

heads separately noted below. With respect to many of them it is a matter of regret that no trustworthy source of specific information exists; and thus the origin, vicissitudes, and progress of really important trades can only be recorded in vague and general terms.

**Textile manufactures.**—The industries embraced under this head were the first which gave Glasgow a place among the great manufacturing communities; but though, through many changes and fluctuations, they continue to yield extensive employment, they now occupy a comparatively secondary position. In the cotton trade, which originated about 1780, Glasgow possesses several factories which are reckoned among the largest in the trade; the industry has, however, for a number of years been in a stationary if not declining condition. The manufacture of light textures has always been the leading feature of the Glasgow trade,—plain, striped, and figured muslins, gingham, and fancy fabrics forming the staple. Thread manufacture, although specially a Paisley industry, is also extensively prosecuted in Glasgow. According to a return obtained in 1875 the whole cotton industry of Scotland afforded employment to 33,276 individuals, and excepting about 10 per cent. it was entirely centred in Glasgow and the surrounding district. Jute and silk are staples worked only to an inconsiderable extent in Glasgow, though about a century ago the manufacture of silk gauze flourished extensively, and has left traces of its former importance to the present day. The most characteristic of woollen and worsted manufactures is carpet weaving, all the leading kinds of carpets being extensively made, and the "tapestry" curtains and portieres made by several firms are examples of highly artistic woollen fabrics.

**Bleaching, Printing, and Dyeing.**—These allied industries took root in the Glasgow district at an earlier period than that of their introduction into the rival regions of Lancashire, calico-printing having been begun near Glasgow in 1738. The use of chlorine in bleaching was first introduced in Great Britain at Glasgow in 1787, on the suggestion of the illustrious James Watt, by his father-in-law, a local bleacher; and it was a Glasgow bleacher—Charles Tennant—who first made and introduced bleaching powder (chloride of lime). The dyeing of Turkey red was begun as a British industry at Glasgow by two eminent citizens—David Dale and George M'Intosh—and that unequalled colour was long locally known as Dale's red. All these industries continue to hold a foremost place in Glasgow, a large amount of grey cloth being sent from the Lancashire looms to be bleached and printed in the Scotch works. In particular Turkey red dyeing and printing have developed to an extent unequalled in any other manufacturing centre.

**Chemical Manufactures.**—The operations of bleaching and calico-printing in the early part of last century gave rise to such chemical manufactures—the preparation of dye liquors, &c.—as these industries demand. The discovery of bleaching powder by Charles Tennant in 1789 led directly to the development of the great chemical works of C. Tennant & Co. at St Rollox and its various branches, and gave the first great impetus to chemical manufactures in Glasgow. Among the prominent chemical industries are to be reckoned the alkali trades—including soda, bleaching powder, and soap-making—the preparation of alum and prussiates of potash, bichromate of potash manufacture (an industry peculiarly identified with Glasgow), the extraction of iodine and other products from sea-weeds, dynamite and gun-powder manufacture, the making of flint glass, bottle glass, paper, white-lead and other pigments, and brewing and the distillation of spirits. The numerous chemical preparations used in the bleaching and calico-printing trades are also among the local manufactures, as well as the preparation of starch, British gum, and dextrine, and the manufacture of lucifer matches.

**Iron Manufacture and other Metallurgical Industries.**—Although the blast furnaces of Scotland are distributed over several of the midland counties, the great proportion of them are in Lanarkshire and Ayrshire, and the trade is entirely controlled and practically monopolized in Glasgow. The discovery of the value of blackband ironstone by Mushet and the invention of the hot-blast by Neilson were two events which exercised a wonderful influence on the development of iron smelting in Scotland. So rapid was the expansion of the industry during the earlier half of this century that in 1859 one-third of the whole iron produced in the United Kingdom was Scotch. For 20 years past the trade has shown little elasticity, the annual production averaging about a million tons of pig iron,—the maximum output having been reached in 1870, when 1,206,000 tons were smelted. In 1877 of a total of 152 furnaces existing there were 109 in blast, and of these being 131 were situated in Lanarkshire and Ayrshire, 102 of these being in operation. The entire output of pig iron in that year was 982,000 tons, while in 1878 from 90 furnaces in blast the production is estimated at 902,000 tons. The number of malleable iron works in Glasgow and its neighbourhood is 22, having had during 1877 345 puddling furnaces and 53 rolling mills in operation. Mild steel is manufactured on an extensive scale by the Siemens-Martin process, and a small amount of crucible cast steel is also made. Other metallurgical industries include the extraction of copper by Henderson's wet process, and a limited amount of zinc smelting.

