of a stop pin in the key is also drilled by machinery. The screws for the bottom of the keys are made from a cylinder of metal, corresponding in thickness to the extreme diameter of the size of the head of the screw, also by the operation of cutters. Even the washers are turned in a correspondingly automatic manner by placing the perforated disc to form the washer on a perpendicularly rotating spindle, the upper end of which is formed into a projecting shoulder, corresponding to the form of the perforation of the washer, on this the washer is dropped; a cutter formed to produce the level of the external circumference of the washer is brought down upon by means of a lever, and finishes it. The heads of the keys, the squares of the plugs, and the nuts of couplings are also finished by means of suitably formed cutters. Without elaborate

illustrations, it is almost impossible to convey any adequate idea of the ingenious mechanical arrangements invented to produce the results arrived at. Still it may be hoped that the brief sketch given will enable practical readers to comprehend that the work accomplished must necessarily be very superior in regularity and appearance, to that produced by mere hand labour, which is thereby reduced to a minimum, and is confined to simply "seating" the plugs by a trifling grinding with loam, and then lubricating them with grease to facilitate their easy working, and fitting them together. The ordinary *modus operandi* of producing the same class of works by means of hand labour has already been described, and may be referred to by way of contrast. While the advantage of hand labour in the formation and finish of the artistic parts of gas fittings, and in fitting the several parts together, will still remain a necessity, it may with confidence be affirmed, that the structural parts named can be better accomplished by means of automatic machinery. Sticklers for old modes of working may object to its adoption, and say—if the tools are not properly set, great quantities of plugs or barrels will be rendered useless. Granted: but on the setting of the tools and intelligent superintendence of the execution of the work, the success depends; and carelessness, ignorance, or something worse, can alone cause failure.

The system which we have attempted to describe has been perfected by Mr. Joseph Breeden, whose eminently practical knowledge in the manufacture of gas fittings is shown in the construction of the various machines calculated to accomplish the varied operations described. It need not be added that, to work the system profitably, considerable quantities of articles require to be produced, and in this the machinery employed forms no exception to the rule of the application of automatic machinery for the production of other articles in metal. "It is the quantity produced which pays." Various manufacturers, it is understood, have applied machinery without success, or with only comparative success. If they have failed, they must have done so owing to the inadequacy of the means they employed to accomplish the end; the imperfect construction of their machinery, or the want of care, skill, and practical knowledge in grinding the cutters, and setting the tools. It should not be forgotten that parts of articles very much more complicated than swing, swivel, and universal joints, and other parts of gas fittings, are produced by machinery; among others, portions of Gun Furniture, including gun locks, as they are produced at

the Government Gun Factory at Enfield and the Small Arms Manufactory at Small Heath, near Birmingham; also the several parts of Mortise, Chest, Safe, and other Locks of Hobbs'. There is, therefore, no reason why Gas Fittings, so far as regards the parts named, should not be, as they are, equally successfully produced.

Ultimately it may confidently be predicted that machinery will be adopted for the production of parts of the common fittings by all the larger manufacturers in the gas fittings' trade. And as taste is improved and fashion operates, new forms and combinations of forms of fittings, to replace old and to supply new, will be called for. In the production of these, a greater amount of skilled labour, united with artistic feeling and knowledge, will be evolved; and the exercise of the powers of mind, in connection with superior manipulative skill, will certainly result in producing a superior class of workmen, the existence of which, really lies at the foundation of superior execution in works in metal, particularly brass, and as exemplified in the production of the best class of Ornamental Gas Fittings.

In order to illustrate the reduction effected in the prices of gas fittings, a comparison has been made of these as they appear in an old pattern book of the year 1820, with one now in circulation. It will at once be understood that the several parts of fittings were by no means so numerous nor so various as they at present are. The prices of similar articles of the two periods *will now be compared as under*:—

	1820.	1866.
A stiff bracket, straight, 12 inches long	5/-	1/9
Single ditto, back to swivel and cock, 12 inches long	8/5, 6/6	1/9½ 1/11½
Double ditto, ditto ditto	12/5	3/9
Single pendant, fast top, five-eighths down rod, three-eighths in bend	13/-	
Same article, but with swing top		5/6
Double pendant, same size and style of tube	19/6	
Ditto ditto, but swing top		10/-
Harp pendant	50/-	21/-
One-light pendants, formed with corona rim, cast, 15 inches diameter, three cut out of sheet metal link chains, and stamped rollers, behind one of which chains a small tube came down to conduct the gas; *no swing joint*. Other examples in which there were no chains, but with two tubes	33/-, 39/-, 44/-, 50/-	
One-light pendants, more useful and attractive, fitted with water slide		14/-, 21/-

	1820.	1866.
Two-light STIFF pendants or chandeliers, consisting of two tubes placed asunder and attached to two small brackets, by no means attractive	56/-, 60/-	
Another example, with down rod, cast body, with two scroll bunches attached, husk in centre of down tube, two chains	84/-	
Two-light water-slide pendants, with stamped or cast work		18/6
A three-light stiff, similar to the two-light, but with additional attractions in the form of a cast perch or lizard back pin	110/-	
Three-light water slides, very much more attractive, can now be purchased from		25/- up to 50/-
Elbow Argand burners, 1 inch diameter.	3/6	2/2¾
Crutch ditto ditto	3/8	2/5½
Three-jet Nib burners	10/- per doz.	/4½ per doz.
Batwing burners	9/- per doz.	/4½ per doz.
Three-eighth inch tap, long end and barrel	1/8	/7
Nosepieces with jet or batwing	15/- per doz.	2/10½ per doz.
Ball joints	10/-, 8/8, 8/-	1/1 to 2/3
One-inch main taps, internally screwed, no caps, each	14/-	2/11
Three-fourth inch ditto ditto „	5/4	1/7
One-half inch ditto ditto „	4/-	1/3½

It would have been interesting to have carried out the comparison further, but unfortunately we have not the means for doing so, as the old pattern book referred to contains only representations and prices of articles stated or compared, with the exception of scroll brackets, which in the 1820 book are priced from 11*s.* 6*d.* up to 24*s.* for 12 inch. Equally good can now be purchased from 5*s.* up to 17*s.*, and rendered more attractive by the introduction of ornamental tube, and very much better designed scrolls, &c. The slight difference in weight of metal does not at all—even admitting the articles priced in the 1820 book to be heavier—account for the difference in price. The increased demand for fittings of all kinds, whether plain or ornamental, has operated beneficially in not only reducing the price, but in producing a superior article as regards design, workmanship, and finish. On the authority of a practical manufacturer it may here be stated, that workmen engaged in the leading parts of the gas trade are now getting higher wages, or more money than they did fifteen or twenty years ago. If more work is done for the money earned, its execution is facilitated by appliances which at an early stage of the manufacture did not exist; the filing of key heads, or the squaring of the plugs, is not now effected by the hand labour of boys, but by machinery. Plugging has become a

mechanical operation, and the skilled labour absorbed in the production of mill and other common fittings, taps, &c., has been turned into other and more profitable departments of the manufacture, where there is a greater necessity for skill and intelligence, and in which it can be displayed.

As regards the manufacture of gas fittings, they may be said to involve the highest class of talent at command in brass manufactures, viz., that of the designer and modeller. In the majority of manufactories the designer is the modeller also. In one or two establishments the designer confines himself to the production of designs only, leaving to the modeller the production of the designs in wax, pipe clay, &c. The repairers and chasers are employed in the "work" in chopping up or rendering the parts of the castings from the patterns sharper and more distinct in the detail. Experienced workmen are required for fitting the several parts together of chandeliers, &c.—"Dippers," to "dip" and "bronze" the work, and "burnishers" to burnish it. Boys and lads afford considerable assistance to workmen. The latter, when quick and expert, earn fair wages. Female labour is seldom taken advantage of in the gas fittings' trade, and is generally confined to the lacquering and the wrapping up of the finished goods. Workmen who undertake to execute work complete, including dipping and burnishing, and pay their own workmen, frequently earn from £2 to £4 per week. Workmen who work separately, from 25*s.* to 35*s.* per week. Dippers and bronzers, 20*s.* to 25*s.* per week. Lads between twelve and eighteen years of age, 7*s.* 6*d.* to 17*s.* Boys, 3*s.* 6*d.* to 6*s.* Lacquering women, 8*s.* to 10*s.* per week. In the early part of the year, when the winter orders for the home trade are completed, and no foreign orders are in hand, there is frequently a little slackness in demand, but such periods are taken advantage of by manufacturers to revise old patterns and prepare new for the ensuing winter trade.

9.—NAVAL AND ORDNANCE BRASSFOUNDRY.

Originally a considerable number of the articles included in the department designated as Naval Brassfoundry were produced by manufacturers of cabinet brassfoundry, and to some extent they still are and continue to be represented in their pattern books, these articles are, however, limited in variety, and confined to Cabin Hooks, Lashing and Rope Eyes, the smaller varieties of Hinges, leaving the great ma-

jority of objects or appliances in brass and gun metal for ships' use to be made in the towns where ship building is practised, as London, Liverpool, Bristol, Glasgow, Greenock, &c. The increase in the commerce of this country and in shipping yearly, has not been without its influence on the brass trade. It has been already shown, in reference to the engineering trade (that such articles as steam-taps, pressure gauges, whistles, and other brass articles made in engineering establishments) have been transferred to be manufactured in Birmingham; so in like manner the great quantities of articles made of brass for ship building purposes have now been transferred to this town for production or manufacture, and arose as a special department of the brass trade in the year 1844, when Mr. James Marrian, of Slaney-street, commenced a manufactory for the production of the various special articles in use by shipbuilders, uniting those already, or formerly made. In this he was aided by skilled workmen acquainted with the technical peculiarities and uses of the articles required. Various regulations issued by the Office charged with the Marine Administration of the country, by the Board of Admiralty, as regards seagoing and coasting vessels carrying signal lights, have in no small degree operated in extending this branch of trade. The specialities which distinguish the articles produced are their substantiality as to material, thorough good fitting, workmanship, and finish, all of which require an amount of strength, to resist wear and tear, the hard usuage to which they are subjected by the war of elements, and consequent strain to which they are exposed when in active service. Among the specialities produced may be named receptacles for ships' compasses or binnacles, portlights or scuttles, by which light is admitted and the sea excluded, decklights for a similar purpose, lashing and rope eyes, ring bolts, pulleys of an ordinary kind, and others with friction rollers in order to diminish friction to a minimum; strong and substantial hinges of various forms, adapted to suit the several purposes of the doors to which they are attached, and which swing on them; quadrants of various forms to regulate the opening of the down sashes; sash lifts, rowlocks, belaying pins, cabin railings, so useful to provide sea legs for landsmen; stair and poop railings, stanchions, basin rings, hasps and staples, and boat hooks; and an infinite variety of means of artificial lighting in the form of candle and oil lamps, fitted up with gimmal joints in order that in whatever position the ship is placed (or whether she lurches or rolls) the lamp retains its vertical position, the oil

and wick, or candle, remains in its receptacle, and the light continues to burn. Taps, valves of various kinds, pumps and other articles adapted for sanitary purposes on shipboard, are also included among the articles made. Allusion has been made to the regulations issued by the Admiralty in reference to signal lights for attachment to various parts of ships, in order to prevent collision. These take the form of lanterns, of a very substantial character, glazed with various coloured discs of glass; occasionally the glass is globular. In every case the glass of these lamps, whether marked for masthead, port, starboard, or anchor, is either protected by bars, or so sunk into the metal frame of the lamp that injury to it under even extraordinary circumstances is nearly impossible. Bells mounted on brass frames or standards, and signal cannons or brass guns, fitted in working frames, and appliances for the burning of various coloured lights as signals, indicate somewhat imperfectly the various articles which come within the province of the manufacture of the Naval Brassfounder.

Ordnance Brassfoundry, as its name indicates, deals with the production of articles connected with fittings for artillery. The guns themselves, if of brass or gun metal, are chiefly cast at Woolwich, and turned and bored out there; but the fittings have been largely produced in the establishment already named. These fittings, however, it should be understood, are applied not only to brass or bronze guns, but also to the best varieties—as the Whitworth, Armstrong, and others—made of wrought or cast iron or steel. The Crimean, Indian, and Chinese wars, more especially the Crimean, it will be recollected, directed the attention of the authorities at the War Office to the improvement necessary in implements of war, and particularly to the defects in ordnance. The result was, that not only in the structure of the guns, the material or metal of which they were made, but in the appliances to secure certainty of aim and discharge, improvements were introduced. Thus the detonating or hammer lock replaced the lighted match of the gunner, and "sights" attached to the end of the gun furnished the means of correctly pointing it so as to cover the object aimed at or the point against which the fire was directed. The arrangement of a screw aided the director of the gun in elevating or depressing, and maintaining it in position till discharged; and the fuzee, graduated in order to effect the explosion of the shell in which it was introduced, at the calculated distance where it fell, increased the efficiency of the destructive missile.

Of such aids to modern warfare as percussion or hammer locks and covers, tangent sights, elevating screws, fuzees, &c., large numbers were produced during the progress of the recent wars, and still continue to be produced from time to time in the establishment named. 3,000 shell fuzee were orders frequent during the war.

The articles mentioned, and others of an analagous character, indicate the sphere of operations and the productions of Ordnance brassfoundry.

The processes involved in the production of the Naval and Ordnance brassfoundry articles are similar to those practised in other departments of the finished brass trade or manufacture, viz.—casting, filing, turning, and screwing. The style of finish, however, is somewhat different in the majority of the articles, and is technically known as "sanded," *i.e.*, produced by passing over the article, when filed flat, sand, or emery paper, or cloth, in the direction of the file marks, and thus producing uniformity of surface. In turned articles, after turning, the sand, or emery paper, or cloth, is applied to the article revolving in the lathe. The articles are then protected from oxidation by lacquering, dipping, or bronzing; and burnishing is practised, as already described. In the more ornamental examples, as lamps for saloons and railings for cabins, &c., the composition of the brass is similar to that used for articles of ordinary brass manufacture; but in large hinges and Ordnance fittings, gun or bronze metal is adopted, composed of ten parts copper and one part of block tin. The wages of workmen vary from 15*s.* to 25*s.* per week; superior workmen, employed on best work, earn from 25*s.* to 30*s.* Women are not engaged in this trade except as lacquerers. Lads earn from 3*s.* 6*d.* to 7*s.* 6*d.* per week. Casters are paid per cwt. for the work produced, whether common, common fine, or cored work. At present there are about eighty hands employed in the manufacture of Naval brassfoundry and Ordnance fittings.

As the greatest difficulty has been found in arriving at the periods when the several departments of the brassfoundry trades became separate branches, it has been deemed important to record, for the benefit of future enquirers, the origin of this branch of manufacture, which promises in future years to become much more extensive and complete than it is at present.

At an early stage of the enquiry which has resulted in this report, 400 circulars were sent out, addressed to manufacturers engaged in the production of raw material, as sheet metal, &c., and also to others who made finished brass articles. On the fly-leaf of the circular a list of materials consumed in the brass trade was given, with a request that it might be filled up and returned to the Chairman of the Industrial Committee. Of these circulars, 29 were returned as "dead letters," 12 without any information, and of 327 no notice was taken.* Only 32 contained information of the kind desired, and one was returned signed by "An overtaxed manufacturer," with the request that the Committee would kindly inform the public, through the press, if these papers were destined to come into the hands of the Assessors of Taxes. From the 32 circulars, the editor of this volume selected 17 returns, which bore evidence of being of a *bonâ fide* character, and gave the figures to the present writer, who has added the consumption of material in one establishment. The results are as follow:—

MATERIAL CONSUMED ANNUALLY BY HOUSES ENGAGED IN THE BRASS MANUFACTURE.

	By 17 Houses.	By 1 House only.	Total Consumption by 18 Houses.
Brass, in Tons	1,725		1,725
Copper	1,030	450	1,480
Iron			
Zinc	950	250	1,200
Lead	40		40
Tin	80	50	130
Coals	10,414	4,000	14,414
Coke	1,000	1,050	2,050
Aquafortis (in carboys, by number or weight) Tons	32	21½	53½
Oil of Vitriol „	6	12	18
Lacquer (*Best*, in gallons)	109	250	359
„ Methylated	1,889	800	2,689
Argol (by weight) lbs.	1,112		1,112
Number of Furnaces usually at work	86	15	101
„ Casting Pots of Stourbridge Clay	45,972		45,972
„ Plumbago	56		56
Rolling Mill, pairs of rolls	34	8	42
Muffles for Annealing Metal	25	3	28
Number of People Employed.			
Men	1,095	450	1,545
Boys	632	270	902
Women & Girls, as Lacquerers: Chargers of Tube, Press Women, & Wrappers-up	217	70	287
Modellers, Chasers, or Pattern Makers	19	10	29

* [As each of the circulars sent out had a *stamped* and addressed cover for the return, the 327 manufacturers have benefited by this enquiry to the extent of one penny each.—EDITOR.]

CONSUMPTION OF MATERIAL IN THE BRASS TRADES AND ITS EFFECTS ON OTHER INDUSTRIES.

By the return already introduced from only a few manufacturers, some idea of the quantity of material used in the brass trade may be formed; but it is not only the immense consumption of copper and zinc which forms the component parts of the metal brass, or the labour absorbed in the trade itself, which make it so important an element in the trade of Birmingham. The immense quantity of coals consumed for steam engines, the coke which is used for heating the furnaces in which the metal is melted, and in soldering stoves, the Stourbridge clay consumed in the making of crucibles, the tons of loam and sand quarried for forming the moulds, the wood charcoal ground into powder for dusting the moulds, and the bean and other flour with which the moulds are dusted form a vast addition to local trades. Besides these natural products, chemical science contributes largely to the materials used; of these, boracic acid from the lagoons of Tuscany, in the form of the borax of commerce, is consumed in tons for soldering purposes. The lead chambers of the acid manufacturer supply thousands of carboys of oil of vitriol, for cleansing the rough oxide from the surface of the tubes and metal which have been soldered; and larger quantities of nitric acid or aquafortis are used for dipping purposes. Crude tartar, in the form of powder, (the deposit found at the bottom of wine casks) and called argol, is also used in connection with the operation of dipping. Also spirit of wine—the spirit in which seedlac is dissolved to form the lacquer used to protect brass work when finished—is consumed in immense quantities; and the brown and white papers in which the goods are wrapped up, may alone be estimated by thousands of tons, and the superficial area which produces elm and other timber used for making the packing cases and casks is very great. It is yet a doubtful matter, whether methylated spirit of wine is equally good for lacquer-making purposes; but the removal of the fiscal duties from spirits of wine to be used for manufacturing purposes by the introduction of methyline (largely promoted by the exertions of the late Henry Smith, Esq.,) has been no mean boon to the brass trade. The abolition of the duties on paper has been equally beneficial, and modern chemistry, as applied to manufactures, has in no direction operated more efficiently than in the reduction of the prices of aquafortis and oil of vitriol. The former, sold prior to 1802, at 5*d.* per lb., can now be had at

2*d.* per lb.; the latter, we are told, sold prior to 1800, at 3*s.* per lb., in that year it was reduced to 1*s.* per lb.; it is now sold at 1*d.* per lb.