**Engineering.**—With abundance of iron and coal, and great

facilities of both land and water carriage, it is only to be expected that mechanical engineering should be carried on in Glasgow with peculiar energy and success. Almost all departments of engineering work are well represented in the district; and among the special features of the industries may be enumerated the great water and gas pipe casting establishments, sanitary and general iron-founding, malleable iron tube making, locomotive engine building, the manufacture of sugar machinery and of sewing machines,—two great establishments on the model of American factories for the latter trade being conducted by the Singer and the Howe Machine Companies respectively. The marine engineering works of the Clyde—which in many instances are worked in direct connexion with shipbuilding yards—are equipped on a scale worthy of the great industry of which they form an important part; and few establishments exist in any other quarter capable of producing the enormous forgings for propeller shafts, &c., of ocean steamers, which form a regular item in the undertakings of Glasgow engineering firms.

**Shipbuilding** is the greatest of all the modern industries of Glasgow, and the position attained by the shipbuilders of the Clyde is a matter of imperial consequence and national pride. The shipbuilding yards of the Clyde extend from Rutherglen above Glasgow to Greenock, Dumbarton, Port Glasgow, and Greenock having an important stake in the industry. In some years about half the total tonnage built in the United Kingdom has been launched from the Clyde yards, as is shown by the following statement:—

	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Tonnage launched, Clyde.....	196,229	230,347	232,926	262,430	211,482	174,524	169,383
Tonnage launched, United Kingdom	331,058	474,718	453,543	603,867	472,058	378,020	450,963

During the year 1878 the tonnage launched on the Clyde from the yards of 35 different firms amounted to 222,853 tons, one vessel, the "Gallia," built for the Cunard Company, being of 5200 tons burthen,—a tonnage, however, which has been exceeded by the Guion steamer "Arizona" (5500 tons), launched in 1879. The work turned out is very diversified, but as a rule of the highest class, and includes armour-plated and other vessels for the Royal Navy, mail and passenger ocean steamers for the great Transatlantic and other lines, river steamboats famous throughout the world for swiftness and elegance of appointments, merchant sailing vessels, dredging plant, and hopper barges. With the exception of a very insignificant proportion of wooden vessels, the whole of the shipping built on the Clyde is of iron and steel, the latter having recently been introduced with great success. The shipbuilding trade in Glasgow indeed owes its extraordinary expansion almost entirely to the rapid supplanting of wood by iron as a building material. Twenty years ago, in 1859, the tonnage launched measured only 35,709 tons, from which amount, by rapid strides, it reached in 1863 a total of 123,262 tons, and in 1874 the maximum amount of 262,430 tons was floated off.

**COMMERCE.**—For a century past the records of the Clyde Navigation Trust indicate that the trade of Glasgow, so far as regards shipping, has progressed, with few and unimportant fluctuations, with steady rapidity. In 1778 the annual revenue of the Clyde Trust was £1733; in 1828 it amounted to £17,669, a tenfold increase in 50 years; and in 1878 the total amounted to £217,100. Of course these figures do not necessarily indicate a corresponding expansion of shipping trade, though they probably bear a close relation to the comparative value of cargoes carried. In the year 1828 the tonnage of vessels of all kinds which arrived in the harbour of Glasgow was 696,261, the sailing vessels having numbered 4405 of 214,315 tons, and the steamers 7100 of 481,946 tons. For the year ending 30th June 1878 the arrivals of sailing ships numbered 2727, with 457,290 tons capacity, and of steamers there were 13,210, the tonnage of which amounted to 2,154,733 tons,—in all 15,937 arrivals with a gross tonnage of 2,612,023 tons, being the greatest amount on record. In that year the weight of goods imported from abroad was 658,319 tons; and coastwise 586,576 tons were landed at Glasgow, making in all 1,244,895 tons. The foreign imports consisted in largest measure of Indian corn, wheat, flour, and other food substances, with timber, pyrites, iron ore, and sulphur, the coasting arrivals containing principally limestone, iron, cement, potter's clay, salt, timber, and food stuffs. The goods shipped to foreign ports amounted to 712,249 tons, and coastwise 603,374 tons left Glasgow, making in all 1,315,623 tons. The principal exports were coal, iron, cast pipes, chairs and other railway iron, chemical manufactures, and general machinery, with malt liquors and spirits; and in the coasting trade the leading articles were of a similar general description. The great bulk of the foreign trade is with New York and Canadian ports, India, France, Spain, and Belgium; and coasting traffic beyond the Clyde estuary is directed principally to Liverpool, Belfast, Dublin, Londonderry, Waterford, Bristol, and London; but there are few commercial ports throughout the world which have not more or less direct trading communication with the port and harbour of Glasgow. (J. H. S.—J. P.A.)

## GLASS

## HISTORY.

**T**HE art of glass-making, unlike that of pottery, would appear not to have been discovered and practised by different nations independently, but to have gradually spread from a single centre. No trace of it was observed among the inhabitants of America at the time when that continent was discovered, although considerable progress in the arts had been made by some among them, e.g., the Mexicans and Peruvians; but the steps by which it reached China may be indicated with much probability. The credit of the invention was given by the ancients to the Phœnicians, as is shown by the well-known story of its fortuitous discovery by Phœnician merchants, who rested their cooking pots on blocks of natron (sub-carbonate of soda), and found glass produced by the union under heat of the alkali and the sand of the shore (Pliny, *Nat. Hist.*, xxxvi. 26, 65). A glassy mass may, however, be produced in the smelting of many metallic ores, silica being present, while the fuel supplies the alkali; or by the combustion of great masses of reeds or straw, in which the elements of glass are present,—lumps of coarse imperfect glass being often found on the spot where a stack of wheat has been burned. Now the Egyptians practised metallurgical operations from a very early period, and vast heaps of straw are, and no doubt have been from the earliest times, accumulated in that country, and probably not unfrequently set on fire. The adoption of glass as a substance capable of being made subservient to the use of mankind may therefore be due to the intelligence of some one who noticed its fortuitous production there. Be this as it may, by far the earliest examples of glass existing of which the dates are attested by inscriptions are of Egyptian origin. The earliest of these, a small lion's head of opaque blue glass of very fine colour, but changed externally to an olive green, was found at Thebes by Signor Drovetti, and is now in the British Museum;<sup>1</sup> on the underside are hieroglyphics containing the name of Nuatuf IV., whose date according to Lepsius's chronology was 2423–2380 B.C. A bead of dusky green glass bears the phenomenon of Hatsu, a queen who is conjectured to have lived about 1450 B.C. (Wilkinson, *Manners and Customs of the Ancient Egyptians*, vol. iii. p. 88). That such may be the real dates of these objects is confirmed by the fact that glass bottles containing red wine are represented on monuments of the fourth dynasty, more than 4000 years old; and in the tombs at Beni Hasan, dating from the reign of Usurtesen I., at least 2000 years B.C., the process of glass-blowing is represented in an unmistakable manner (Wilkinson, vol. iii. p. 89). Very many examples of glass found in Egypt may be seen in museums, but, as they rarely bear inscriptions, it would be difficult to trace the progress of the art through them; no competent person has hitherto undertaken the task. The manufacture probably continued to flourish as well during the period of the native monarchy as in that of the Greek dynasty; and its importance after the subjugation of the country to Rome was probably even increased by the new market then opened to its products. Martial (*Ep.*, xxi. 74) alludes to the importation of Egyptian glass into Rome; and it is mentioned in an ordinance of Aurelian Hadrian in a letter addressed to the consul Servianus mentions glass-blowing as one of the chief industrial occupations of the inhabitants of Alexandria. The manufacture was not confined to that city, but was also carried on in the

<sup>1</sup> See introduction to *Catalogue of Glass Vessels in the South Kensington Museum*, where an engraving of it is given.

lower Diospolis on Lake Mensaleh, as appears by a passage in the *Periplus Maris Erythraei* (c. 6).