In order to show the quantity and value of metals consumed in one year, in the brass manufacture, the following estimate is introduced:—

TOTAL CONSUMPTION AND VALUE OF METALS CONSUMED IN THE BRASS MANUFACTURES OF BIRMINGHAM IN THE YEAR 1865.

	Tons.	Rate per Ton. £ s. d.	Value. £
Copper consumed in finished Brassfoundry, Gas Fittings, &c.	2,000	...	...
Copper consumed in Yellow Metal Sheathing, Bolts, &c.	6,000	...	...
Copper consumed in Locomotive and Marine Boiler Tubes	5,000	...	...
Copper consumed in Telegraphic Copper Wire, Brass Wire for export, Pins, Screws, and other purposes	4,000	...	...
Copper consumed in Rolled Brass, not Sheathing	2,000	...	...
	19,000	at 86 0 0	1,634,000
Old Brass, Sheathing, as Muntz's, (returned for remelting)	5,000	„ 60 13 4	303,333⅓
Old Locomotive Tubes, as Green's solid tube	2,000	„ 60 0 0	120,000
Old metal received from the sweeping of shops, turnings, filings, and caster's dirt, and collected by hawkers, and in the country	1,000	„ 56 0 0	56,000
Spelter, or Zinc, used in making Brass	11,000	„ 21 12 0	237,600
Block Tin, used in making Bells, Mill Brasses, Gun Metal Castings, Tin Solder, Patterns, &c.	200	„ 94 0 0	18,800
Lead, for filling Balance Weights of Water Sliding Pendants in Patterns, Solder, and in Cock Metal	100	„ 19 5 0	1,925
			£2,371,658⅓

The next table illustrates the increase of establishments and manufacturers engaged in the brass manufacture, at three separate periods, *i.e.*, 1800, 1830, and 1865.

	1800.	1830.	1865.
Manufacturers entered as Brass Founders and Stampers, &c.	28	144	176
Bell and Cock Founders, Plumbers' Brass Founders, &c.	6	32	39
Brass Candlesticks	6	17	14
Brass Casters	2	10	42
Curtain Rings	2	5	4
Brass Nails	1	9	3
Rolled Brass and Wire	5	17	31
Tube Makers	0	12	20
Lamp, Lustre, and Chandelier Makers, for oil and candles, and small ornaments, in 1865, including Paraffin Lamps, also Gas Fittings Manufacturers, same also being included under the generic term of Brass Founder	0	29	63
Gas Fittings	0	5	25
Mediæval Brass Foundry	0	0	4
	50	280	421
Number of Manufacturers by enumeration	50	160	216

Thus in 1800 there were engaged 50 manufacturers in apparently seven branches of the manufacture; in 1830, 160 manufacturers in eleven branches; and in 1865, 216. The number of establishments shown—280 in 1830, and the 421 in 1865—arises from manufacturers engaging in several branches of the business, and their being entered in Directories under the several headings. Accepting the latter arrangement, the result is as follows:

1780	.	50	.	1825	.	163	.	1847	.	301
1783	.	78	.	1833	.	174	.	1853	.	357
1821	.	112	.	1843	.	178	.	1865	.	421

INCREASE OF MANUFACTURERS.—IMPROVEMENTS IN MANUFACTORIES.

The increase of the number of manufacturers is, however, less an index to the expansion of the Brass Manufactures of Birmingham than the extension of the premises of many old establishments, and the increased number of hands now employed therein. Formerly, with the exception of such manufactories as those of Timothy Smith and Sons, Messenger's, and the Cambridge Street Works of R. W. Winfield, who in the beginning of the present century erected new premises, the works were small, and the workshops low-roofed and imperfectly lighted. They were in fact dwelling-houses converted into workshops, and were chiefly situated down courts, the manufacturer residing in the house in front. Suburban residences in the early days of the Brassfoundry trade had not come into fashion. The manufacturer was not unfre-

quently his own "rough warehouseman," and some 20, 30, or 40 workmen included, his whole productive power. They treddled the turning lathe, and he, not unfrequently, begirt with apron, examined the work, tied it up, made out the invoice, and sent off the finished work to its destination. This primitive state of things has, however, changed, and within the last twenty years manufactories have been specially built with reference to the requirements of the manufacture, the workshops frequently large, roomy, often well ventilated, (though too little attention is still paid to ventilation,) surrounding, in many instances, the three sides of a square, with offices and warehouses in front. Shafting, worked by steam power, is led into the shopping to drive the lathes. The casting shops are separate buildings, high-roofed, with means to allow the escape of the noxious fumes arising from the metal when pouring. Special provision is also made for "dipping," and a supply of water is in the immediate vicinity of the shed, in which also provision is made to allow of the escape of the acid vapours. The same holds good in reference to lacquering rooms in newly-erected works. Formerly these consisted of a miserably small and cramped room, with a couple of iron plate stoves or hot-hearths, presenting 48 feet of iron heated to a high temperature, and a low roof, rarely exceeding 11 feet in height, the room itself in size 12 by 15 feet. In this room some five or six females worked. Now these rooms are of large dimensions, and with high roofs. If so much has been done in the manufactories and appliances for the production of finished brass goods, an equal change for the better is recognisable in establishments for the production of sheet metal, wire, tube, &c. For the creechy rolls, the primitive draw-benches, and clattering wire blocks, rolls of great size and power, fitted into massive iron frames with adjusting indexes, drawbenches with admirably fitting trains of wheels and chains of great strength, and wire-drawing blocks well fitted, revolving truly and silently, have taken the place of their imperfectly constructed representatives in a preceding generation, and demonstrate the advantage taken of improved mechanical skill to facilitate production and lighten labour. At the same time it should be stated that the buildings in which the new machinery is fitted up are large, ample, high-roofed, and of course on a ground floor. All the workmen being seen at once, the means of inpsection and supervision are thus materially simplified, and the contrast afforded by comparing the new with the old establish-

ments, of which some are still in existence, is very startling. Allusion has been made to increase of workmen in manufactories of comparatively long standing; thus some Cabinet Brass-foundry establishments, which ten or twelve years ago employed each about 60 or 80 hands, now employ from 150 to 200 each; and one house which embraces several branches of the Brass trade, and which in 1835 employed not more than 100 workmen, now numbers 800. A document which came into the possession of the writer is curiously illustrative of the progress of the establishment named, and shows the following changes:—

In 1835	110	Workmen
„ 1849	433	„
„ 1852	700	„
„ 1866	800	„

The payments of workmen, for the month of April, in the years named, in the same establishment, were as follow:—

1840	£721	16	5
1842	848	13	3
1844	944	10	1
1845	1,176	17	5
1866	2,872	17	3½

The number of workmen and payment of weekly wages would no doubt, in other establishments in the brass trade, show proportionately increased numbers, and increased payments, thus marking unmistakeably the vast increase in the number of workpeople made in five-and-twenty years.

INCREASE OF WORKMEN AND WOMEN.

The growth of the manufactures in brass is further demonstrated by reference to the increase of the labour employed therein, but there are no means of obtaining such an estimate earlier than thirty-five years ago. The following shows the increase, and by no means overstates the amount:—

NUMBER OF WORKPEOPLE MALE AND FEMALE OF ALL AGES ENGAGED IN THE BRASS TRADE IN THE FOLLOWING YEARS:—

1831 . . 1,785 1841 . . 3,408

1851 AND 1861 SHOWS THE NUMBER OF EACH AGE, AND SEX, AND 1865 SPECIALISED AGES OF LACQUERERS.

	1851		1861		
Males above 20	3,081		3,836		
„ under 20	1,833		2,379		
	Males	4,914		Males	6,215
Females above 20	1,111		988		
„ under 20	670		725		
	Females	1,781			
		6,695			
Lacquerers above 20			227		
„ under 20			179		
				Females	2,119
					8,334

If an increase is added equivalent to half the census period it may be assumed that at present, 1866, the number of workpeople employed in the Brass Manufactures is not below 9,500, especially if it is taken into consideration that the demand for labour is increasing, consequent on the rapid extension of the trade.

As regards the remuneration of workmen, &c., the brass trade certainly does not stand in an inferior position, and considering the almost constant employment which it affords to all willing to work, it may be esteemed a desirable occupation. That the remuneration or rate of wages is not declining will be gathered from the following extract from a letter written in 1845:—"May 12th,—The wages of workpeople do not fluctuate much in this establishment, many of the people are paid according to their earnings, *not per day*, but by the piece. The general rates, whether day or piece-work, are as follow:—Best workmen 30*s.* per week; ordinary ditto, 20*s.*; caster, 30*s.* caster's youth, 10*s.*; lacquerer, 10*s.*; wrapper up or warehouse woman, 7*s.* 6*d.*" Best workmen, especially those who can work and superintend, now realise very much higher wages, casters get more, and good and intelligent warehouse women can always command considerably above the amount named.

Upwards of twenty years' experience in connection with the trade suggests to the writer that Hutton's remark, made in 1780, about "the master knowing his way to affluence, and the servant to liquor," is true as regards the first part of the assertion, but the last is now only true exceptionally. The workmen in connection with the brassfoundry trade, as a body, in sobriety are not inferior to any other class of workmen engaged in other industries. They are prudent and careful, many of them possess houses of their own through land and building societies, and not a few have, by saving, accumulated money. Their dwellings have frequently trim gardens attached, and offer a favourable contrast to the squalid poverty observable in workmen's dwellings engaged in other departments of industry; while Factory Clubs and Sick Societies encourage habits of prudence. Where workmen are irregular —such irregularity arising from intemperate habits—the writer is of opinion that there is often a lack of proper supervision on the part of those in authority; an experience gathered by connection with upwards of 1,200 workmen leads him to this conclusion.

There is, however, another side to this picture, and we now turn to it for consideration and examination, as shown in—

DISEASES OF THE WORKPEOPLE ENGAGED IN THE BRASS MANUFACTURE; FEMALE LABOUR, ETC., ITS EFFECTS, PRESENT AND FUTURE.

The diseases common to the brassfoundry trade are chiefly of a pulmonary nature, and arise, in the case of finishers, from the dust evolved in filing the brass; and in casters, from the dust which rises during moulding, and the condensed fumes of the volatised zinc from the melted brass in the operation of pouring.* Brass casters are almost unanimously said to be short-lived; and the writer of this, from practical experience, founded on observation, concurs in the verdict. On this head, it should be remarked, that the liability to the diseases named may be largely checked by a more efficient system of ventilation in finishing shops, and the position of casting shops. The latter especially should not be under work shops, but entirely apart, with nothing built over them, and should be high roofed, with sky lights to open to allow of the speedy escape of the fumes of the molten metal. The state of the weather often determines the succession of attacks, which are more frequent in foggy or heavy weather, when the fumes escape more slowly. There is also the consideration, that in many of the recently erected brassfoundry works, while the castings' shops have been built separately, they have been built in the centre of a square or yard, but being lower in elevation, they stand as in a well—the fumes escape but slowly—and then penetrate into the workshops surrounding, invariably with sashes open for ventilation, or through broken panes of glass. The chimneys of the casting shops, though high, do not operate in carrying off the fumes; these, by their specific gravity, taint and vitiate the air in the square of the manufactory. On this subject, Dr. Greenhow remarks, "few of the casters past middle life are entirely free from difficulty of breathing, attended by more or less cough and expectoration;" though it should be stated, that in all probability "the large quantity of beer consumed may materially aid the development of the asthma-like form of the disease." C. Turner Thackrah, who wrote in 1832, also clearly describes the form of disease under which brass casters suffer—and says, "it affects the respiration, and less directly also the digestive organs; it is attended with difficulty of breathing, cough, pain at the stomach, and sometimes, morning

* Dr. Percy mentions an "evergreen" practical brass maker seventy years of age, who for sixty years had been engaged in the trade, did not get a continuous night's rest out of five nights every week during that period, yet he appeared vigorous, and by *no means unhappy*. Exceptions don't form the rule. Experience is against Dr. Percy.

vomiting. In Leeds, we did not find one brassfounder forty years of age." Thackrah, however, admits that later investigation resulted in finding two—one of sixty, and the other seventy years of age.

As a general rule, in Birmingham the Brass Finishers do not appear to be a long-lived race; but exceptional cases will be found of workmen at work at the age of sixty. Brassfoundry operatives employed in finishing do not seem to suffer directly, if the ordinary laws of health are observed. In one department of the operations in brassfoundry—that of Acid Finish or Dipping—it may be confidently asserted that there are not any dippers reaching the age of sixty years who have practised the operation from early youth. In such cases also the respiratory organs and stomach suffer. The popular remedy among dippers for obviating the effects of the acid is copious draughts of milk. Here also, as in casting, the effect of the acid is more apparent in cloudy weather, when the fumes are dissipated with difficulty, and in summer, when the acid is affected by the heat, evolving the fumes more copiously.

The prevalence of diseases of the nervous system and of the organs of respiration as affecting in-patients in the General Hospital, amounting to, from June 30, 1864, to July 1, 1865, 261; and as out patients to 1,542 cases, leads to the conclusion that the diseases of the respiratory organs might be diminished by a greater attention to proper ventilation, and that those of the nervous system might also be diminished by a less amount of female labour. At first sight there seems no connection between female labour and nervous disease; but not only single women are employed in the brass trade, but mothers of families too. Birmingham operatives marry early: the girl-wife becomes a mother, but, from early associations, she likes the manufactory better than her home—likes the company of the workers, and her earnings "help to keep the house." As soon as she can go to the manufactory after her confinement she goes (the absence on these occasions rarely exceeds one month), and the infant is left the greater part of the day to be fed on artificial food, and is usually attended to by a child not more than six or seven years of age. The food is generally indigestible—illness is the natural consequence of this unnatural mode of feeding infants. Children, healthy at birth, dwindle rapidly under this system, fall into bad health, become uneasy, restless, and fractious; opiates are administered to produce sleep and allay these symptoms; the result is, the seeds of nervous disease are sown, and, in the majority

of cases, early death ensues. An operative of the better class stated "that he collects money for the expenses attendant on deaths of children—150 females are employed in the factory he is connected with—and he believed that ten out of every twelve children borne by the married women in that factory die within a few months after birth." In the united parishes of Birmingham and Aston the death-rate of children was as for the ten years, *i.e.*, 1851 to 1861 :—

In Birmingham, at less than One Year of age . . .	14·121
In Aston, ditto ditto . . .	5·175
In Birmingham, between One and Five Years . . .	11·469
In Aston, ditto ditto . . .	3·752
Total	34·517

Deaths arising from phthisis are excluded from the causes of death given. The mortality is traceable to infantile diseases, entirely attributable to the want of the tender care of the mother in feeding and attending to her offspring. Medical statisticians are quite aware that under ordinary circumstances infantile complaints are by no means so fatal. The diseases from which these children died are stated to have been diarrhœa (no doubt attributable to improper diet); injured respiratory organs, (arising from cold and inattention); nervous disease, (encouraged by the use of opiates); small pox, scarlatina, measles, and whooping cough, (the fatality doubtless occurring from the want of necessary care in nursing, owing to the absence of the mother at the manufactory.) The population of Birmingham, including Aston, at the census of 1861, amounted to 290,076, and the infantile deaths within the ten years between 1851 and 1861 amounted to 34,517 ! ! or nearly one-ninth of its population, strangled it may be said at the portals of existence. Is there not here grave food for reflection? does it not demonstrate the baneful effects of the employment of married females in manufactories? Thus children, imperfectly fed, with constitutions feeble at first, and partly enfeebled by the use of opiates, uncared for in infancy, uneducated in childhood, at six or seven years find their way into factories, and become the male and female helps. They in turn, at an early age, become the feeble parents of a feebler offspring, and the grand type of the English workman is lost, or rapidly disappearing, and being replaced by a physically inferior race, with less muscle, of lower stature, with the nervous system exalted, and the powers of endurance diminished. While the writer of this desires in the future

no Utopia or fabled Atlantis, yet there are certain principles impressed originally on all created things; laws, which to obey is life, to neglect is death. These laws operate unceasingly, regardless alike of man's cupidity, or ignorance. Experience shows that imperfectly developed parents produce an enfeebled offspring, physically weak, and prone to disease; that the best nurse for a child is its mother; that at certain periods the frame of woman requires rest and immunity from labour; that the tender years of youth should not be passed within the walls of a factory, or the frame subjected to labour during its growth; that youth is the season when the elements of education are best imparted; but all these several important considerations are ignored by the present system of factory labour. Dr. Greenhow's able report on Public Health, in 1861, remains unchallenged as regards the death-rate of children and the employment of women; and Mr. E. White's report in reference to the employment of children in the hardware manufactures has been questioned only as to the truth of some of the statements. All these, however, cannot be errors. At the bottom, no doubt, lies a solid substratum of facts, by no means flattering to our vanity.

While female labour and the employment of juvenile assistants are, in all probability, less common in the brass trade than in others, still, as an integral part of the great factory system, it is not blameless. (There are 2,119 females, being one-fourth of the labour employed in the brass trade.) While admitting that in certain operations in the brass trade, such as lacquering and wrapping-up, women may be employed with advantage to themselves, unmarried females should alone be employed. Married women should be excluded from any such work, as also from the use of the press in cutting-out and piercing, and other operations which they now undertake, and for which they are physically unfitted. The "piece" system of payment favours the employment of juvenile labour, as the manufacturer pays for the work brought in, and seldom exercises any control over the "helps" of the workmen who undertake it. In the same manner numbers of girls are employed by forewomen who undertake to do work by the piece. Here also no restraint is exercised. Thus the system of female labour and juvenile employment, fostered by ignorance and competition, has grown and is increasing, resulting in the neglect of the preparation for household duties and the attractions of a home. "Many of the children die, the mothers become familiarised with the fact, and speak of the

deaths of their children with a degree of *nonchalance* rarely met with among women who devote themselves mainly to the care of their offspring;" and these are the mothers who deliver over the child of six or seven years of age to the foreman or other operative for a paltry sum of 1*s.* 6*d.* or 2*s.* per week—the price of childhood neglected and natural affection lost. Liberty not unfrequently means license, and Legislative interference is frequently uncalled for; but, in the wholesale employment of female and juvenile labour, it is surely justifiable to place some limits on such degrading work. Legislation has borne good fruit as regards other industries, and though less abused in the hardware trades than others, still a little wholesome interference would be productive of much good—in all probability less with reference to the *present* than in the *future*; but as all legislation should deal with the future, a present check would be beneficial. With advanced views in education, it appears preposterous to send children to work uneducated; and females intended by nature for the helpmates (not the competitors) of man, in the discharge of domestic duties; to convert these two elements into manufactory helps may for the present assist the competitive contest, but what of the future? Nemesis lives in the abuse of the natural laws—if persisted in the mechanics of England will become an undomesticated race, ale-houses will take the place of household hearths, and their children become *gamins* in the truest sense of the word. It needs no Government enquiry to tell us "*that in Birmingham the proportion of married women who work in factories, away from home, is undoubtedly increasing*," and, as a natural result, preparation for domestic duties is being ignored, homes are uncared for, and juvenile life is recklessly sacrificed.