Much of the Egyptian glass was uncoloured and of a somewhat dusky hue; of the coloured and ornamental varieties perhaps the most characteristic examples are the small vases usually in the form of either alabastra or amphora, but occasionally in that of an Egyptian column. In these the prevailing colour is a deep transparent blue; but not unfrequently the colour of the body of the vase is some shade of pale buff, fawn, or white (an imitation probably of arragonite, Egyptian alabaster), sometimes deep green, and in rare cases red. In almost every example the surface is ornamented by bands of colour, white, yellow, or turquoise blue, forming zigzag lines; in some examples there are only two or three such lines, in others the whole surface is covered by them. These lines are incorporated with the surface of the vessel, but do not penetrate through its entire thickness. By the Greeks and Etruscans such vessels were evidently much valued; the amphora have been occasionally found in tombs, furnished with a stand of gold. In Rhodes and elsewhere they have been found associated with objects which probably do not date from an earlier period than the 3d or 4th century before Christ, and it does not appear that they are met with in tombs later than the Christian era; when coloured or ornamental glass vessels are discovered in these last, they are of a different character. Another species of glass manufacture in which the Egyptians would appear to have been peculiarly skilled is the so-called mosaic glass, formed by the union of rods of various colours in such a manner as to form a pattern; the rod so formed was then reheated and drawn out until reduced to a very small size, a square inch or less, and divided into tablets by being cut transversely, each of these tablets presenting the pattern traversing its substance and visible on each face. This process was no doubt first practised in Egypt, and is never seen in such perfection as in objects of a decidedly Egyptian character in design or in colour. Very beautiful pieces of ornament of an architectural character are met with, which probably once served as decorations of caskets or other small pieces of furniture, or of triquetts; also tragic masks, human faces, and birds. Some of the last-named are represented with such truth of colouring and delicacy of detail that even the separate feathers of the wings and tail are well distinguished, although, as in an example in the British Museum, a human-headed hawk, the piece which contains the figure may not exceed three-fourths of an inch in its largest dimension. Works of this description probably belong to the period when Egypt passed under Roman domination, as similar objects, though of inferior delicacy, appear to have been made in Rome.

The Phœnicians probably derived their knowledge of the art from Egypt; whether this be so or not, they undoubtedly practised it from a very early period and to a very large extent. Probably much the same processes were employed in Phœnicia and Egypt during some centuries before the Christian era, as they certainly were in Phœnicia, Egypt, and Rome for some centuries after. It seems probable that the earliest products of the industry of Phœnicia in the art of glass-making are the coloured beads which have been found in almost all parts of Europe, in India and other parts of Asia, and in Africa. The "aggr" beads, so much valued by the Ashantees and other natives of that part of Africa which lies near the Gold Coast, have probably the same origin. These coloured beads are usually of opaque glass; they exhibit great variety of colour and



pattern, and very different degrees of skill in manipulation. Their wide dispersion may be referred with much probability to their having been objects of barter between the Phœnician merchants and the barbarous inhabitants of the various countries with which they traded. It is probable, however, that many of the specimens which exist in our museums date from times several centuries later than those in which Tyre and Sidon flourished; for, as we may learn from the *Periplus* and Strabo, glass in various forms was an article imported in the 1st and 2d centuries, as well into the emporia of the Red Sea as into the ports of Britain. Even at the present day beads are very extensively made at Venice for export to Africa, which bear a resemblance, doubtless not accidental, to those which we have reason to believe to be of very early date.

Next in date to the earlier Egyptian examples mentioned above would appear to be the vase of transparent greenish glass found in the north-west palace of Nineveh, and now in the British Museum. On one side of this a lion is engraved, and also a line of cuneiform characters, in which is the name of Sargon, king of Assyria, 722 B.C. Fragments of coloured glasses were also found there, but our materials are too scanty to enable us to form any decided opinion as to the degree of perfection to which the art was carried in Assyria. Many of the specimens discovered by Layard at Nineveh have all the appearance of being Roman, and were no doubt derived from the Roman colony, Niniva Claudiopolis, which occupied the same site.