Having already pointed out the influences which have led to the extension of the trade, as new branches of manufactures resulting from discoveries made by scientific men, and the practical application of their discoveries, as in gas lighting, locomotion, &c., &c., there is yet another element which has operated, and which in any paper dealing with the history and progress of an important branch of local industry, should not be passed over—the element of Taste, rendered visible in Art, as displayed by Industry. Readers, who have watched the progress of the brass manufactures in Birmingham, must be aware that within the last twenty years, the ornamental features introduced on the objects produced are of a much higher character, and approximate more nearly to good orna-

ment than formerly. The means by which this progress has been made, it may be said unhesitatingly, are the issues of illustrated works, directing attention to the application of art to industry; Schools of Art; and, more potent still, Exhibitions of Manufactures, as the local Exhibition of 1849, and the International Exhibitions of 1851, 1855, and 1862.

LITERARY AND PICTORIAL INFLUENCES WHICH HAVE OPERATED ON THE BRASS TRADE.

As regards pictorial and literary influences on the ornamental brassfoundry trade, not much could be expected from such works as Piranesi, Stuart's Athens, or Cottingham's Designs for Metal Works, confined, where used, to the designer only. To workmen these were sealed books, and these books in time circumscribed the style of work designed and produced. The process of designing then consisted of drawing pieces from the works named, and sticking them together. In the year 1839, the Art Journal appeared, and took up the subject of Art applied to the results of Industry. It grappled manfully with the question of applied ornament, and showed how utility and beauty could be combined. Woodcuts illustrated the descriptions of the pen, and new forms were presented for the consideration of the designer. The work being cheap passed into the hands of the artisan; and then began that improvement in designs in metal, which has not ceased, and will not cease so long as Birmingham produces metal work. To S. C. Hall, Esq., F.S.A., the editor of the work named, is unquestionably due the merit of introducing or originating a work which, while it educated the taste of the purchaser, operated on that of the producer, designer, and artisan too. Other competitors entered the field, but failed; and still, month after month, the Art Journal conveys its lessons of art, and its illustrations of art and industry to the amateur's library, to the designer and modeller in their manufactory studio, and to the artisan in his workshop. The bold, energetic, and instructive writings of Augustus Welby Pugin, illustrated by his etching needle, though at first they found only few readers, yet such few were well fitted to disseminate true principles; the writings of Matthew Digby Wyatt, particularly his great book on Metal Work, admirably illustrated, and with descriptive notices of the history and processes of metal working; the Industrial Arts of the Nineteenth Century; the Grammar of Ornament, by Owen Jones; the Illustrated Catalogue of the Exhibition of

1851; Cassell's Illustrated Exhibitor, and other Works, have all been silently operating in improving and elevating the taste alike of buyer, manufacturer, and workman. Manufacturers of metal work now know that substantiality is only one element, and that unless a second—that of ornament—be added, they stand but an unequal chance with rivals who unite both elements in the works they produce. In successful results we are apt to overlook influences; but personal observation, extending over a period of twenty-five years, leads the writer to the conclusion that the circulation of illustrated works among artisans, treating on ornament and applied design, has operated in no small degree in elevating the ornamental brass work of Birmingham to the position it occupies; and that such influence in effect is second only to that arising out of

LOAN COLLECTIONS, MUSEUMS OF OBJECTS OF ART OR INDUSTRY, AND EXHIBITIONS OF INDUSTRIAL ART,

as those held in 1851 and 1862, at the Society of Arts; in London, in 1850, and at South Kensington Museum in 1862; the reality or examination of the objects themselves being superior to even the most perfect representation by means of woodcuts, engravings, lithographs, or photographic copies. The great advance made by Birmingham in things ornamental, took its rise from the local Exhibition of Manufactures, held in a temporary building erected on the ground now occupied by the Bingley Exhibition Hall. In the year 1849, on the occasion of the visit of the British Association in that year —there for the first time Birmingham manufacturers of brass and other metal work met face to face; and as their articles were in juxta-position, they then felt their respective strength, and they learned their weakness in respect to each other. In 1851, their works were submitted to a test of a far more important character, and for the first time English metallic manufactures were tested against those of all nations who contributed to the first International Exhibition. The French, with the experience of centuries to aid them, united to the test of eleven previous Exhibitions of Industry, shone with telling force in all as regards metal work of an ornamental kind. Their familiarity with ornament of all styles—boldness of conception—delicacy of manipulation—freedom of execution —perfect knowledge of the figure—were fully shown. To English eyes there was a great originality—an originality, however, gathered from accumulated stores of ornament,

garnered up in the Hotel Cluny, The Louvre, Versailles, Fontainebleau, and other treasure-houses in France. England now possesses in her South Kensington Museum more than an equivalent to the collections enshrined in the receptacles already named in France; thanks to the untiring energy and perseverance of Henry Cole, Esq., C.B.; and Birmingham, were she wise, would also have her Museum of objects, especially of best metal work. South Kensington Museum should be sacked, and its spoils distributed among the great manufacturing centres of England. Its works in gold, silver, bronze, brass, and iron, to Birmingham; its steel works to Sheffield, &c., &c. At all events, its surplus examples should be distributed, for local Museums in towns engaged in manufactures, to which the examples would be illustrative and suggestive. Art, like other mental attributes, grows with what it feeds upon. The æsthetic qualities, inherent to Frenchmen educated in the direction of manufactures, naturally turned to examples produced by the artists whom the patronage of former rulers of France had encouraged; and far from being slavish copies of old examples, modified by the modern French designer's brain, they brought forth fruit in original works, in which, while old ornament was introduced, its arrangement was changed, and it thus became an original work; it received additional beauties from the manipulative skill displayed by the artisans who worked out the ideas of the designer, and by the taste and intelligence of the manufacturer at whose suggestion the object was executed. With such works, crowds of English workmen became for the first time acquainted. They saw that with which they were not familiar, which they treasured up for after use, and which became apparent in the English metal work displayed in the Exhibition of 1862, when again means of comparison were afforded, and an opportunity occurred of testing the progress made within the eleven years which had elapsed. However, the seed sown in 1851 had not been sown by the wayside; it had fallen on good ground, and bore a thousand-fold harvest. It was not only visible in specialities prepared for Exhibition purposes, but it had penetrated into things for every-day use—into cabinet brassfoundry, gas fittings, and into brass work generally; while in no particular was the substantial character of English work sacrificed, or its ornamentation impaired. Incongruities in style were more generally avoided, and an improved and progressively improving element was recognisable. Without these Exhibitions, such progress as has been made could not have been attained in the same

limited time. Regarded with prejudice at first, English manufacturers looked at Exhibitions with suspicion; and it may be questioned whether without the powerful patronage and prestige of the Prince Consort, an Exhibition of Manufactures ever could have been held. That it was held is now matter of congratulation, and that a second followed and gave us the opportunity of seeing the progress made is equally so. They demonstrated the fact, that while the substantial is the natural result of the exercise of the industry of Englishmen, deeper still there lies the innate seed of that which education can also produce—the beautiful; and they showed that English designers and artisans can successfully compete with nations who have long been tacitly admitted as rulers in the empire of taste, and whose manufactures have until recently monopolised the sales in the marts of commerce all over the world. If England has succeeded as she has in introducing her manufactures of an ornamental kind into other countries, she has been enabled to do so all the earlier by and through the Exhibitions of manufactures which have been held during the last few years.

As a means of demonstrating progress, Exhibitions are unequalled, they show the position of the manufactures of the competing countries—the progressive advancement of old establishments; they introduce new establishments to public notice; display at a glance to artisans new features worthy of attention; educate the buyer, stimulate the manufacturer to increased exertion, direct attention to new modes of production, and processes until then unknown, or if known but imperfectly understood. The period has long since gone past when it was stated in reference to exhibitions of manufactures that "No body of British manufacturers would submit to be the actors in such a theatrical pageant" as a writer in the *Edinburgh Review* characterised the Paris Exposition of the year 1819. Exhibitions of works of Industry are now recognised as institutions of all countries, as such they are supported, and from such it may be questioned if any other locality has been benefitted thereby to the same extent as Birmingham. The display of the works produced there, publicly exhibited on the stalls of Exhibitions, showed to the world that these were not "lacquered shams;" and the result of each succeeding exhibition has been to demonstrate that Birmingham industry is progressive, capable of improvement, and improving; that while producing the useful, she is equally successful in the production of the ornamental. The means by which her position has been vindicated, her progress rendered

strikingly apparent, and the demand for the productions of her manufactures in brass increased, are, in a great measure, owing to the publicity and to the instructive lessons afforded by Industrial Exhibitions.

BRASS MANUFACTURES AS AFFECTED BY PATENT LAWS AND THE REGISTRATION OF DESIGNS.

Recently there has been a considerable amount of opposition displayed against the operation of Patent Laws, but it is satisfactory to state that among the opponents Birmingham men are not to be found. They acknowledge the advantages of a system which has protected invention, and by that protection has stimulated and encouraged it. In no department of the great manufacturing system of this country have patents operated more beneficially than on the manipulation and chemistry of metals, and the present prosperous condition of the local brass manufacture is in no small degree attributable to Patent Law protection. In a competitive community of manufacturers a patent which confers speed in execution, superiority or cheapness of production, or a new arrangement of parts, is invaluable to the possessor, and should be equally so to the inventor, if allowed to participate, as he ought to, in the profits of his invention. Those familiar with the brass trade of Birmingham will have no difficulty in recalling to their minds not a few inventions which have largely aided in swelling the fortunes of manufacturers, and benefitted the public. Among such patents may be named the patent cased tube of Cook and Attwood, (really invented by Sir Edward Thomason); Green's solid brass locomotive tube, Muntz's sheathing metal, many inventions connected with cabinet brassfoundry, cock making, the manufacture of gas fittings, and others in connection with other departments of the brass manufacture.

In connection with the protection to inventions afforded by the Patent Laws, there is yet another form of protection by which the brass trade of Birmingham has been largely benefitted, viz.:—The Registration of Ornamental Designs. As the former Laws benefit and stimulate invention, so the Ornamental Registration Act has operated very materially in evolving ornamental designs, and in increasing the number and variety of ornamental objects in metal produced, particularly in brass. From a satisfactory source it has been ascertained that in consequence of the reduction of the fee for

registration from £3 to £1, and the extension of the period of protection from three to five years, the number of registered designs have increased five-fold.

The merit of the change is due entirely to the operation of the Birmingham Chamber of Commerce.

LOCAL SCHOOL OF ART—ITS INFLUENCE.

As regards the operation of the Local School of Art on the Brassfoundry trade, while it must be admitted that the teaching of drawing and modelling are means to an end, the aid received from it has hitherto amounted chiefly to an education of the eye and hand to the appreciation of form, and the production of drawings and models, but not of an original character, or if so, unfitted, and inapplicable for practical or trade purposes. Up to the present time no leading establishment in the brass trade is *entirely* dependent upon a designer trained in the local School of Art. The Birmingham School has produced no local Godfrey Sykes; yet it would be wrong to affirm that its influence is *nil*, and it should be stated that the support it receives from the manufacturers, as a body, is exceedingly limited, and unworthy of a community dependent in a great measure on the improved ornamental character of the objects produced for sale. Anything like a real and abiding interest in the progress of the School does not appear to be felt, even by its Committee, who, selected ostensibly to direct the studies of the artisan pupils or students to practical results, virtually fail to do so, and thereby ignore the intention of the School as a means of improving the manufactures of the town. The total number of students in the Birmingham School is at present 873, of whom 190 are females, 200 pupils of King Edward's School, and 483 are students of the artisan class, or those for the benefit of whom the School was originally instituted. Of the latter number 30 are connected with the brassfoundry trade as modellers, chasers, and workmen. While, however, the direct operation of the local School of Art may appear to have exercised but little influence, the operations of its students in manufactories have no doubt largely facilitated the carrying out of designs produced by designers not trained in the School. The education of the eye leads to the correct appreciation of form, intelligence is awakened thereby, and if originality of conception has not hitherto marked the works of the students of the local School of Art, it has at least been the means o

training up a superior class of artisans. The School has therefore strong claims on the manufacturers whose productions are improved thereby, directly and indirectly too.

SCIENTIFIC EDUCATION.

As regards scientific education, with the exception of the industrial classes connected with the Midland Institute, Birmingham possesses no means of educating its artisans in the *rationale* of the processes involved in the successful cultivation of science as applied to metallic industry; and no branch of manufactures would be more effectively benefitted by an infusion of science than the brass trade of Birmingham. That hitherto matters have gone on without the aid of science, simply proves that they would go on much better with it. It should not be concealed that practice and experience are in the great majority of cases at present the only guides. The laws which rule the operations in metallurgy and chemistry are only rarely, and exceptionally known, and then but partially understood by practical men. Phenomena, which occur from time to time, perplex, harass, and interfere with the progress of work. Waste is the consequence, and products are lost which might have been utilised, and increased profits would follow as a consequence of their utilisation. It is not too much to say that, up to the present time, the brass trade, as a rule, has been conducted without reference to scientific principles; that practice has hitherto been its only guide; that the little science which has been brought to bear upon it has come from without, not from within; and that a scientific education, or scientific instruction in connection therewith, would largely add to the present success of its operations. The necessity for this, though it may not be apparent to the great majority of manufacturers, is not the less needful on that account, but, nationally, it is of the utmost importance. Uneducated manufacturers and others sneer at science, because they know nothing of its value, or of the profits to be realised by its application. They forget the sources from which these came; yet science, all-bountiful, gave to Birmingham her trade in gas fittings, her solid metal tube trade, her telegraphic wire manufacture in iron, and copper, and her great industry in electro-metallurgy. "All the facilities of intercourse," said a statesman, who should have died hereafter, "are operating as bounties to skill and intelligence; they are shortening the distance between producer and consumer; and it is not safe for us to

remain behind hand; for, depend upon it, if we are inferior in point of skill, knowledge, and intelligence, or general knowledge, to the manufacturers and producers of other countries, the increased facilities of intercourse will result in transferring the demand from us to others." This, spoken twenty-four years ago, is very much more applicable now, when knowledge has increased, and industrial education is embraced as an element among the recognised duties of continental states and countries, which they consider they owe to the peoples under their rule. Liebig thus clearly demonstrates the necessity for scientific education when he says, "Ordinary intelligence, with local advantages of cheap raw material, may long preserve a monopoly in special manufactures, until a competing nation, by the intelligence of her educated artisans, becomes more than equivalent to the difference in the price of the raw material. The nation most quickly promoting the intellectual development of its artisans *must*, by an inevitable law of nature, *advance*, whilst the country neglecting the industrial training must as *inevitably recede*—stationary it cannot remain. The superabundance of capital may for a time preserve a country from a quick depression, even should it lapse in its intellectual training; but the support thus given can only be temporary and illusive, for if by the purchase of foreign talent the necessary knowledge be infused into home manufactures, this has the effect of raising the intellectual element in the foreign country, and finally accelerating its success as a competing nation." At no period of the world's history was it so necessary as now, that skill and science should be wedded together for the promotion of the industrial arts; and Humbolt said truly, many years ago, that "An equal appreciation of all parts of knowledge is an especial requirement of the present epoch, in which the material wealth and the increasing prosperity of nations are in a great measure based on a more enlightened employment of natural products and forces." The only institution in the town which deals with the important element of Industrial Education is the Birmingham and Midland Institute, in connection with which there are classes for workmen, by attending which they will be largely assisted and instructed in science in connection with their special department of industry. These classes have been the means of doing much good; several of the students have gained high distinctions, and have become valuable aids in connection with manufactories. Still the number attending these classes is small as

an aid to manufactures; among the seventeen students in the practical chemistry class, there is *not one* connected with the Brass Trade! But if manufacturers, as a body, are indifferent to the success of valuable institutions for the cultivation of practical or applied science, their subordinates may be pardoned if they neglect them. Yet, indifferent as manufacturers are, they spend money in purchasing inventions, which they cannot thoroughly test by their own knowledge, thus holding out in many cases a bonus to empiricism and ignorance. All the great successes in manufactures have been achieved by science, and by working on scientific principles. If a discovery has been accidentally made, and it has been successful, it has been so only because it has been in accordance with science; as such, therefore, the necessity for the study of science is of paramount importance, especially in connection with metallic industry.

ORDINARY EDUCATION IN REFERENCE TO MANUFACTURES.

Although existing schools have done good work, they do not operate efficiently in educating children of tender years who are hard worked all day in a manufactory; muscular exertion destroys mental energy for the time. The child or boy who has worked even ten-and-a-half hours is thereby unfitted to attend to or master lessons at a night school, (held frequently in an ill-aired, badly ventilated apartment); in such cases the brain refuses to act, when the muscular system is exhausted. Especially is this so with children. Though the philosopher in his study may change his subject and turn to another, the transition from the workshop to the night school of the child or boy seldom or never produces satisfactory results. Some instances may be found where even factory children in after life have acquired a very great amount of knowledge, but these are rare and exceptional cases. Every enquiry tends to show that to depend only on Night, or Sunday Schools for the education of children is to depend on what never can be alone an efficient means of Education, the elements of which should be given before the child is sent to the manufactory, and then as much as possible during the day. It is to the credit of Birmingham manufacturers, that many now acknowledge a desire to see the children, and young people employed by them, at least instructed in the rudiments of education. "I know," says one of the most intelligent of our

manufacturers, in a recent discussion,* "that a considerable class of children is greatly neglected, and I join my brother manufacturers in a steady desire that our necks may be put under the yoke of the Factory Act, to remedy the evil. If notwithstanding the absence of that Act we stand as well as the best of other manufacturing towns, we may hope, with the help of it, to rise above them." The peculiar industries of the town require general as well as special education. Until the increasing and thoughtless competition is checked by some of the provisions of a Factory Act, ignorance must and will prevail, and be painfully apparent. The root of the evil, it is believed, lies in the present system of allowing workmen, more especially "piece-men and women," to employ such helps as they choose, the manufacturer seldom exercising any control whatever as to the age, education, or physical development of the boy or girl employed. Given then a compulsory rule, the abuse would be checked. It is impossible to show that legislation which is attended with beneficial results in one class of manufactures will not be beneficial in another. Manufacturers are aware that overtime working, as a rule, is not beneficial in proportion to the hours worked, or the money expended in payment thereof. "Gurth is no longer the born thrawl of Cedric the Saxon," and if we acknowledge that intelligence is God-given, the development of that intelligence by education is a duty incumbent on those who receive benefit and profit by the labours of those who are uneducated. Opposition, therefore, to the introduction of an Act which would materially aid in educating, is, to say the least, unwise. Efforts towards factory schools deserve recognition, and of these the most successful have been the school originated by the late John Fawkner Winfield, Esq., in the Cambridge Street Works, still in operation, and that connected with the works of William Tonks and Sons, both of which schools are devoted to the education of youths employed in the brass trade in the establishments named.

CONCLUDING REMARKS.

At an early period of the pleasant, and at the same time troublesome, duty of reporting on the history and condition of the Brass Trade, the writer abandoned the intention of producing a report of a purely technical character. His reason

* Letter from Mr. William Lucas Sargant, to Lord Lyttelton, December 16th, 1865, on the Education of Birmingham, and on Commissions of Enquiry. Birmingham: Benjamin Hall.

for doing so was the consideration that those engaged in the trade or manufacture treated of rarely read such reports, and to the general reader a technical report would have proved uninteresting. He has, therefore, taken the license given by the Local Industries Committee to introduce matter which he hopes will be found, as associated with the history of the branch of the trade treated of and its various processes, alike interesting and curious. The facts have grown in his hands to a length which he had not anticipated when he assented to the request of the Committee to write the report. His enquiries, however, impressed upon him the consideration that the history of a noble local industry remained to be written, the origin of its several branches traced, and the period of the introduction of these chronicled for the benefit of future historians of arts and manufactures. This he has attempted to do. The success with which this has been accomplished he leaves to the reader. Even if he has succeeded in arriving only at approximate results, he will feel satisfied, and the time consumed in collecting the information will not have been lost. If, at times, opinions have been expressed strongly, they have arisen from experience gathered over a number of years, in which he has been directly or indirectly connected with the trades described. Edmund Burke, who gave Birmingham the name of the "Toyshop of Europe," said on one occasion, "I approach the institutions of my country not with the desire to break down, but rather to substitute something which is good for what is bad, and thus to strengthen and build them up to a greater extent than at present." With similar feelings the writer has approached the brass trade. If he has pointed out wants and defects, it is that these may be supplied and remedied; from the love he bears to it, if he has indicated future results, it is because he believes that such will be attained. The period is fast approaching when scientific research will be valued and appreciated in manufactures much more than it is at present, and he who will avail himself of the results will in proportion be more successful. The future progress of the manufactures in brass is dependent on a larger employment of mechanical appliances and chemical and metallurgical knowledge. If, as regards the large proportion of female and juvenile labour employed, he has also expressed himself strongly, it is because he believes that such is calculated to operate locally, socially, and nationally, in morally and physically restraining alike the mental and physical development of the young, and in preventing the destruction of the social home-comforts of man by reducing

woman from a helpmate to man and placing her in a sphere of labour for which she never was intended. Where he has recorded inventions or improvements he has, as far as possible, given the merit of these to the original inventor or improver; and he considers the large amount of prosperity and the present great extension of the trade and manufacture of brass is in no slight degree to be attributed to the total absence of trade societies and of strikes. This has consolidated the trade with no sacrifice of comfort on the part of the workmen. In all he has done, however, he has sought only the elevation of the manufacture which he has reported upon, and its future advancement.

It remains now for him to mention gratefully the assistance given him in enabling him to produce this report; and he acknowledges that to M. P. W. Boulton, Esq., of Tew Park, Oxfordshire, descendant of the truly great Matthew Boulton, and to Samuel Smiles, Esq., Author of "Self Help," "The Lives of the Engineers," and of "Boulton and Watt," he is indebted for the history of the Birmingham Brass and Spelter Company; to the proprietors of *Aris's Birmingham Gazette* for information received by the examination of early volumes of that paper; and to Dr. Percy's admirable work on Metallurgy for the early cost at which brass was made; to J. D. Weston, Esq., of Bristol, and W. H. Keates, Esq., of Liverpool, for the histories of the brass manufactures in Bristol and Cheadle; to Daniel J. Fleetwood, Esq., for his estimates of the metal consumed in the brass manufactures of this town; to Mr. Crosbie (formerly of Messrs. Alston and Green's) for information respecting the solid brass tube trade; and to other gentlemen, whose names he is not permitted to state, his thanks are also due. The thirty-two manufacturers who promptly responded to the circular of the Local Industrial Committee are also entitled to his thanks. It is to be hoped respecting those who did not reply, whether from want of time or from other motives (the "Overtaxed Manufacturer" included), that the publication of this report will show that the history and elevation of their manufactures was the only end sought. Those who declined from motives of trade secresy may be told, that if they had sent in returns no advantage could have been taken for other than the purposes of this report, as the returns were seen by the Chairman only, who gave the present writer aggregate results without the names of any of the manufacturers who made the returns, and thus the "Assessor of Taxes" was not enlightened thereby.

In conclusion, it is hoped that in future years, when the present manufacturers of brass goods are represented by their descendants, and the artisans who throng the busy workshops are replaced by others—when the hand which wields the pen with which this is written shall be at rest for ever—this report may be read and referred to, and may be regarded as a truthful history of the rise, progress, position, and extent of the local industry in Brass at the period of the Meeting of the British Association in Birmingham, in the year A.D., 1865.

CAST AND ELECTRO-DEPOSIT STATUARY IN BRONZE AND COPPER.

By W. C. AITKEN.

The production of bronze statuary is an art of very ancient origin. It is alluded to in Bible story, and in profane history its records are chronicled. The immense number of Alexander's statues adorning the cities which owned his sway, were characterised by an early writer as "the mob of Alexander." Corinth, alone, boasted of her three thousand statues, and exclusive of the huge Colossus, a still greater number thronged the squares and courtyards of Rhodes. In later days, bronze statuary adorned the splendour of the Byzantine Emperors, and later still, when the light of the Crescent paled before the brilliancy of the Cross, the genius of Italy claimed supremacy in this as in every other department of art. In it worked Della Robbia, Sansovino, Verrochio, Cellini, John of Bologna, Michael Angelo, and a host of other artists in whose hands it assumed endless forms of grandeur and beauty; now a gigantic statue; now a subject-fountain, cooling with its waters the noonday heat of an Italian city; now a pulpit, such as that in the great Church of St. Peter; and now a gateway to guard the entrance to the sanctuary. The doors of the Baptistery at Florence, in which the skill of Lorenzo Ghiberti has given expression alike to his piety, and the rich exuberance of his fancy, remain indeed, among the noblest monuments of ancient or modern art. Every panel is filled with a subject from Holy writ:—"The rock, the fountain, the flowing river with its pebbled bed, the great sea, the clouds of heaven, the herb of the field, the fruit-tree bearing fruit, the creeping thing, the bird, the beast, the man, and the angels, mingle their fair forms on the bronze of Ghiberti." Michael Angelo, himself, in gazing on them, is said to have whispered, "So grand, so beautiful are they, that they are worthy to be the gates of

heaven." In Germany, the most celebrated artists in bronze, were the Vischers, whose fonts, tombs, and shrines, still adorn many of the churches of Germany, and particularly that of St. Sebald, at Nuremberg. The celebrated monument, also, of the Emperor Maximilian I., at Innspruck, testifies the skill of the artist casters of the period. Spain can boast of the great bronze candelabrum at Seville, the pulpits at Santiago, and the colossal "Faith" surmounting the tower of the Giralda. France can point to the tombs of two bishops at Amiens, executed in the 12th century, as tokens of her early proficiency in the art. Bavaria, within the last thirty years, has produced many noble bronze statues, as witness the one of Hermann, 42 feet high; and the majestic "Bavaria" that overlooks Munich from the Theresien Weise, modelled by Schwanthaler, but cast by Stiglmaier, 50 feet high, and cast in seven pieces.

Bronze statues, cast by Englishmen, such as William Torrel, at an earlier period, and William Austin, at a later, were also not uncommon in England as monumental memorials. Torregiano executed the monument of Henry VII.; Rovezzano, those of Henry VIII., and his wife, Jane Seymour, in Westminster Abbey. For our first public statues, we are indebted to the fine taste of Charles 1., whose bronze effigy, in Charing Cross, was modelled and cast by Le Sueur, of the School of John of Bologna. That of James II., in Whitehall Gardens, is the work of Grinling Gibbons, the celebrated wood-carver. With the Georgian era came in an increased demand for bronze statuary, and the bigwigs and Roman toga reigned for a period. For many years previous to 1823, Westmacott had been the only caster of bronze statuary in England; one example of his being the Nelson, in the Bull-ring, which for at least fifty years was the only statue of which Birmingham could boast. In that year, the first life-sized bronzed statue ever produced out of the metropolis was cast in Birmingham, by Sir Edward Thomason, at the Church-street Works. The worthy knight, following the advice of the great Florentine, Benvenuto Cellini, who declared it to be "The duty of all men, in whatever state or condition of life they are placed, who have performed praiseworthy actions, or distinguished themselves by gallant exploits, to be their own biographers," thought fit, in his 66th year, to publish certain details of his autobiography, under the title, "Memoirs of Half-a-Century." In this work, the history of the casting of the first statue in Birmingham is thus given:—In 1823, Thomason caused to be made a model, 6 feet in height, of

George IV., "the attitude of which was the King in his robes of state, with the sceptre in his right hand, and holding back the folds of his robe with his left." Up to this time, Westmacott was the only caster of bronze statuary, of a large size, in the kingdom, and the process by which he cast was kept secret.

"The moulds of my figure were made of a peculiar mixture of fine sand and plaster of Paris. They were dried by many small stoves all round the inside of the casting room. The core was suspended in a beautiful manner by innumerable small wires called pins, so that the copper or metal should flow round the core and melt them when the metal was poured in. I had built a cast-house, and after a minute examination of the moulds, finding them perfectly dry, the furnace of the tall chimney was charged with a quantity of the purest refined copper, with a fraction of lead and zinc. Suddenly I recollected reading of the alarming state in which Benvenuto Cellini found himself on suspecting at the moment of the casting of his Perseus, at Florence, that he had not charged the furnace with sufficient metal (the sure forerunner of a failure), that he was that morning laid up with the gout,* and that in the height of irritation he sent round to his neighbours to buy, borrow, or beg all their copper kettles, stewpans, saucepans, &c. I was determined that mine should not fail for want of this precaution; therefore I had two tons and a half put into the furnace. Large bellows were suspended and worked by relays of men, without ceasing, during the time of fluxion, which I found took from eleven o'clock on the Thursday till seven o'clock on the Saturday morning. I then gave directions that the trial should be made and the furnace tapped. Exactly at two o'clock on Saturday, October 2, 1823, this decision of mine being made known, many persons of great respectability requested to be present. I endeavoured to persuade them from it, having heard of many instances that whilst the hydrogen gas was formed by the hot metal coming in contact with the damp sand (the sand having been carelessly dried), an explosion did in one case absolutely blow up part of the building. No remonstrance would do, and the cast-house was completely filled with respectable persons of both sexes. The metal, however, ran as pure as water, without accident or blemish. It took about four days to cool, and was found quite perfect. My modellers had been alternately modelling the statue of the king and the four Venetian horses [copies of those which now stand above the façade of St. Mark's Church, at Venice, the work of Lysippus, a celebrated Greek sculptor, who lived 325 years B.C.], of their proper height, each being 5ft. 4in. Having understood that the attempt had never been made before, I decided to have them done after an idea of my own. I therefore obtained a small model of them. I made up my mind that they should be finished and mounted upon the pediment of my manufactory on the same day that the statue of his Majesty should be cast. This was effected, to the astonishment of my townsmen."—Vol. I., 245—248.

With this feat, probably, would have terminated the history of bronze casting in Birmingham, but for the spirit and enter-

* The knight gives a remarkably free reading of Cellini's doings. It was not the "gout" with which he was afflicted, but an intermitting fever; nor is there any evidence of a deficiency of metal. Owing to a workman's negligence the metal had been allowed to cool, and the "sixty pounds of pewter and all my pewter dishes, amounting to about 200," were put in to render it more fluid He did not, however, buy, borrow, or beg his neighbours' copper kettles, &c. The deficiency, amounting to almost half of one of the feet of the statue had been anticipated by Cellini, who pointed out to Duke Cosmo de Medici that such a result was probable.

prise of the Messrs. Elkington, who subsequently added this to their other processes connected with fine art manufacture.

The processes involved in the production of bronze statuary are numerous and interesting. In the *cire-perdue*, or wax process, the core is built up on a structure of iron bars, which forms the skeleton of the statue, the bars following the curves of the extremities of the figure, human or equestrian, the arms of the man, the arched neck, the legs and tail of the horse, &c. This skeleton stands on a platform with provision for introducing fire under it, so as to allow the wax used in the process to be withdrawn. It is then built up with a mixture of clay, pounded brick or burnt clay, horse-dung and hair, capable of being easily worked when moist and very solid when dry, so as to present the general contour of the subject, but less than the proposed statue by just the thickness of the metal to be employed. Over all this is laid wax to the same thickness, on which the sculptor works and expresses all the details. When the work is satisfactory from every point, ascending rods of wax, representing the channels by which the air is to find exit on the metal entering the mould, are placed wherever required. Viewed in this state, the model and its accompaniments strongly suggest the venous and arterial system of the human body as shown in anatomical works, with the difference that the wax-rods are external to the body of the model, which is visible through their intervening meshwork. The whole model and rods are then painted over with fine loam in a liquid state. This speedily dries, and another coat is added, the process being repeated until the crust is sufficiently strong to sustain a superincumbent mass of thick loam plastered on, the mould thus formed having a rough resemblance in general form to the statue to be cast; after which it is bound round with hoops and bars of iron. The platform before-mentioned, on which the model is built up, is either at the bottom of a pit, or stands over a pit into which the mould can be lowered before casting. This pit, when the mould has arrived at this stage, is filled up with sand and bricks to the level of the surrounding ground, so as completely to envelope the mould, the wax-rods projecting to the surface. A fire is then lighted under the platform, and the wax forming the outer coating of the core, and exactly representing the metal to be cast, melted out. The mould is then gradually heated up to nearly a red heat, and when completely dry is in a condition to receive the molten metal from a reverberatory furnace standing on the surface of the ground in close

proximity to the mould. Jets are made for the introduction of the metal, and the apertures left by the melting of the wax-rods afford a ready means of exit for the air. The plug of the furnace is withdrawn, the metal flowing out enters the mould, fills it, and the statue is cast. If the air in the mould is not completely expelled, it becomes condensed, and presents an obstruction to the metal, a defective portion in the statue being the result, as in the foot of Cellini's Perseus in the grand square at Florence.

The *cire-perdue* process, assuming the cast to be taken from an original model, is a hazardous operation, since, if the casting is defective, the entire work of the artist is lost, as was the case with the first competitive panel for the Baptistery gates, at Florence, cast by Ghiberti, which he consequently had to re-model.

By this process was cast the statue of Louis XIII., in 1699, the whole being cast in one piece. It is now usual to cast large works in several pieces. Thus, for instance, in an equestrian statue, the body of the horse, its neck and head, its legs and tail, and the body of the rider, would all be separate castings, afterwards united with pins, or "burned" together by causing a stream of metal to flow over the junction of the pieces in juxtaposition until they are fused into one. There are methods, however, of employing the *cire-perdue* process without losing the artist's work in case of accident. A plaster cast, or series of piece-moulds, is sometimes taken from the model, and this cast filled with the necessary thickness of wax arranged round another core. Another method is to build up the piece-moulds taken from the original model round the core, pour in the wax, remove the mould, add the necessary air-channel pipes, and proceed as before.

The *cire-perdue* process was the one employed by the Chinese and Japanese, for the production of many of those peculiar and complicated castings which figured so conspicuously in the International Exhibitions of 1851 and 1862.

Another method, however, is generally practised for moulding figures in bronze. A model is made in plaster, and a piece mould of Caen sand about 1½ inch or 2 inches thick made round it, the sizes of the pieces being determined by the shape and character of the portions they copy. These pieces are backed with plaster of Paris to about a foot in thickness, with indentations cut in their horizontal thickness into which the succeeding portion of the mould fits. The

mould is then taken to pieces, dried, and rebuilt in the casting pit. It is then filled with core composition in a liquid state, and when this is sufficiently hardened again taken to pieces. The core thus obtained is thoroughly dried, and reduced in size by scraping away as much of the material as would represent the thickness of the metal to be cast. This done, the mould is again built up over the core, and the pit filled, &c., as in the former process. The statue is completed, after its removal from the mould, by cutting off the "jets," removing roughnesses where they occur, and giving greater sharpness to the details when necessary, by means of large chasing tools and riffles. The ancient Greeks had another method of casting, which depended on the shrinkage of the material of which the core was made, this shrinkage of the core from the mould forming the space into which the metal was poured.

The composition of bronze varies very slightly in the older examples. It is occasionally formed by adding a small proportion of lead to the copper and tin.

Since the introduction of the art of artistic bronze casting into Birmingham, the following statues have been cast by Messrs. Elkington, at the Newhall-street Works. 1. Sir Robert Peel, 7ft. high, modelled by Mr. P. Hollins, now standing at the top of New-street. 2. General Ferè, 7ft. 6in. high, sent to South America. 3. The "Guards' Memorial," consisting of three guardsmen, 9ft., and a figure of Victory, 10ft. 6in. high, modelled by John Bell, now standing in Pall Mall, London. 4. Three equestrian statues of the late Prince Consort, modelled by Thornycroft, 13 feet high, distributed to Liverpool, Halifax, and Wolverhampton. 5. Last, but not least, the noble and chivalrous colossal equestrian statue of Lord Hardinge, modelled by Foley. Around it, in the square of Calcutta, where it stands, the Arab horse-dealers gather at sundown, and comparing the steed with their own desert-born barbs, pronounce it no work of human hands, but those of the wonder-working genii, while the natives gazing up in reverence, whisper of the doings of the "Great Sahib."

It is matter of regret that with the exception of a portion of the Hardinge group, no record of the weights of these statues can be furnished. The body of the horse in the Hardinge statue weighed 4¼ tons, a considerable portion of the metal being furnished by guns captured in the Affghan war by him whose memory they now serve to perpetuate.

It will be at once understood that the production of a bronze statue of colossal or even life-size by any of these processes is a work of great difficulty and no little risk. Even with every precaution, an immense force is exercised on the walls of the furnace by the molten metal, by which they may be burst; the mould may fail just as the metal enters it; compressed air may rend the mould and allow the metal to escape; the metal itself in running may, by some unforeseen event, occasion failure in the casting, and thus the artist's labour of months or even years be sacrificed in a moment.

ELECTRO-DEPOSIT STATUARY.