The Greeks, excellent in the ceramic art, do not appear to have cultivated the art of glass-making at a very early period; but it was probably made in many places on the shores of the Mediterranean for some centuries before the Christian era. At Mycenæ many disks of opaque vitreous pastes were found by Schliemann, and very similar objects at Ialysus in Rhodes; but it is not certain that these may not have been brought from Egypt, where very similar objects have been found, or whether they ought not to be attributed to Greek or to Phœnician artisans. At Camirus in Rhodes, however, many vessels of glass of very elegant forms have been discovered, which were probably made in the island.

In Etruscan tombs in Italy are also found glass vessels of peculiar character; these are small bowls resembling in form the half of an egg; they are usually of the variety of glass which is mentioned further on as "madrepore," the ground green and transparent, the stars yellow, while patches of colour of gold and of filigree glass are sometimes interspersed. They differ from and appear to be earlier than the madrepore glass, fragments of which are so often found in Rome. They are also said to be found in Magna Græcia. Another variety found in tombs in the same district is of blue and opaque glass, with much gold in leaf, all twisted together; the most frequent form in which this kind of glass has been found is that of a bottle several inches long and about one inch in diameter, without a neck, having probably had a mounting of gold. It remains to be determined whether these should be attributed to a Greek or to a Phœnician origin. Glass, however, was occasionally used for purposes of architectural decoration during the best period of Grecian art, for Stuart and Revett, when describing the temple of Minerva Polias at Athens, give the following note:—"A remarkable singularity observed in the capitals of this portico is in the plaited torus between the volutes having been inlaid at the interstices with coloured stones or glass." Mr H. March Phillips states that he well remembers having remarked these decorations, and that he believes them to be of blue glass.<sup>1</sup>

<sup>1</sup> An example of the employment of glass in a like manner is indicated by the odd story which Pliny tells (*Nat. Hist.*, xxxvii. 5, 17) that on the tomb of Hermias, a prince of the island of Cyprus,

In the first centuries of our era the art of glass-making was developed at Rome and other cities under Roman rule in a most remarkable manner, and it reached a point of excellence which in some respects has never been excelled or even perhaps equalled. It may appear a somewhat exaggerated assertion that glass was used for more purposes, and in one sense more extensively, by the Romans of the imperial period than by ourselves in the present day; but it is one which can be borne out by evidence. It is true that the use of glass for windows was only gradually extending itself at the time when Roman civilization sank under the torrent of German and Hunnish barbarism, and that its employment for optical instruments was only known in a rudimentary stage; but for domestic purposes, for architectural decoration, and for personal ornaments glass was unquestionably much more used than at the present day. It must be remembered that the Romans possessed no fine porcelain decorated with lively colours and a beautiful glaze; Samian ware was the most decorative kind of pottery which was then made. Coloured and ornamental glass held among them much the same place for table services, vessels for toilet use, and the like, as that held among us by porcelain. Pliny (*Nat. Hist.*, xxxvi. 26, 67) tells us that for drinking vessels it was even preferred to gold and silver. Trebellius Pollio, however, relates of the emperor Gallienus that he drank from golden cups, despising glass, than which, he said, nothing was more vulgar. Glass was largely used in pavements, and in thin plates as a coating for walls. It was used in windows, though by no means exclusively, mica, alabaster, and shells having been also employed. Glass, in flat pieces, such as might be employed for windows, has been found in the ruins of Roman houses, both in England and in Italy, and in the house of the faun at Pompeii a small pane in a bronze frame remains. Glass of this description seems to have been cast on a stone, and is usually very uneven and full of defects; although capable of transmitting light, it must have given at best an indifferent view of external objects. When the window openings were large, as was the case in basilicas and other public buildings and even in houses, the pieces of glass were, doubtless, fixed in pierced slabs of marble or in frames of wood or bronze.

The invention and ingenuity employed by the Roman artisans in producing variety in glass vessels are most remarkable; almost every means of decoration appears to have been tried, and many methods of manipulating glass, which have been considered inventions, have in reality been anticipated by the glass-workers of the period under consideration. The fertility of invention which devised so many modes of ornamentation and so many shades of colour, and the skill with which the manual execution is carried out, alike deserve great admiration. This prodigious variety seems to show that glass-making was at that time carried on, not as now in large establishments, which produce great quantities of articles identical in form and pattern, but by many artificers, each working on a small scale. This circumstance enables us to understand why very pure and crystalline glass was, as Pliny tells us, more valued than any other kind. To produce glass very pure and free from striæ and bubbles, long-continued fusion is required; this the system of working of the ancients did not allow, and their glass is in consequence remarkable for the great abundance of bubbles and defects which it contains.

was a marble figure of a lion with eyes of emerald which shone so brightly into the sea that they frightened away the tunnies from the adjacent fisheries, so that it became necessary to change the eyes. In the great marble lion discovered by Mr Newton near Cnidus, and now in the British Museum, in the place of the eyes are deep sockets which probably, like those of the Cypriote lion, were filled with coloured glass.