But science, in her bounty, has provided other means of reproducing the sculptor's labours on his clay or waxen model, in enduring metal, with a certainty of success and impossibility of failure. The agent by which this reproduction is effected is untiring in its operation, strong now and for ever, as on creation's morn, pervading all nature, the source of light and heat, heard in the roll of the thunder, and made visible in the lightning's flash. Captured by science and chained to her car, it has become docile, obedient, and willing under the kindly care of Philosophy. Though first received with suspicion at the gates of Industry, once fairly within her portals, with a tub for a kitchen, and an earthenware tube for a parlour, fed on cakes of zinc, buttered with quicksilver, and with acid to drink, it first showed a specimen of its working powers in the copy of a little coin, but so thin, so very thin! With further encouragement it copied a basso relievo,—a little thicker;—then it produced a statuette. "Give me more elbow-room," it cried; "Increase the number of my chambers! Give me more cakes, more drink! Lengthen my arms of copper-wire! Make my workshop bigger, I care not how far distant. I will work from eve to morn, from morn to dewy eve; I want no day of rest! Give me what I ask, and leave me alone to work!" And its kindly masters,*—now, alas! no more,—gave it all it asked and left it. Weeks and weeks afterwards, in the plaster mould left in its workshop-bath of coppery blue water, was found the metal statue of a man, not a mere film in thickness, but stout and strong. Many a time and oft, since then, has it done likewise, creating everlasting images that shall present to the eyes of coming generations the features of men mighty in battle and wise

* The late Henry and G. R. Elkington, Esqs.

in council, noble benefactors, lordly poets, deep historians, students of science, careworn and sorely buffetted in life, who have enriched the world by inventions that have cheapened production, diminished labour, and ministered to the material comforts of all ranks and conditions of men.

What is this power by which the statue is built up, particle by particle, as the bee builds up her cell? It is born of the subtle fluid which pervades the universe. It is recognised by Science as Electricity, Magnetism, Galvanism. Its name in Industry is Electro-Metallurgy.

The process is simply that of depositing metal, restored to its metallic form from a solution, on a surface exposed to the action of a galvanic battery—the apparatus being enlarged, the battery power increased, the solution-vats widened and deepened according to the requirements of the moulds, and the quantity of the solution in which after being prepared they are immersed. Troughs are now provided as much as 15ft. in length, 8ft. in width, and 9ft. in depth, capable of containing 6,680 gallons. The strength of the solution of sulphate of copper is maintained by immense sheets of copper suspended in the vat. The moulds are in plaster, and taken from the original model in pieces of such a shape and size as to be easily removed, and readily put together again. After being varnished, to hinder absorption of the solution, the interior of the mould is coated with black lead, which attracts the copper thrown down from the solution when decomposed by the electric current, and which, grain by grain, builds up the statue. It is an error to suppose that statues thus produced are necessarily thin or irregular in thickness of substance. I have seen examples of deposited copper $\frac{3}{4}$in. in thickness, and few of the statues I have examined were less than $\frac{3}{8}$in. If solidity of substance and purity of metal can ensure durability, then assuredly the copper statuary produced by this process may be expected to be everlasting. That pure copper resists the action of sea-water better than any other metal has been proved by its employment in sheathing for ships. Its indestructibility by exposure to the atmosphere is evidenced by the preservation of the statue of Buddha, belonging apparently to the earlist ages of the Buddhist faith, and consequently nearly 2,500 years old, discovered at Sooltangunge, on the Ganges, and lately presented to the Birmingham Art Gallery, by Mr. S. Thornton. This statue, however, is cast in unrefined copper, as will be seen by the following analysis furnished by Daniel Forbes, Esq., F.R.S.:—

Copper	91·502
Iron	7·591
Silver	0·021
Gold	0·005
Nickel	.....traces
Manganese	.....traces
Arsenic	0·079
Sulphur	0·500
Insoluble slab	0·292
Total	100,000

If copper thus impure, and with iron in its composition, will last for twenty-five centuries, there seems no practical limit to the probable durability of metal at once denser and purer than any cast copper can possibly be. The idol itself is cast, and filled with sand, which, in all probability, formed its core, the thickness of the metal being by no means so uniform as that of a deposited statue.

By electro-metallurgy, as has been said, all risk arising from an immense accumulation of molten metal is avoided. The action of the electrical current is certain in its operation, and with batteries of sufficient power, and vats of sufficient dimensions, there is no limit to the size of the object that can be produced. So far as the active power itself is concerned, it could, with the same ease, take an impression of a three-penny piece or build up grain by grain a colossus like that which, with a stretch of fifty feet from rock to rock, bestrode the harbour mouth of Rhodes—the Titan of statues, one of whose thumbs no ordinary mortal could embrace, whose little finger exceeded the dimensions of most life-sized statues, and under whose mighty stride could pass a vessel in full sail, haply guided by the lamp upheld in the outstretched hand, which the mariner, at night, could see from the Egyptian shore, and bearing homeward to their citadelled city a company of Knights of St. John from battle with the Paynim Infidel onHoly Land.*

A prejudice against statues produced by electro-metallurgy was at first created by some examples of very limited thickness of metal having got abroad, from an examination of which it was concluded that the process could not accomplish work of a more substantial character. That this prejudice has now almost entirely disappeared will be evident from the following

* The Colossus was the work of Chares, of Lindus. It took 12 years to produce, and cost a sum equivalent to about £70,000. It was thrown down by an earthquake, and the Rhodians, forbidden by an oracle, refused the proffered aid of Greek and Egyptian artists to restore and re-erect it. In the year 655, the Saracens being then in possession of the island, the metal was sold by an officer of the Caliph Othman to a Jewish merchant, who, we are told, loaded 900 camels with the fragments. [If the Colossus bestrode the harbour, and was thrown down by an earthquake, it must have fallen into the sea.—EDITOR.].

enumeration of works produced by Messrs. Elkington within the last five years :—

Subject.	Height.	Artist.	Where Erected
	ft. ins.		
Samuel Crompton, the persecuted inventor of the Spinning Jenny. A seated figure	7 6	W. Calder Marshall	Bolton.
Oliver Goldsmith	9 6	Foley	Dublin.
Exhibition Memorial, comprising,			
1. Her Majesty as "Peace"	10 6	Durham	Hyde Park, London.
2. The Prince Consort	10 6		
3. Europe	6 6		
4. Asia	...		
5. Africa	...		
6 America	...		
The Prince Consort	10 6	Durham	Guernsey.
A Naiad	6 0	Alex. Munro	Boston.
Lord Hill	6 6	W. Theed	Wellington College.
Lord Howe	...		
General Murray	...		
Lord Hopetoun	7 0		
Lord Combermere	6 6		
The Prince Consort	6 9	Durham	
Sir W. Stevenson	8 6	De Epegry	Mauritius.
The Prince Consort	6 9	Theed	(For Duchess of Sutherland)
— Feilden, M.P.	8 6	Foley	Oldham.
Malcolm Canmore, King of Scotland	6 6	Theed	Balmoral.
General Seaton	8 0	G. G. Adams	
The Earl of Eglinton, L.-L. of Ireland	13 6	McDowell	Dublin.

The statue last named weighed two tons, and was three-eighths of an inch in thickness throughout.

It is now customary to cast bronze statues in several pieces, and the same plan is observed in those produced by electro-metallurgy; the belts, or other ornamental projections in clothing or armour, offering the means of effecting the junctions without rendering them obtrusive. After being taken from the mould, the several parts are trimmed up and fitted together, and the whole statue is coated with a liquid bronze to give uniformity of colour. An oxide once formed on the surface decay is arrested, the density of the metal preventing its penetrating beyond a mere line in thickness.

On the whole, judging from the progress made within the last five years, it seems highly probable that, in the production of bronze statuary, the process of casting will ere long be entirely superseded by the simpler, safer, and more certain operations of electro-metallurgy.

THE ART OF STAINED GLASS IN BIRMINGHAM.

By JOHN HARDMAN POWELL.

The old English spirit of architectural and decorative art, after a trance of centuries, has now happily revived, and is rapidly recalling its old expression to the face of the country. This great reaction is felt to the furthest corner of our island; and excepting, perhaps, that of the fifteenth century, is without a parallel in its Art-history. Of this movement, the revival of stained glass has become an important feature, and the demand for coloured windows seems, from its urgency, as if actuated by a desire to expiate the blind fury which tore down the ancient glass, and the ignorant neglect which left it to drop from its lead-work.

Birmingham and its suburban churches—St. Martin's, old St. John's (Deritend), the Chapels of St. Catherine and the Friars Minor, Edgbaston, Harborne, and Aston, all, without doubt, were once partially, if not entirely, glazed in the ancient manner; but not a fragment of the glass remains to show us what it was. All record even of it has perished, except a meagre mention by our historian of three coats of arms of the Lords Dudley, Tamworth, and Birmingham in the chancel windows of St. Martin's, and of some old armorial glass of the Dudley family, and a figure of Sir Walter Arden, in St. John's, Deritend.

It does not seem to be known whether glass-painting had been practised in Birmingham before 1784, but it is nearly certain that, if so, the art had been dead for a long time previously. In that year Francis Eginton first began to paint glass at Soho, where he is said "to have brought his art to astonishing perfection." He seems to have produced a great number of works, among which are cited, windows for St. George's Chapel, Windsor, containing the arms of the Knights of the Garter; for Salisbury and Lichfield Cathedrals; St. Asaph's and Magdalen College, Oxford. In the last he

restored from an engraving, by Sadeler, a "Last Judgment," by Christofer Swartz, which had been injured by a storm in 1703, besides painting eight other windows of benefactors in the ante-chapel. Windows of his workmanship are also to be found in Merton College Chapel, the palaces of the Bishops of Derry and Armagh; Wanstead Church, Essex; and St. Martin's Outchurch, London. He also painted glass for Hampton Court, Wardour and Arundel Castles; and in August, 1794, Beckford gave him a commission for windows, amounting in value to £12,000, for Fonthill. Orders, moreover, are said to have poured in from foreign Courts; and some of his finest windows are reported to be at Amsterdam.

In these works no knowledge whatever is shown of the mediæval principles of glass painting, or rather a direct antagonism is displayed to all the canons of ancient art. The designs, stretching over the whole light, without borderings or geometric or architectural forms, were divided into a number of squares by an iron frame, which gives them the appearance of being seen through a portcullis. They were made out entirely by enamel colour—brown shade and yellow stain on a white base, with little or no outline and few leads. The drawing and tinting of the draperies and complexions is generally soft, dreamy, and pulpy; the composition, colour, and effect, being often marked by the feeble elegance so common in pictures of the style in which Sir Joshua was master. These works, in fact, are so many pictorial transparencies. As windows, they set at defiance all the rules of art and every principle of construction. Still, in despite of their defects, we are constrained to feel grateful to the man who was the pioneer in our town to break out of the dreary blank of white light in which we were lost—who did something while others did nothing—who made earnest efforts, believing in his craft—and who really produced large and imposing works under tremendous difficulties.

We have a few specimens of his work near us. One is the east window of the south aisle in the old church at Aston, put up in memory of Letitia Dearden, about 1792, by Catherine and Edward Johnstone. For subject there is one peach-cheeked damsel being assisted to rise out of a very brown cracked tomb by two others in wings—all done in enamel. His most important work, however, in this neighbourhood, is the east window of St. Paul's, one of the "lions of the town," of which our historian magniloquently says—"This window was made by that celebrated artist, Francis Eginton, in 1791, at a cost of

400 guineas." It presents to the spectator a sea of bistre, with a few finger points of light and streaks of colour. It is not till the eye has become accustomed to the sombre tone, that masses of huge brown limbs are discoverable—then a horse's head—then a herculean St. Paul daringly displayed across the centre light. Above, the figure of our blessed Lord is seen falling through a bright rent in some very black clouds. On the dexter side is a group which may be intended to represent the Christian Church suffering under Saul's persecution—brown flesh in quantities, with a few pieces of rich colour. On the sinister side is St. Paul in an agony, supported by an attendant, and receiving his sight from a very sun-burnt Ananias. Two-thirds of this window are positively opaque by any ordinary light; and if the entire church were filled with glass of the same character, the congregation would have to grope about for their pews at mid-day. Nevertheless, there is a far superior tone about this window to that of most glass of the same period. It is a bold and great effort. Eginton could have been no mean or timid artist, and must have been well conversant with the works of the Italian painters of the 17th century.

Francis Eginton died on Lady-day, 1805. William Raphael Eginton, probably son of Francis, is marked in the Birmingham Directory, of 1818, as glass-painter and stainer to her late Royal Highness, the Princess Charlotte of Wales, and the Duke of Sussex. In the same work is mentioned H. H. Peacock, ornamental glass-painter, New-street. Of their works, we know simply nothing.

F. and C. Pemberton come next in historical order. They boldly proclaimed their adherence to the principle, that glass-painting may legitimately attempt all the effects of the finest paintings and frescoes. In 1849, they spoke of Eginton as "the great reviver of modern glass-painting," and were, consequently, quite consistent in upholding the superiority of smooth glass as a rule to the older and more uneven material. It is, therefore, no matter of surprise to find in their works the same wants of definite rules as in Eginton's, and the same absence of the jewel-like beauty so conspicuous in the ancient examples. Their works have been chiefly of a domestic character.

Messrs. Chance Brothers and Co., whose large Glass Works are justly celebrated, have for many years carried on a branch of painting on glass. For the success of this department, they at first engaged the services of M. Bontemps, who

communicated some interesting results to the chemical section of the Meeting of the British Association in 1849. After M. Bontemps, Mr. Jones was head of the department till 1857, when he was succeeded by Mr. Sebastian Evans, who had previously been associated with the Mr. F. W. Oliphant, presently to be mentioned. During the time that the talent of this artist was employed on their works, a marked change was observable. The old rough make of glass was brought more into use, and for the Exhibition of 1862, a very important work was produced from Mr. Evans's drawings, well-known as the "Robin Hood Window." Although its merits were under the disadvantages of being placed in a position and light totally unsuited to them, there was ample evidence of the great advance made by this firm since the Birmingham Exhibition of 1849, where their best work was the East window of the Cemetery Church, Hockley. Besides the Robin Hood Window, some smaller lights of foliage were exhibited in 1862, which displayed still more clearly an observance of the old principles. The material, made by themselves, was brilliant, and the arrangement geometric and mosaic in treatment.

Robert Henderson was a Birmingham painter on glass for many years. He started in Temple Row about 1820, and removed, later, into New-street. His works are in enamel, chiefly of the domestic character of that unhappy time; sandy-red borders, strong orange vine-work, in high relief, with black shadows. Some, however, are of a better class; such as the enamel windows at Castle Bromwich Hall, Mr. Russell's, at Handsworth, and one of a heraldic character, at Alton Towers, painted for Earl John, of Shrewsbury. He painted a few ecclesiastical works—a "Carriage of the Cross" for Bilston Catholic Church, and some emblems in Trinity Chapel, Birmingham. He died in 1848.

In 1837, Mr. John Hardman, then of Paradise-street, in this town, became acquainted with Augustus Welby Pugin, who had just aroused the attention of Englishmen to the degraded state of their architecture and art by his scathing denunciation of the Pagan Renaissance of the 16th century, and by his unmerciful exposure and castigation of shams in construction. They soon formed an almost brotherly friendship, which lasted undisturbed during fifteen years of daily correspondence and frequent personal converse, until the fiery genius of Pugin was so early consumed in its own fierce brilliancy. This friendship resulted in Mr. Hardman's under-

taking to start metal and glass works, on strict mediæval principles, from the designs of Mr. Pugin. In the former, Mr. Hardman was master of all the processes: in the latter, he required the assistance of some one skilled in the practical mixture of the yellow and brown stains, and in burning in the kilns. The two sons of Robert Henderson possessed these requisite qualifications, and the elder was, besides, a fair painter on glass. An engagement was made with them and with their chief painter, Mr. Hinckley, who had been with them twenty-four years. A muffle was built, and with two or three boys the work was started. Before this time, Mr. Pugin had had many successful windows made from his drawings by Mr. Wailes, of Newcastle, and Mr. Warrington, of London, some of which are in St. Chad's Cathedral in this town; but he was wishful to have his glass executed more immediately under his own care, and the direction of one whose views for the progress of mediæval art were entirely in accordance with his own, and whose energy and earnestness promised active co-operation in the work. Mr. Pugin, having undertaken to find designs and drawings, built a cartoon-room attached to his house, St. Augustine's, at Ramsgate, and there, with his son Edward, then a boy of eleven, and the fortunate writer of this report, who had just become his pupil, he made the cartoons for his first windows at St. Cuthbert's College, Ushaw, frequently producing as many drawings before breakfast as would suffice an artist of ordinary energy for a whole day's work. Orders came in fast, and it was necessary to procure assistance. Mr. Francis W. Oliphant, an artist well skilled in drawing the human figure, and a firm believer in the true principles of his art, whose early death is deeply to be deplored, was accordingly employed, and frequently went down to Ramsgate from London. Still the orders multiplied, and youths were sent down from Birmingham to be taught in the right way. In the course of time a band of draughtsmen was thus formed, sufficiently skilled, after the sad death of their great master, to carry on, under Mr. Hardman's guidance, the large works in stained glass which had been started on so small a scale fifteen years before.

Mr. Hardman found it necessary still to extend his works, and consequently removed to more convenient premises in Newhall Hill. During the twenty-three years that have elapsed, the processes have been gradually improved, and the number of works executed has been very considerable. With very few exceptions, and those for special reasons, no works

have been repeated; but each one has been designed and carried out in the style of the stonework it was intended to fill, and with a careful eye to the circumstances of its situation.

For the last few years as many as from 80 to 100 hands have been employed, and in nearly every instance Birmingham youths have been taken as apprentices. One was a bricklayer's lad, another cleaned an engine, another made his first outlines in chalk—caricatures of his friends, of course, on the soles of the shoes he had to brush—a circumstance which first drew Mr. Hardman's attention to his talent. On the whole, there is ample proof that even in towns so intimate with coal and iron as Birmingham, so apparently given up to a worship of material, plenty of artistic talent is to be found, which only requires, as all arts do—the highest most of all—fostering and cultivating, in order to produce good fruit.

A sketch of the progress of stained glass in this town would be incomplete without mention of the works of Messrs. Lloyd and Summerfield, at Birmingham Heath, who for at least thirty years have made coloured glass for this purpose with great success. They made the first glass from old specimens painted by Mr. Hardman, and though Messrs. Powell, of Whitefriars, and Hartley, of Sunderland, have deservedly earned so much praise for their imitations of the make and tones of the old glass, still there are many colours made by our townsmen that have not been surpassed, if equalled.

Altogether, the retrospect of the three-and-twenty years is decidedly encouraging. The true principles of the old art have been triumphantly re-established on the ruins of the picture-making process; the rough glass has triumphed over the smooth—pot-metal over enamel—mosaic treatment over shadowed relief—artistic conventionalism over mechanical imitation of nature—symbolisation over material representation. We may be well pardoned for being jubilant over so important a victory, won, not by superiority of artistic talent, but by the mere fact that an observance of the true and constructive principle of the art has been once more recognised as the one condition of excellence.

THE REVIVED ART OF METAL-WORKING IN THE PRECIOUS METALS, BRASS AND IRON, ON MEDIÆVAL, OR TRUE PRINCIPLES.

By W. C. AITKEN.