The Romans had at their command, of transparent colours, blue, green, purple or amethystine, amber, brown, and rose; of opaque colours, white, black, red, blue, yellow, green, and orange. There are many shades of the former as well as of the latter, particularly of transparent blue, and of opaque blue, yellow, and green. Of opaque colours many varieties appear to be due to the mixture of one colour with another. In any large collection of fragments it would be easy to find eight or ten varieties of opaque blue, ranging from lapis lazuli to turquoise or to lavender, and six or seven of opaque green. Of red the varieties are fewer; the finest is a crimson red of very beautiful tint, and there are various gradations from this to a dull brick red. One variety forms the ground of a very good imitation of porphyry; and there is a dull semi-transparent red which, when light is passed through it, appears to be of a dull green hue. With these colours the Roman *vitarius* worked, either using them singly or blending them in almost every conceivable combination, sometimes, it must be owned, with a rather gaudy and inharmonious effect.

These combinations of colour were effected in two ways:—first, by glasses of two or more colours being combined so as to traverse the entire substance of the object; and, secondly, by the superposition of the one colour on the other.

To the former class belong all those termed mosaic and mille fiori, where the process of manufacture was the preliminary union, by heat, of threads of glass into a rod, which when cut transversely exhibited the same pattern in every section. Such rods were placed together side by side, and united by heat into a mass which was then formed into cups or other vessels. A vast quantity of small cups and pateras were made by this means in patterns which bear considerable resemblance to the surfaces of madreporæ, and are of the same kind as those which by the Venetians are termed "mille fiori." In these every colour and every shade of colour seem to have been tried in great variety of combination with effects more or less pleasing, but transparent violet or purple appears to have been the most common ground colour. Although most of the vessels of this mille fiori glass were small, some were made of large size; a fragment in the possession of the present writer must have formed part of a dish not less than 20 inches in diameter. Another variety of glass, evidently much used, is that in which transparent brown glass is so mixed with opaque white and blue as to resemble onyx. This was sometimes done with great success, and very perfect imitations of the natural stone were produced. Sometimes purple glass is used in place of brown, probably with the design of imitating the precious murhine. Imitations of porphyry, of serpentine, and of granite are also met with, but these were used chiefly in pavements, and for the decoration of walls, for which purposes the onyx-glass was likewise employed. Under this head must also be included the interlacing of bands and threads both of white and of coloured glass. Vessels are found composed of bands either so placed in sections as to present a plaited pattern, or simply arranged side by side; others, again, resemble the Venetian *vitro di trina*, threads of opaque white or yellow glass being twisted with clear transparent glass, and the vessel then formed by the welding together of the rods so made. Blue threads are occasionally intermixed, and several varieties of pattern may be found; but this branch of the art does not appear to have been carried by the Romans to anything like the perfection to which it was afterwards brought by the Venetians.

So few examples of glass vessels of this period which have been painted in enamel have come down to us that

it has been questioned whether that art was then practised; but several specimens have been recently described which can leave no doubt on the point; decisive examples are afforded by two cups found at Vaspelev, in Denmark, engravings of which are published in the *Annaler for Nordisk Oldkyndeghed* for 1861, p. 305. These are small cups, 3 inches and 2½ inches high, 3¾ inches and 3 inches wide, with feet and straight sides; on the larger are a lion and a bull, on the lesser two birds with grapes, and on each some smaller ornaments. On the latter are the letters DVB. R. The colours are vitrified and slightly in relief; green, blue, and brown may be distinguished. They were found with Roman bronze vessels and other articles. Vessels also are not uncommon on the surface of which enamel colours appear in the form of spots; it is probable that these were applied in the form of melted glass, not, as in true enamel painting, in that of a finely divided powder tempered with an essential oil and applied cold.