This department of Metallic Industry, which has now reached a prominent position in this town, is of comparatively recent introduction. It owes its existence, indeed, to the enthusiasm, energy, and perseverance of one who "should have died hereafter," Augustus Welby Pugin, whose earnest and unselfish efforts to restore Christian architecture in its full integrity have now, at last, received unqualified recognition. In the early part of his career, he had succeeded in impressing on some few admirers the truth of the principles he advocated with regard both to construction and style of architecture; but when commissioned to put those principles into practice, he found himself surrounded by difficulties on all hands. Not the least of these difficulties arose from the total obliteration of all the old true principles on which metal had been worked. Modern methods of production, readier, cheaper, every way more adapted to meet the demands of the present day, had been universally adopted, and not a single specimen was to be procured of metal-work in the style, and of the character, required. Such was the state of this art in England when Pugin first took in hand the great task of its revival.

In his journeyings through the length and breadth of the United Kingdom, and over the continent of Europe, in pursuit of the one great object of his life, he had studied and examined not only the architectural features of mediæval art, but every example of metal work associated with it, which time, the spoiler, and the Iconoclast had left. Modern gold and silver smiths, he felt, had ceased to be artists. The blacksmith's craft, once hardly less artistic than that of his brother artificers

in the precious metals, had now become purely mechanical. The true character of metal work had everywhere been lost sight of. The press, with its punch and bed, had replaced the delicately beautiful process of saw-piercing; the stamp and die had usurped the province of the beater-up; chasing had degenerated into a mere process for giving a mottled appearance to portions of the surface of an object in metal, appropriate texture being altogether ignored; engraving, carelessly executed, had gone off into the region of *rococo*, or had been subverted into the production of meaningless scrolls, queer shells, and impossible birds; enamelling, in its true sense, was almost a lost art, and where practised was most imperfectly executed, the colours being confined to a translucent blue, and the black introduced in mourning rings and brooches; *repoussé*, in its delicacy and beauty, was only occasionally in its integrity practised in France, where it was revived in 1838. In brass-work, the colour, as well as the reflective and ductile properties of the metal, were all partially obliterated in the hands of the caster. It was dimmed by the acid finish produced by "dipping," and falsified by the process of bronzing. Iron, the national metal, worked by English blacksmiths of old into such quaint, graceful, curious, and involved forms, uniting ornament with use—or in the hands of continental metal-workers, Matsys, Peter Vischer, and Nuremberg artificers, forged into well-cover and grille, ornamental door-handle and floreated hinge, such as even yet, decayed with rust and broken, startle us with the artistic beauty of their conception, the boldness, freedom, and minuteness of execution—iron, so nobly employed of yore, had now, for all ornamental purposes, been consigned to the mere caster and moulder, and if hammered at all was only hammered into prosaic utilities.

But it was not enough to feel these things, and to have formed a clear conception of what should be but was not. Pugin's ideas might have passed with him to the grave, had not the great revivalist been brought face to face with the realiser—the designer with the producer. In 1838, Augustus Welby Pugin was introduced to John Hardman, of Birmingham, a manufacturer possessed of means and a thorough knowledge of metal-working—above all, an enthusaist, prepared to carry out, in the face of every difficulty, the conceptions of the artist-designer. The connection thus commenced, under circumstances alike honourable to both, rapidly ripened into the closest friendship, and terminated only with the too early death

of Pugin. Such was the beginning of the revival which has now developed an important branch of industry, and exercised an influence on metal-working generally, closely akin to that of the Pre-Raphaelite movement on painting. It has had the effect of making metal-workers *think*, apparently for the first time for some centuries, and has been the means of creating a superior class of skilled artificers, who claim for themselves a special department of metallic industry. Wherever metal-work on mediæval principles is now practised, its origin can be traced to Birmingham as the parent stem, and a large proportion of the artisans first employed in it by other firms and manufacturers have acquired their skill and learnt the secrets of their art at the works of John Hardman. It is honourable alike to the adaptive capabilities of Birmingham artisans and the spirit of Birmingham manufacturers, that this town, so often stigmatized as the centre of the production of "lacquered shams," should have been selected by Pugin as the field for carrying out his conceptions, and that under the guidance of his genius it should have so nobly taken the lead in the production of realities.

The difficulties attendant on the establishment of a trade involving such a radical change in the *modus operandi*, and so many processes wholly dissimilar from those then existing and practised, may be understood by intelligent practical men, but can hardly be so by the uninitiated. The whole revival was a series of experiments. Three centuries of neglect, and the loss of old traditions which might have unveiled the secrets of the old artists, had left the whole work to be commenced afresh.

"A few years ago," says Pugin, in answer to a virulent attack made on him by a writer in the *Rambler*—

"It was impossible to procure even the commonest articles of church furniture in any but the most debased style—not a carver in wood or stone; and in metal work such was the difficulty of procuring operatives, that we were compelled, for the first altar lamp ever produced by us, to employ an old German workman, who made jelly-moulds for pastry-cooks, as the only one who understood beating up copper to the old forms. . . . . We were compelled simultaneously to carry on works in masonry, carpentry, wood and stone carving, painted glass, encaustic tiles, incised brasses, metal work from the most precious to the most common, embroidery, silk-weaving, and brocades."

This necessity for reviving the old methods of working metals, &c., arose simply from the total inadequacy of the new methods to produce the same effect. It was only, however, when mechanical inventions intruded on the domains of art and tended to the subversion of the principles they were

intended to advance, that Pugin considered them objectionable. Stamping, pressing, die-work, and casting he would not have rejected or objected to, simply because they were modern processes. He disliked them because they were in their very nature opposed to the true principles of art,—because their application and operation resulted in the substitution of monotonous repetition for beautiful variety—flatness for bold relief with all its attendant light and shadow—because they tended to encourage a cheap and false magnificence, and to degrade the principles of ornamental design in deference to the exigencies of a ready-made manufacture. In modern metal-work, too, as opposed to ancient or mediæval, a constant confusion of processes is perceptible in which the distinctive character of the metal is lost. What is cast should have been beaten, and what is beaten should have been cast. The old workers never, or very seldom, committed errors of this kind. The fitness of the metal for the purpose intended was one of the first considerations; thus, portions of metalwork to support weight perpendicularly, such as columns, &c., would be generally cast, and afterwards engraved or chased. Due regard was also paid to the value of the metal emplcyed. Bronze, a mixture of copper and tin, would be cast, while gold and silver would be beaten. Iron, again, would be enhanced in value, not by casting, as in the case of the minute Berlin ornaments, but by taking advantage of its ductile and fibrous properties, and the facilities it presented when heated for the operations of the hammer-man. That iron was thus manipulated as a metal for the display of cunning workmanship, instead of being cast, did not arise from ignorance of the casting process. Boutell mentions a cast iron monumental slab at Barwash, in Surrey, bearing a cross and inscription in relief, which sufficiently attests the skill of the mediæval casters. The preference shown for hammered iron was due to their understanding the fact so eloquently stated by John Ruskin, that—

"Iron is eminently a ductile and tenacious substance, tenacious above all things, ductile more than most. When you want tenacity, therefore, and involved form, take wrought iron. It is eminently made for that. It is the material given to the sculptor as the companion of marble, with a message from the lips of the Earth-Mother:—'Here's for you to cut, and here's for you to hammer. Shape this; twist that. What is solid and simple, carve out; what is thin and entangled, beat out. I give you all kinds of forms to be delighted in—fluttering leaves as well as fair bodies; twisted branches as well as open brows. The leaf and the branch you may beat and drag into their imagery; the body and brow you shall reverently touch into their imagery. And if you choose rightly and work rightly, what you do shall be safe afterwards. Your slender leaves shall not break off in my tenacious iron, though they may be rusted a little with an iron autumn.'"

This poetic expression of the fitness of different materials for different purposes is strictly in accordance with mediæval principles, as is the following account of the characteristics of Gothic ornament :—

"While other styles of ornament (says the same author) indicate softness and beauty, and soothe like the melody of sweet music, that of the Gothic startles like a clarion's note or the trumpet's call, for it had its origin in the industry of the tribes of the North, whose energies were quickened by the coldness of the climate, which, consequently, gives expression in all they do, as opposed to that of the langour of the Southern tribes; and, however much of fire there may be in the heart of that langour, even lava itself may flow languidly. Activity, united with rigidity, is a leading characteristic of the mediæval workman; but the rigidity is of the kind which gives tension to movement and stiffness to resistance—which makes the lightning forked rather than curved—the stoutest oak branch angular rather than bending. It gives a firmness analogous to the long skeleton of man, united by the muscles, or the fibres of wood in the tree. Gothic ornamentation ever stands out in prickly independence and frosty fortitude, jutting into crocket, and freezing into pinnacle; here germinating into a blossom; there knitting itself into a branch, alternately; thorny, bossy, and bristling; writhed into every form of nervous entanglement; but even when most graceful, never languid, always quickset, erring, if at all, ever on the side of brasqueness."

The main principle, in fact, of mediæval metal work, was to construct firmly and substantially that which was afterwards adorned appropriately and beautifully, keeping ever in view the purpose for which the object was intended, and the futility of decoration, except as subservient to, and growing out of, the construction.

When Pugin and Hardman first attempted to reduce this principle to practice no effort was made to start a manufactory, bnt the several objects were made by workmen selected for superior skill, taste, adaptation, talent, and ingenuity. The earliest objects produced were small in size, and chiefly of the precious metals—hanging lamps, candlesticks, chalices, flagons, metal mountings for books, mitres, pastoral staffs, &c. On these various and dissimilar objects were lavished much cunning workmanship on the part of the artificer, and much care and attention on the part of the designer, to whose revision and scrutiny they were subjected at each stage of the processes through which they passed. When of gold or silver, they were raised from thin plates of metal embellished with surface ornament by beating up. Delicate filigree work was associated with beautifully reticulated lace-like perforations, produced by saw-piercing—engraving, carefully and painstakingly executed, with richly hued stones, not facetted but polished—enamels of various tints, with brilliant surfaces of gold or silver, or the contrast of both produced by parcel gilding. The visions of

the revivalist were realised in the triumph of the producer and and artisan. It is no figure of speech to say that these early works were indeed labours of love. The work had been done for the work's sake. The revival of the processes employed by the metal-workers of the olden time had, after much travail, pain, and sacrifice, been accomplished, and Pugin's long-cherished day-dream had at last become a living reality.

In 1845, the craftsmen engaged on these experimental works were concentrated in a single establishment in Great Charles-street, where Messrs. John Hardman and Co. thenceforth carried on business as ecclesiastical and civil metal-workers. In 1849 they added glass-painting in the styles of the 13th, 14th, and 15th centuries to their other business, and thus founded the first establishment for the production both of metal-work and glass on revival principles.

On Pugin's death in 1852, his gifted pupil and son-in-law, Mr. J. H. Powell, undertook the artistic direction of both departments, and has ever since most ably maintained the high reputation of the establishment, in which were produced, chiefly under the superintending eye of Pugin, the metal work of the new Palace, at Westminster, for Alton Towers, Lismore Castle, and a number of other buildings public and private.

That metal-work, misnamed Gothic, had previously been attempted is true, but neither in conception, design, nor execution did it approximate to mediæval metal-work. Such was the prevailing oblivion of all true principles before the era of Pugin, that any work, however preposterously it might outrage all the fundamental canons of art, was considered excellent Gothic, provided only it displayed a sufficient amount of cuspings, crockets, finials, and grotesque masks. Works of the period on Gothic architecture supplied the details of buildings erected in stone and lime, from which the designs for these astonishing works in metal were cribbed without hesitation. Thus an altar-tomb, originally built up and carved in Purbeck marble, furnished the model for a clock-case; a popular "door-porter," or weight to keep open a door, was fashioned in the likeness of the gable-end of a mediæval house, plus a long handle protruding from the finial of the said gable, while the same design, minus the long handle, did duty for a thermometer-stand; French lamp-heads towered aloft on three or four united pillars surmounting a base formed by four "Gothic" gables, a "Gothic" doorway being introduced in each panel, and the panels themselves rising from a plinth: "Gothic" inkstands, "Gothic" letter-weights, "Gothic"

match and spill-boxes, "Gothic" fenders and grates of a like character were also all elaborated by casting, and perpetuated in manifold and melancholy numbers and variety. "Birmingham Gothic," of this kind, received at the hands of Pugin the severest of castigations, but not one whit more severe than it deserved. The producers of these monstrosities, in fact, totally misunderstood or ignored the properties of the material in which they worked. They went to work as if the qualities of metal were the same as those of stone or wood. No mediæval craftsman could have erred so grossly and so wilfully. The Gothic metal-worker never would have adopted a stone or wood treatment for his material. He would never have cast his cusps and crockets. He would have hammered his metal thin, marked the outline of the leafage, cut the pieces from the sheet, and beat them up into their manifold involved forms of curve and quirk and twist. Stone, he knew, was granular, and only partially cohesive; wood fibrous, but weak; bulk was required to give strength to both. Metal, he knew, was tenacious and ductile, strong in its lightness, and as he knew so he wrought. If he worked in brass, the structural part, where strength was required, was cast, and the ornamentation produced from thin plates of metal. Light and shadow he obtained with the hammer, bossing portions of the leaves up into convexities on the one side with their corresponding concavities on the other, curling the petals of his blossoms, expanding those of his flowers, working carefully over every portion of the object before giving it the final polish which should show off to best advantage its gold-like colour and reflective sheen, when flashing in the sunshine or glistening radiant in the light of sconce, corona, or candelabrum. There is no reason to suppose that the mediæval metal-workers were ignorant of the action of acids on metal, which was as familiar to the alchemist of the misnamed "dark ages" as to the chemist of to-day. But the workman of the middle ages refused to accept a mode of finish which at best could only approximate to the characteristic brilliancy of the metal he wrought. He deliberately preferred perfection achieved by painstaking care to a false finish effected by an easy process.

Was bronze the metal to be wrought? One of the distinctive characteristics of bronze is to blacken on exposure to the atmosphere. Be sure the mediæval craftsman did not forget this peculiarity. He cast his bronze in moulds, he graved it with chisels of various forms, he riffled it and left it in its

massiveness and grandeur. Thus wrought Michael Angelo a statue to guard the tomb of a vicious Medici, with gaze on countenance "fascinating and intolerable." Thus Ghiberti, the everlasting portals storied with scenes from Holy Writ, which grace the Baptistery at Florence. Thus Cellini his Perseus and Andromeda. Thus Donatello his work now at Padua, in commemoration of Erasmo de Nari, who led the armies of Venice to victory. Thus Torrigiano, the metal-worker, for the monuments of Henry VII. and the Duchess of Richmond in Westminster Abbey, the Santa Croce of England. In each and all these works just so much finish was given as would secure the right effect, and they were then left for time to tone and colour.

Iron, again, was treated in strict accordance with its peculiar properties, and a distinction was drawn between works executed for various purposes. Thus pieces of iron-work for external decoration were bold, firm, pronounced, both in design and execution. The expression left no doubt as to the metal worked. Every advantage was taken of its "nervous-fibrous" structure. The crestings which broke the sky-lines of mediæval roofs stood out against the blue sky with a demonstrative energy which proclaimed at once the metal thus dragged into form, beaten against its will into spire and spike and stem and leaf and blossom, by a will and intelligence which stamped visibly in the marks of the hammer the evidence of its presence. In works to be seen nearer, a more perfect finish was given, but the same principle held good. The iron treatment was not to be misunderstood. Mediæval principles of construction themselves encouraged the desire for ornamental iron-work. No architect would have designed a door to hang on butt-hinges. He would never have secreted a mortise-lock in its side, or stuck on it knobs of glass or china. The floreated hinges he attached to his doors not only adorned but strengthened them and exercised both the designing power of the architect and the skill of the artisan. Biscornette's hinges, on which hung the portals of Notre Dame, were so curiously wrought as to suggest the idea that they had not been produced by merely human hands. Locks, too, boldly asserting themselves on the exterior of the door, afforded another opportunity for the display of cunning workmanship in iron mouldings, quatre-foils, and floreations, or not unfrequently told the story of the house and its founder. The bolts were turned by pendent handles elaborately worked, and the keys presented yet another field for the exercise of the iron-worker's skill. Even nail and

bolt-heads assumed ornamental forms, and added beauty to the doors they protected and strengthened. Grates were then not constructed of cast but of wrought-iron. The andirons, or "dogs," often bearing the heraldic emblazonment of the family, were examples of appropriate ornament, and the fire irons were in unison with the other accessories of the hearth. Exterior and interior railings, in like manner, were always of wrought iron, the work of the hammer-man and fitter. If of round iron, they were intertwined; if of square, adorned by twisting certain portions of the bars while hot. The terminals were honestly worked. Transverse bars, when these occurred in pairs horizontally, were enriched by rosettes and heraldic shields. When tracery was introduced it was wrought in plates of metal, variously perforated and laid over each other. Imitation vegetation was cut out of thin iron, and twisted or bent with pliers; the leaves, veined by the graver or chisel, being welded or soldered to the stems. As all hand-work bears evidence of its origin, so also does machine-work. Molten metal flowing into a matrix by its own gravity can never rival the results produced by the skilful hammer-man. Cast iron as you may, carve or model patterns, mould them elaborately, produce relief by false coreing, the result will never be aught else but cast-iron, fragile, snapping at a touch, each piece hateful to the artist's eye from its stereotyped similarity to its fellows. Similarity produced by hand-labour is similarity with diversity, uniformity without monotony. The work tells of the keen eye and cunning hand, of human will and intelligence intuitively acting on true principles, because comprehending the nature of the material and the object of the work. In cast-iron we recognise only the machine-made copy of a copy; in wrought-iron we feel the presence of the thought which the craftsman has stamped upon his work. One brings us face to face with matter, the other with mind.

The processes employed in the special department of revived metal-working are either formative or decorative. The former include casting, raising from thin plates of metal, and forging; the latter, principally employed upon the precious metals, are—

I. Engraving, or incising the metal by means of gravers into ornamental designs furnished by the artist. These incisions are frequently filled with various substances to render the engraving more distinct, or to add to the beauty and value of the object, the chief processes employed for this purpose being damascening, niello-work, and enamelling.

Damascening is filling up the lines made by the graver with threads or wires of gold or silver, the incisions being peculiarly cut, so as to hold the metal introduced when beaten into them. This process was formerly frequently employed in the embellishment of arms, armour, caskets, &c., formed of iron or steel.

Niello is a black metallic substance, produced by melting and mixing together silver, copper, lead, and sulphur. The product, after being reduced to powder, is applied to the lines of the engraving and fused into them by heating in a muffle. The niello is then ground down to the surface of the metal, and the whole is polished. By filling the incisions with printers' ink in taking proofs for niellos, Finiguerra originated copper-plate printing in 1452.

Enamelling consists in fusing glass or other vitreous substances, coloured with various metallic oxides, into the incisions; opaque enamels are produced by the addition of oxide of tin to the mixture. Enamels are applied by three distinct methods, producing the varieties known as encrusted, translucent, in relief, and painted. With the latter, however, we have little to do. It was chiefly, and most successfully practised at Limoges, and bears a close relation to enamel painting as applied to glass and pottery. The enamels with which the old metal-workers had to do, and the use of which Pugin successfully laboured to revive, were the cloisonné, the champlevé, and the encrusted. The cloisonné is produced by fastening together with hard solder slender strips of metal which formed the outline of the subject to be represented. This metallic outline is soldered on a plate of metal, frequently gold; and before filling with enamel much resembles a pastry-cook's shape, for cutting leaves, &c. The spaces, or cells, are then filled in with enamel of various colours. The champlevé, on the contrary, was produced by cutting the design into the surface of the metal, the spaces to be filled with enamel being sunk, and the portions intended for the outline, or to separate the colours of the enamel, being left standing. The enamel, itself, is reduced to a granulated powder, and in this state is applied with a small spatula. When the incisions or troughs are filled with the various colours, the work is placed in a muffle, which is heated sufficiently to fuse the enamel into the spaces, the use of a muffle being necessary in order to prevent any injurious gases evolved by the fuel coming in contact with the enamel and spoiling its purity and brilliancy. If, after fusing, the surface of the enamel is too far below the walls of the cell

prepared for its reception, more is applied and fused. The whole is then ground down to the level of the surface of the metal, polished with hones, and finally "lapped" to secure brilliancy of finish.

Encrusted enamel is applied to the surface of the metal without engraving, the various objects represented, leaves, fruit, flowers, figures, &c., being rendered in their natural colours. In this variety, the enamels are left with the "fire-glaze" produced by fusing still upon them without any after-polishing.

II. "Filigree-work" is the formation of certain portions of ornament from twisted wires, or wires twisted together into geometric or other designs.

III. "Saw-piercing" is sawing minute geometric or other ornamental apertures in thin plates of metal, so as to produce a reticulated appearance. The workman sketches his design on the metal, drills holes wherever necessary, passes his delicate saw through the holes, and with its assistance detaches the surplus metal as his drawing or his taste may dictate. This process is represented in modern metal-working by "piercing" effected by punch and bed, a purely mechanical process, which can no more reproduce the infinite variety obtained by saw-piercing than cast iron can imitate the effect of wrought.

IV. "Beating-up," "bossing," or "Repoussé work," by which designs in low or high relief are produced, is a charmingly artistic and effective variety of ornamental metal-work. The article or portion of an article to be worked having been "raised" into form, and the design traced, the parts which are required to be convex are punched up from the interior. The article is then filled with pitch, and worked on by the beater with variously-shaped small punches till the design, foliage, geometric ornament, figures, or whatever it may be, is sufficiently made out. It is then worked upon with small riffles, texture is given by matting tools, or the forms and details are finished with the graver. Opposed to this is the modern method of stamping with dies, objectionable on account of the want of relief, sharpness, and finish which all die-work displays, as well as the constant repetition of the same forms, which the expense of sinking new dies necessarily involves. Stamping, in fact, is the mortal foe of variety and originality of design, and the "beaten" work is as infinitely preferable to the products of the stamp and die as saw-pierced work is to those of the "press-tool" and "bed."

V. Gilding.—The revivalist still prefers the old amalgam process to electro-gilding on account of the superior durability of the work. A paste composed of gold, in combination with mercury, is applied to the surface to be gilt. The mercury is then evaporated by heat, and leaves the gold firmly adhering to the metal.

"Parcel-gilding" is chiefly introduced in articles of silver where additional richness is desired, as in the knob or boss, and the cup of a chalice. It consists simply in gilding the portions intended to show as gold.

Burnishing is still, as in mediæval times, effected with burnishers made of hard stone, agate, bloodstone, &c. Brass, it may be observed by the way, was formerly, and is still by the revivalist, polished by abrasion or friction, after being carefully filed or scraped, ground and honed—no other method fully bringing out the true colour of the metal.

VI. In working iron, the methods adopted by the mediæval craftsman and his modern descendant were and are very various. In the case of locks, for instance, and their ornamental covers, while some were decorated with plates wrought in the ordinary way, others were sculptured in cold iron. Figures also were produced by the same means. In floreated hinges where veins, ribs, or mouldings occur, they were generally produced by striking the hot iron into a die, the strips or bars being bent into their convolutions or floreations. Leaves also, where foliage was introduced, were struck in like manner to produce the veins, and afterwards welded on to the stem. Occasionally, however, the veins, both on the stem and leaves, were sculptured, as were the birds and other adornments of the hinges on the doors of Notre Dame at Paris. The twisting of square bars, which gives such variety when introduced into railings, was effected by heating the bar at the part intended to be twisted, holding the bar in a vice, applying a wrench, and twisting the bar round. When the twist in one portion had reached the desired pitch the iron was cooled. If the work was inaccurate, the part was reheated, and the error rectified, or the part still hot was twisted more.

Until within the last thirty years, the limited styles of manipulation practised amply justify Pugin's remarks on the condition of iron-working at the time he commenced his revival. "Ironsmiths were artists formerly, and great artists too; but now-a-days, if you apply even to a 'capital hand,' to copy any ordinary piece of old iron-work, he will tell you he

does a particular class of iron-work, and does not think there is a man in the trade who could undertake the job."

After a lapse of nearly thirty years, the art of revived metal-working has ceased to be a matter of observation or comment. The difficulties which attended its earlier existence are now almost forgotten, and processes are now practised as matters of routine which were then only re-discovered and mastered after sore labour and heavy sacrifice. In the present day, "doing the work for the work's sake," sounds almost a mere figure of speech; but, in simple fact, nothing short of good and earnest workmanship *can* execute work in accordance with true principles.

The experiments of the revivalists have long since developed a branch of manufacture too extensive to be confined to the establishment in which they were originally tried, and several others have been started for the production of a similar class of work, nearly all of which, however, trace their origin to some connection with the original house.

In 1849, the results of the early labours of Pugin and Hardman were first publicly shown in the Birmingham Exhibition of Manufactures, held in connection with the visit of the British Association, in a temporary building on the site of Bingley Hall. In 1851, the Mediæval Court in the International Exhibition displayed their united labours in connection with the works of other manufacturers in other materials, executed on mediæval principles. Up to this time there were no similar establishments for the production of metal-work in the same style. In the Reports of the Jurors on the Exhibition of 1851, full justice was at length done to the efforts of the revivalists, and the perfect intelligence with which the designs were made and the work executed were particularly pointed out. In the special class of metal-work for ecclesiastical purposes, it was remarked that continental productions displayed far less intelligence in design, and were throughout imbued with the peculiar character proverbially, though improperly, attributed to "Birmingham ware." The works of Pugin and Hardman displayed nothing of this character; and the skill and manipulative processes by which they were produced, were pointed out as being applicable to brass work in varied and ornate styles, while the admirable fitness of the works themselves for the purposes for which they were designed was clearly set forth. They were light, yet strong where lightness was an object; where strength was needed it was given; ornamentation grew out of construction, to which it was sub-

servient. On comparison of these works with examples of ornamentation and execution exhibited by metal-workers in other styles, the Jurors observe that—"while the former are honest, useful, characteristic, and therefore beautiful, the latter are flashy and grotesque, full of little prettinesses, put together without any leading motive, and having no definite character or true construction;" a verdict worth recording, as clearly pointing out the distinction between works executed on the revived true principles and those "got up" on the false but ordinarily adopted principles of modern manufacture.

The innovations made by the revivalists with regard to processes, finish, &c., were, however, almost secondary to those made in form and construction. The accepted types of articles in metal work, whether for ecclesiastical purposes, for public or private buildings, or for domestic use, underwent a thorough revision. Carefully studied geometric ornament took the place of the nondescript florid style formerly in vogue, and substantiality and soundness in construction that of the old flimsiness and falsehood. In the hands of the revived metal worker the vessels of the sanctuary have become worthier of their hallowed intention and use, no longer as of old poorly figured with devices indicative of pagan, rather than of Christian worship, but meetly adorned with symbols of the sacrifice their contents are intended to commemorate and typify. In metal fittings for lighting, also, the same improvement is visible, and the revivalist has shown that even the unpicturesqueness of modern costume is capable of artistic treatment in the memorial brasses which again are beginning to adorn the pavements and walls of our churches and cathedrals.

Nor is the change for the better confined to ecclesiastical decoration. Wherever public or private buildings are erected in accordance with the intention of architects belonging to that school of which Pugin was the founder, the same influence is apparent in the metal work employed in the external and internal furnishings, or associated with the labours of the carpenter and builder.

The mistaken prejudice, too, which during the early years of the revival regarded its principles as merely subservient to the spread and exaltation of a particular creed, religion, or fancy, has long since almost disappeared. By laymen and cleric, by Churchmen High and Low, by Calvinist and Arminian, by Unitarian and Methodist, works are now demanded bearing the stamp of the revival.

> "Give all thou canst; high Heaven rejects the lore
> Of nicely calculated less or more:"

is no shibboleth of a creed, or war-cry of a party, but an axiom which all true men, wherever they may be found, are ready to accept. If religion be a truth, it is a mockery to introduce things false,—shams in material or construction,—into its temples.

Up to 1852, mediæval metal-working was confined to the establishment of John Hardman and Co. In that year three workmen, formerly in the employ of the firm, commenced business in Birmingham on their own account. Eventually, the partnership was dissolved, and the result has been that there are now four separate establishments in the town. Long before this time, however, as if Warwickshire, with its magnificent ecclesiastical and baronial remains of the mediæval period, were determined to show itself worthy to be the cradle of the revival movement, Mr. Francis Alexander Skidmore, of Coventry, in 1847, enthusiastically entered as a labourer in the same field, attracted by a powerful sympathy in taste and feeling with the revivalists. He was at that time engaged in the jewellery trade, and his earliest works were chiefly executed in the precious metals; but at a later period he essayed and accomplished larger works in other metals, the roof of the Oxford Museum, composed entirely of wrought iron; and the screens of Lichfield and Hereford Cathedrals, the structural parts of which are of cast, and the ornamental of hammered iron, adorned and beautified with other metals. Wrought on mediæval principles, these works admirably fulfil the purposes of use and ornament for which they were intended, and demonstrate how iron, the metal, par excellence, of the present day may, under skilful treatment, become the vehicle of artistic expression.

The demand for "revival" metal-work has now long since originated the establishment of other houses, in London and elsewhere; but it is satisfactory to trace to Birmingham the first foundation of a trade which substitutes the reality for the semblance, earnest and conscientious work for make-believe, and which has given a renewed vitality to the only true principles of metal working.

The production of such metal-work demands, as may be supposed, a far higher class of talent than that required in ordinary manufacture, and is consequently more costly. Not unfrequently, a single work exercises the skill of designer, modeller, repairer, chaser, saw-piercer, engraver, fitter, polisher, gilder, and burnisher; and more elaborate and costly works, in addition, that of enameller and repoussé-worker. Careful

supervision of the work while in progress is of the utmost importance to secure a successful result. Such works, therefore, can never be cheap in the common acceptation of the term, nor can they be produced quickly. The demand for them, consequently, although extending, is practically limited to those whose taste is sufficiently educated to appreciate them, and whose purse is long enough to purchase. Cheap metal-work, mis-named Gothic, is no doubt plentiful enough, with quite a profusion, may be, for the money, of cuspings, finials, foliage, and flowers; possibly, if of brass, beaten, polished, and lacquered; or, if of iron, scumbled over with paint to hide defective workmanship; but where is the vivifying spirit which permeates that which it attempts to imitate? The leaves look as if cut by tinmen's scissors, and the "beating" is nothing more than the administration of two or three blows with a round-faced hammer on a wooden block. Even at the best, these works are

> "So coldly sweet, so deadly fair.
> We start, for soul is wanting there!"

They are Gothic only in name, and no architect who wishes to carry out his work in the true spirit of the mediæval artist is justified in condescending to adopt them.

At the present time not fewer than 300 craftsmen are employed in the production of mediæval metal-work in Birmingham as designers, modellers, casters, fitters, workers in gold, silver, brass and iron, painters, enamellers, and engravers.

The difficulty experienced in arriving at the origin and early history of the several separate branches of the brass-trade in Birmingham has induced the writer to record, for the benefit of future enquirers, the rise and progress up to the present time of the revived art of metal-working. The restoration of this art in its integrity has been effected by the earnest labour, sacrifice, and love of John Hardman; and at the cost of a precious life, that of Augustus Welby Pugin, to whose memory is dedicated this account of the art of working in the precious metals, brass and iron, on those true principles which he was the first in modern days to enunciate, and his friend to carry out in practice.

PAPIER MÂCHÉ MANUFACTURE.

By W. C. AITKEN.

The papier mâché manufacture is a speciality of industry for which Birmingham has been long and deservedly famous. Nowhere else in this or any other country has an equally excellent quality of material been produced, and the decoration, if it has often transgressed the limits of good taste, has often also been designed in admirable accordance with the properties of the material and the surface decorated.

The invention of the material, as produced by pasting together sheets of paper, is due to Henry Clay, of 19, Newhall-street, in early life an apprentice to the celebrated John Baskerville, who, at that time, was engaged in the japanning trade. Long previous to Clay's invention, however, papier mâché had been made by reducing paper to pulp and pressing it into dies. Clay did not take out his patent till 1772. He formed the papier mâché by pasting together sheets of spongy paper over variously shaped "cores" or moulds of metal. At an early period he indicated the future extensive application of his invention for panels for chariots, cabins of ships, window shutters, mantle-pieces, tea-trays, card and dressing tables, and every other species of elegant furniture.* He also stated that it could be sawn, planed or turned like wood, and that after being japanned, it would be brought up to the highest polish by friction with the human hand. Many of the original articles made by him are still in use, and fully confirm the enduring character he claimed for his material.

Clay amassed a princely fortune by his manufacture, and

* After referring to the introduction of the trade, and solidity of the material, which "bears the operation of the same tools as those used by carpenters, joiners, and cabinet-makers, such as saws, chisels," &c., and to the patronage of his Majesty, the Birmingham "Directory," of 1780, adds,—"The articles made of papier mâché, at this [Clay's] and other manufactories of the town are tables, cabinets, tea-trays, cadees, panels for doors, coaches, chaises, sedans, and snuff-boxes," &c.

this, probably, in connection with the plucky character of the man, raised him to the office of High Sheriff of Warwickshire, which he filled with credit in 1790. At one period 300 hands were employed in his manufactory, but in 1802, the number had been gradually reduced to less than 100. His profits were enormous. On a single tray, sold for £5. 8*s*. 9*d*., he made a profit of £3. 8*s*. 2*d*. He basked in the sunshine of royal patronage, gained by a judicious present of a sedan-chair, a vehicle now almost obsolete, to Queen Caroline. The panels of this royal gift were of papier mâché, and the present was supplemented by a set of pier or console tables, adorned with paintings after Guido. Nor was Clay's ingenuity confined to the production of papier mâché. He invented an improved wagon, opening in the middle, and a new canal-lock intended to save one-half the water, and enable the boats that passed to move more speedily. His London house was in King-street, Covent Garden. When his patent expired, the trade was extensively carried on by Small and Son, Guest, Chopping and Bill, and by their sons, who, in addition to the production of finished goods, commenced the manufacture of the papier mâché "blanks," which they supplied to the trade. From this firm arose the justly celebrated one of Jennens and Betteridge, now represented by Mr. John Betteridge. They began business in 1816. From the manufacture of tea-trays they proceeded to the production of other and various objects in the same material, their skill in making, and taste in decorating them giving a character to the trade which greatly raised it in public estimation.

Up to 1836 large objects in papier mâché, such as panels, articles of furniture, tea-trays, &c., were made by pasting sheets of paper together on moulds. In that year Mr. Brindley introduced the manufacture of blanks, &c., from pulp formed in iron or metal moulds, the blanks being dried by heating in the moulds in which they were produced. The patent was contested, and thrown open in 1842. In 1845 the same inventor introduced a new method of producing blanks and portions of articles, by first forming the pulp into sheets, not pressing them between felt surfaces, as in ordinary pasteboard manufacture, but between metal plates, and then pressing the sheets into suitable moulds, to produce the form required. In 1846 he much facilitated the production of ornamental forms in papier mâché by the introduction of moulds with sunk or hollow parts, which produced ornamental parts akin to the carvings on wood furniture, &c.

In 1847, Mr. Theodore Hyla Jennens introduced steaming the blanks, and then subjecting them to pressure in moulds, thus securing a denser material and equal thickness in the blank.

Goods of the best kind are produced by attaching together sheets of a soft grey paper, resembling blotting paper, by a paste of flour and glue, on a metal body of some kind made so as to give the shape to the article required, between every sheet laid on this "core," which is the technical phrase for the metal foundation: it is then covered over, and exposed for some hours in a stove heated to 100 degrees to dry. It is then subjected to a rasping process, and sheet after sheet of paper is thus added, until the required thickness has been attained. The articles are then immersed in linseed oil and spirits of tar, to make them resist moisture, and then they are placed in another hot drying stove, of not less than 200 degrees, and not above 260. Again the inequalities are carefully removed by plane and rasp, and the article is formed as required, when it is then transferred to the varnishing slop, where coat after coat of tar, varnish, and lamp black is repeated until the surfaces of the goods are as level as possible, when they are stoved again for twelve hours. Any inequality being again removed, then the articles are introduced to the artist, who begins his more dignified operations upon them. The final finishing course is that of coating the work with transparent copal varnish, and then with the human hand, and a little rotten-stone applied with water, the last polish is given to the articles.

The "pulp" process consists in reducing paper to a clay-like consistency or viscid mass, or employing pulp not previously converted into paper, and compressing it in moulds by means of a hydraulic, screw, or other press. The superiority of goods formed from sheets pasted together is due to the homogeneiety of the paper from which they are made, as distinguished from the heterogeneous mixed material which forms the pulp. This difference is perceptible in the irregular surface of the latter, visible when the article made from it is finished. This irregularity arises from the presence of harder particles in the pulp, which the brilliant hand-polish, in finish, renders more apparent by making the surface reflective. The "best" papier mâché, made from pasted sheets, not only presents a flat unbroken surface, but is also lighter and stronger than that made from pulp, which is brittle in comparison.

The decorative processes employed have been considerably modified in the course of years. Bronze-gold, in the form of powder, associated with the brilliant blacks and other colours arranged in simple lines, formed the earliest kind of ornamentation. Copies of paintings had been introduced, we are told, in the pier-tables presented to Queen Caroline. About 1816, a peculiar method of decoration was adopted, executed in various-coloured bronzes without the introduction of pigment-colour. On the surface of black or other colour, the subject was painted in gold size, and the different bronzes were applied with small stump-like tools, the flesh tints being indicated with a reddish-hued bronze, and the draperies, &c., with varied tints. Of two examples recently examined, one represents the Goddess of Earth, in a chariot drawn by two chained lions, with two little Cupids as charioteers; the other, Daniel in the Lions' Den. Both were executed by an artist named Davis, who also gained some celebrity by his copies in the same style of rustic subjects by Morland, in which he carefully reproduced the touches of the original artist.

A decorative artist, named Joseph Booth, in the employ of Messrs. Jennens and Betteridge in the years 1821-2-3-4-5, was justly celebrated for his exquisite imitations of Chinese and Japanese ornament. He executed in 1824 a tray for the Prince Regent. The style in which he worked is familiar to connoisseurs. It consists of impasto work, afterwards worked upon with minute finish. Gold-size and whitening produced the elevated portions of rocks, tree-stems, pagodas, bridges, &c.; the foliage and other details were pencilled on with the most delicate of touches. One example, at least, still in existence, demonstrates his rare ability. The best judge must have failed to distinguish the imitation from the original work of Chinese and Japanese artists.

Pearl-shell inlaying, which contrasts so well with the brilliant black of English papier mâché (a process suggested by foreign lac-work) was introduced by George Souter, also a decorator in the employ of Messrs. Jennens and Betteridge, who patented the invention in 1825. The pearl ornaments were made from thin laminæ of shell, from one-hundredth to one-fortieth part of an inch in thickness. The ornament was painted on the pearl with varnish or "stopping-out" material; acid was then applied, and the portions of pearl not protected eaten away. By this method the most delicate ornaments were produced—very much more delicate than those which can be wrought by saw-piercing or cut with press-tools, which last method was adopted to evade Souter's patent.

This process is familiarly known as "inlaying," to which title, however, it has no claim. The work is not inlaid. The pearl-shell ornaments are stuck on the ground of the partially formed article to be decorated, by means of copal or other varnish. When they are all arranged, repeated coatings of tar varnish are applied, which fill up the interstices and gradually cover up all the pearl. The superfluous varnish is then removed with pumice-stone and the ornaments displayed. The object is then polished with rotten-stone, and in this state is ready to receive the additional gold or other decorations.

In 1844 the desire to produce something new induced Mr. Farmer to associate electro-deposit medallions with *papier-mâché* in salvers, card-baskets, portfolios, &c.; and in 1846 a new style of pearl-shell decoration behind glass was introduced by Thomas Gibson. This process consists in executing the subject in gold or colour on glass, leaving the space under which the pearl-shell is to be introduced untouched, or in other cases, glazed with transparent varnish colour, which allows the iridescence of the pearl to shine through it. After attaching the pearl to the glass by means of transparent varnish, the panel or slab is backed up, and introduced into the lid of desk or dressing-case, fire-screen, or chess-board, &c. Attempts were made to infringe this patent also, by the introduction of coloured foils behind glass.

"Gem-inlaying" was invented by Benjamin Giles, and patented by Theodore Hyla Jennens, in 1847. It differs from Gibson's patent only in the substitution of stones of various colours, coloured glass or paste, or in some instances real gems in the place of the pearl-shell, and in executing the work on the reverse side of the glass. Spaces are left in the decoration for the introduction and attachment of the stones, &c., &c., by means of varnish, the colour being heightened by the introduction of coloured foils behind them as in jewellery settings. This style of decoration, where it can be applied, produces a rich and brilliant effect. Singularly enough, eighty-six years ago one Thomas Skidmore applied pastes and stones in a nearly similar manner to the same materials.

In 1864, Mr. John Betteridge—on the reduction in the cost of aluminium consequent on the experiments of Clair Deville, (which resulted in Messrs. Bell, of Newcastle-on-Tyne, entering largely into the manufacture)—applied that metal, and bronze formed from it, to the decoration of envelope-cases, card-trays, binding for albums, &c.

All these methods of decoration involve the employment of hand labour. The various mechanical methods of ornamentation may be more briefly recounted.

The transfer of gold to papier mâché by mechanical means was first accomplished by Mr. C. Breese in 1853, who has since achieved celebrity by the production of instantaneous photographs, reproducing the most transient effects in nature.

In 1856, Samuel Tearne and G. Richmond introduced a colour transfer process, by which a design printed from a series of coloured stones, as in chromo-lithography, on tissue paper, could be transferred to papier mâché, or iron goods, the removal of the paper, as in pottery printing, leaving the design in all its details of colour, &c., on the object to which the transfer had been made. The perfection of the work by this process depends principally on the skill of the printer, very little, if anything, being left to be finished by hand with the pencil. Those who have experimented on "Diaphanie" will readily understand the process, which only differs from it in employing transparent colour.

Besides the ordinary articles for house-consumption, large quantities of panels for steam-boat cabins, dining-room furniture, &c., are made for the export trade to Canada, North and South America, Russia, Spain, &c., besides an immense variety of large pieces of household furniture, wardrobes, loo and other tables, dressing-glasses, sofas, &c., decorated to suit the taste or the want of taste of purchasers in the countries to which they are exported. Of these Messrs. McCallum and Hodson are large producers.

The style of ornamentation adopted in these articles has, there can be little question, materially injured the trade, by fostering a taste for exuberant decoration, opposed to all true principles of ornamental art. It is satisfactory, however, to know that if articles in good taste are required they are to be obtained. The successor of the old house of Jennens and Betteridge, which was practically the first to raise papier mâché goods to the rank of genuine art manufactures, still worthily maintains the credit of his predecessors.

Birmingham has never yet been rivalled or approached in the manufacture of papier mâché. The French have attempted it, but they signally fail in the material, and more curious still in the ornamentation. In the Report on the Paris Exhibition of 1855, it is observed that "the examples exhibited in the French and German departments bore marked evidence of improvement in some of the best articles; but with all their

artistic errors the Birmingham productions were certainly very superior in point of workmanship and finish to any other works of the class." The remarks of another Juror, Mr. D. Wyatt, are even more emphatic. He says:—"A piece taken at random from the stall of Jennens and Betteridge was placed beside the Prussian. The superiority of the former was incontestible. The Birmingham *black* turned that of the Prussian *brown*. The Birmingham hand-polish was clean and smooth to the touch, the Prussian was greasy-looking with varnish and undulating under the hand; in fact it appeared quite coarse by contrast with the English."

Many of those who, in early life, were decorators of papier mâché, have since become artists in the truest sense of the word, and produced pictures which are valued and coveted by collectors. Not a few, also, have turned their attention to painting on glass, several of the best workmen at Messrs. Hardman's having received their artistic education at Messrs. Jennens and Betteridge.

Manufacturers, in the trade, acknowledge the advantage of the Local Schools of Art as auxiliaries in the training of their decorative artists and apprentices.

In the manufacture of papier mâché articles from pulp, it it is estimated that about 300 tons of the raw material are consumed annually, amounting at £25 per ton to £7,500, and the manufactured products being about £1,000 a year. For the production of the grey spongy paper from which the best goods are made, the Farnworth Mills, near Manchester, are the most celebrated. The demand, however, for best goods has materially decreased, and consequently limited that for this kind of paper. The pulp material, although the articles made from it are inferior in appearance and more brittle in substance, is cheaper than the paper; and, consequently, secures the preference for commercial sale and general use.

Upwards of one-half the labour in this manufacture, it is estimated, is done by females, whose hands seem peculiarly fitted to give the brilliant concluding finish to the surface of the articles. Best "handers" realise from 12*s*. to 16*s*. Women employed in other operations as "blackers," &c., from 10*s*. to 12*s*., and girls 6*s*. per week. Decorative artists or painters of ornament receive from 30*s*. to 50*s*. per week, and superior hands employed on special work still higher wages.

It is calculated that in the papier mâché and japan trade about 1,000 hands are now employed. The numbers in 1861 were 428 males and 465 females. There are no means of

arriving at an exact estimate of the numbers employed in papier mâché alone. There are in Birmingham forty-five manufacturers of japanned iron goods, fifteen of whom are also manufacturers of papier mâché.

In the production of what may be termed legitimate articles of papier mâché, such as trays, &c., the trade is not increasing; but there is no falling-off in the demand for large articles of furniture and chairs of combined papier mâché and wood. Large orders for panels for steamboat cabins have also recently been executed, the Birmingham makers having secured the order for decorating the cabins of one of the French Emperor's yachts in competition with French manufacturers.

The tendency to over-elaboration of ornament, fostered by the production of goods for foreign markets has, there can be little doubt, operated in checking the home demand, since purchasers are naturally shy of articles the majority of which, especially in the larger and more elaborate examples, are produced in a depraved taste and vicious style, regardless alike of the material out of which they are made and the purpose for which they are intended. The execution of the ornamentation, so far as manipulation is concerned, is, in the best examples, perfect. The flower-painting is admirable, and the copies of pictures, where introduced, have frequently been rendered with no mean artistic skill; but all such work is inappropriately applied to the decoration of such a material. The same may be said of the profuse use of pearl-work. Pearl flowers are simply an error, as are also those so beautifully coloured and delicately shaped in all their relief, on a horizontal surface, destined to be covered with the paraphernalia of the tea-table. For table tops, &c., conventional ornamentation, in which the design is so drawn as to suggest the idea of *inlaid* ornament, is the most correct in taste. It is only just to the leading papier mâché manufacturers to add that they fully understand the errors of the style generally preferred; but so long as the popular tendency is in favour of ornamentation in which show and glitter preponderate, and articles decorated in accordance with true principles are only selected by buyers of educated taste, it is too much to expect that producers should deliberately shut themselves out of the more extended and profitable market.

COFFIN-FURNITURE.

By W. C. AITKEN.

Birmingham, which does so much for us in life does not desert us in death. It hangs the bells round the coral on which we cut our milk teeth, it furnishes us with the mystic circle of the wedding-ring, and when we have "shuffled off this mortal coil" it will decorate our last cradle of elm or mahogany. "Man," says Sir Thomas Browne, "is a noble animal; splendid in ashes, and pompous in the grave." The most economical of companies in "the black business," whose advertisements appear immediately after the announcements of deaths in our newspapers, find it necessary to nail a groat's-worth of pathetic sham-finery even on a pauper's coffin.

The coffin-furniture manufacture, originally a London trade, seems to have been introduced into Birmingham about 1760, and, as has before been remarked, not improbably gave rise to the stamped brassfoundry trade, the manipulatory processes in the production of coffin-furniture in thin rolled lead, block-tin, or Britannia metal, suggesting the employment of similar methods in the treatment of brass.

Among the earliest known manufacturers of coffin-furniture in Birmingham, was one Mole, a clever workman, ambitious, like many another clever workman before and since, of becoming a master. Having determined, if possible, to introduce Birmingham goods into the London market, he borrowed a sum of money from a Mr. Webster, got up his patterns, started for London, and made his first call on the Messrs. Wagstaffe, then a celebrated town firm engaged in the trade. A strong prejudice existed in the mind of the London undertaker of the period against any article not "town-made," and the Messrs. Wagstaffe at first declined even to look at the "Brummagem" patterns. In the course of conversation, however, in which the Londoner after expatiating on the immea-

surable superiority of metropolitan productions over those of the hardware village, advised the adventurous coffin-decorator to stay at home and eschew entering on a hopeless competition, Mole contrived to impress his adviser with the fact that he was no fool, and at last extorted a promise that the London gentlemen would examine the patterns if Mole would lift the box and the porter who carried it. Mole had not only a shrewd eye for business, but a strong arm for work. He placed the porter on the pattern-chest, and lifted both together on to the counter. The patterns were examined, and henceforth the Birmingham goods had a footing in the London market. Poor Mole, however, did not reap the harvest he had sown. Orders poured in upon him so fast, that Webster, foreseeing a splendid trade, put the screw on his debtor and made him bankrupt, thus securing the business for himself. Mole relapsed into the position of a workman, and died in the service of Mr. Thomas Horne, sen.,* from whose lips the writer received the narrative.

As life precedes death, an increasing population increases the demand for coffin-furniture. Manufacturers and workmen are multiplied, and the cost of production is diminished. It is strange to observe the influence of taste and fashion, and even of nationality, in the character of mortuary ornamentation. The metropolitan undertaker rejects convex or raised coffin breast-plates. He patronises not "improved" designs. He hates plates to handles, and ignores screws wherewith to fasten them so long as a nail is to be had. He abhors lace. He demands that his plates shall be of white metal. He paints not the name of the occupant on the coffin, as do our unenlightened provincial artists, but pricks it on with a punch in a series of dots on the plate, which he then smears over with black varnish. On the other hand the Celtic taste, of the green Isle of the West affects gilded ornament for the funeral chest round which the wake is held and the "keen" chanted. The Gael and Scot and half-Cymri of the West of England also participate in the desire for gilt, although the pure Cymri of Wales prefers the magpie mixture of black and white. It is only the melancholy Anglo-Saxon who chooses the sadness of unmitigated black.

The prices of coffin-furniture vary even more widely than

* The writer takes this opportunity of acknowledging the assistance he has received from this gentleman in reference to several particulars connected with the brass trade, mentioned in a previous report. Mr. Horne was one of our most intelligent and enterprising manufacturers, to whose ingenuity and taste the great improvement which has taken place in the ornamentation of stamped brassfoundry is in a great measure due.

the fashions. The pauper reposes in a coffin the mountings of which cost little more than 4*d.* a set. The well-to-do citizen demands adornments to the value of 8*s.* or 10*s.*, while your landed gentleman or church-dignitary carries mountings with him to his brick-grave or family-vault, to the value of £5 or £6 sterling. Very marvellous are the designs of these adornments—these cherub-heads, bodiless but winged, though guillotined, still smiling and puffy-checked,—this tall damsel, trumpet in hand, about to announce the crack of doom thereon,—this disconsolate, but no less classical matron, embracing the urn over which the cypress, if indeed it be not a weeping willow, is drooping so impossibly,—these terrible pagan inverted torches, symbolic of a fire that is quenched and of nought beyond, if it be not of a fire unquenchable,—these serpents of eternity diligently engaged for ever in the mastication of their own indigestible tails,—these amorphous things that stand for the "restful poppy," or flowers emblematic of the frailty of life. Who shall tell how architecture—classical, gothic, and barbaric—has been ransacked to furnish the ornamentation of coffin breast, foot, and handle-plates? what heterogeneous hash of design has helped to disfigure the metallic lace! Beautiful, sacred, and solemn, should be even the meanest of those last offices we render to those we have loved in life. Surely there is no intrinsic necessity in this miserable desecration—no valid reason why our coffin-mountings should not bear a Christian and appropriate symbolism—why the infant span-long, youth merging into manhood or womanhood, middle age and venerable eld, should not be meetly typified in some simple touching emblem. A little care, a little thought, a little skill, is all that is required to convert these things "with shapeless sculpture decked" from a mere mockery into fitting and significant symbolism. To sink a die good in design costs but little, if any more, than a bad one; and once sunk, the cost of the article produced from it is the same. But the undertaker is like the clown in Hamlet; he "has no feeling of his business." He has to "perform the funeral," and he "performs" it, generally speaking, in a "highly-respectable" fashion.

With regard to material and manufacturing processes, the ordinary metal employed for coffin-breastplates is tinned iron. When gilt or silvered, the tin is coated with size, on which the Dutch metal is laid, and lacquered or varnished over. It is then ready to receive the ornamentation which is produced by a steel or cast-iron die. The impression is given by means

of a large screw press, the die being held in the "bed" by four large screws, and the "force" being fitted into the screw. Motion is communicated to the screw by turning a large cast-iron horizontally-fixed wheel. The screw with the die attached descends, and imparts to the sheet of metal a copy of the die; the number of blows required to "bring up" the pattern rarely exceeding four. Coffin handle-plates and other ornaments are similarly produced. The white coffin-lace is made from tinned metal; the black, from very thin rolled-out lead. At one period, all white lace was produced from Britannia metal or block-tin; but in 1804, one Thomas Dobbs, "a fellow of infinite jest," and of "most excellent fancy," who did "the comic business" on the boards of the Birmingham Theatre Royal, invented his "Albion metal." This "metal, akin in construction to silver plated on copper, consists of tin laid on lead, the two metals being made to cohere by passing them through rolls. This invention has recently afforded fertile ground for litigation in the celebrated "Betts' Metallic Capsule" case. Among other uses to which Dobbs considered his patent metal applicable, he mentioned the manufacture of coffin-furniture, for which it is still universally employed.*

Coffin furniture manufacturers are economical of dies. For lace, dies are sunk on square steel or iron covered with steel, each die being about sixteen inches long, by two-and-a-half or three inches wide. The Albion metal, after having been rolled very thin, is laid on the die and driven in by the "force," the surplus metal being trimmed off with a knife before the lace leaves the die. "Cutting out," or press-tools, are only exceptionally used for getting rid of the surplus metal. In the case of the coffin-plates, &c., this is effected by cutting it away with chisels. Ordinary coffin-handles are all formed of cast-iron; and a single house engaged in the trade consumes, in this branch of the manufacture alone, forty tons of iron per annum.

The usual styles are black, or white on black, the slides, &c., being left white on a black ground, or *vice versâ*. The bright varnishing black at one time formed the only usual mode of finish, but a dead black, picked out with bright, is now a favourite style. Dutch metal, of white or golden hue, has lately been greatly reduced in price, in consequence of being admitted nearly duty free. A packet which once cost 12*s*. 6*d*. can now be had for less than half the money, each packet containing 2,300 leaves.

* Thomas Dobbs was also the inventor of one of the earliest reaping machines.

The blacking used is Pontypool varnish for the bright portions, the dead being a vegetable black ground with turpentine and a "drier." The japanning is done entirely by women, and the varnish is dried in a japanner's stove. External coffin-nails are made of cast-iron by cast-nail manufacturers, the small pins with which the lace is attached being cut in the same manner as ordinary cut-nails.

More expensive varieties of mounting are made of Britannia metal or brass, occasionally electro-plated or gilt. In these the plates are cut out of sheet or Britannia metal, or sheet brass hammered, the handles being also of brass. Occasionally a set of coffin-furniture is executed in bright brass, in the mediæval style, with the shield emblazoned, &c., at a cost of from £20 to £25. This, however, is quite an exceptional case, the friends even of lords temporal and spiritual rarely caring to incur the additional expense.

It is said that as much as from 60 to 80 tons of block tin are consumed annually in Birmingham in the manufacture of coffin-lace.

The number of workpeople employed in the manufacture has not been accurately ascertained, but it is stated, on good authority, to be about 150. The number of manufacturers is twelve. Girls are employed, who make from 3*s.* 6*d.* to 5*s.* per week. Women, as blackers, make from 10*s.* to 12*s.*, payment being made by the piece. The men, who also all work by the piece, make from 18*s.* to 20*s.*; superior workmen (who cut away the surplus metal, &c.), from 20*s.* to 25*s.* or 30*s.*; boys, "up" in the trade, from 5*s.* to 7*s.* per week.

"Coffin-furniture discount" has passed into a proverb. While the old gross prices per set have remained unchanged on the manufacturer's list, competition has advanced the discounts to such an extent that the net cost generally represents considerably less than a-third of the nominal charge. Far be it from us, however, to reveal the mysteries of the trade. The large consumer is entitled to stand on a better footing than the retailer, and the retailer than the public.

The coffin-furniture manufacture stands last in our series of reports on the industries of Birmingham and the hardware district, and thus not inappropriately ushers in

31. 1. 18.

THE END.

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