The first place among those processes in which one colour was superimposed on another may be given to that by which the cameo glass was produced. In this a bubble of opaque white glass was formed at the end of the tube used by the glass-blower; this was coated with transparent blue, and that again with opaque white, and the vessel required was formed from this threefold globe. The outer coat was then removed from that portion which was to constitute the ground, leaving the white for the figures, foliage, or other ornamentation; these were then sculptured by means of the gem-engraver's tools. Pliny no doubt means to refer to this when he says (*Nat. Hist.*, xxxvi. 26, 66), "aliud argenti modo cœlatur," contrasting it with the process of cutting glass by the help of a wheel, to which he refers in the words immediately preceding, "aliud torno teritur."

The famous Portland or Barberini vase is the finest example of this kind of work which has come down to us, and was entire until it was broken into some hundred pieces by a drunken medical student some years ago. The pieces, however, were joined together by Mr Doubleday with extraordinary skill, and the beauty of design and execution may still be appreciated almost as well as when it was intact. A letter written by Wedgwood in 1786 to Sir William Hamilton has been published in the life of the former by Miss Meteyard (vol. ii. p. 577), which contains some interesting remarks upon this beautiful work of art. He concludes with the assertion, "I do not think £5000 for the execution of such a vase, supposing our best artists capable of such a work, would be at all equal to their gains from the works they are now employed in." It is true that the gem-engravers of that day received very high pay for their work.

The two other most remarkable examples of this cameo glass are an amphora at Naples and the Auldjo vase. The amphora measures 1 foot ¾ inch in height, 1 foot 7½ inches in circumference; it is shaped like the earthen amphoras with a foot far too small to support it, and must no doubt have had a stand, probably of gold; the greater part is covered with a most exquisite design of garlands and vines, and two groups of boys gathering and treading grapes and playing on various instruments of music; below these is a line of sheep and goats in varied attitudes. The ground is blue and the figures white. It was found in a house in the Street of Tombs at Pompeii in the year 1839, and is now in the Royal Museum at Naples. It is well engraved in Richardson's *Studies of Ornamental Design*. The Auldjo vase, a part of which is or was in possession of Mr Auldjo, and another in the British Museum, is an oenochœ about 9 inches high; the ornament consists mainly of a most beautiful band of foliage, chiefly of the vine, with bunches of grapes; the ground is blue and the ornaments white;



it was found at Pompeii in the house of the faun. It also has been engraved by Richardson.

Costly as these beautiful objects must have been, a very great number of them existed, for even now fragments of ten to fifteen may probably be met with in the hands of the curiosity dealers in Rome in the course of three or four months. The same process was used in producing large tablets, employed, no doubt, for various decorative purposes. In the South Kensington Museum collection is a fragment of such a tablet or slab; the figure, a portion of which remains, could not have been less than about 14 inches high.

The ground of these cameo glasses is most commonly transparent blue (often lined with opaque white to throw up the colour), but sometimes opaque blue, purple, or dark brown. The superimposed layer, which is sculptured, is generally opaque white. A very few specimens have been met with in which several colours are employed.

At a long interval after these beautiful objects come those vessels which were ornamented either by means of coarse threads trailed over their surfaces and forming rude patterns, or by coloured enamels merely placed on them in lumps; and these, doubtless, were cheap and common wares. But a modification of the first-named process was in use in the 4th and succeeding centuries, showing great ingenuity and manual dexterity,—that, namely, in which the added portions of glass are united to the body of the cup, not throughout, but only at points, and then shaped either by the wheel or by the hand. The attached portions form in some instances inscriptions, as on a cup found at Strasburg, which bears the name of the emperor Maximian (286–310 A.D.), on another in the Vereinigte Sammlungen at Munich, and on a third in the Trivulzi collection at Milan, where the cup is white, the inscription green, and the network blue. Probably, however, the finest example is a situla, 10½ inches high by 8 inches wide at the top and 4 inches at the bottom, preserved in the treasury of St Mark at Venice. This is of glass of a greenish hue; on the upper part is represented, in relief, the chase of a lion by two men on horseback accompanied by dogs; the costume appears to be Byzantine rather than Roman, and the style is very bad. The figures are very much undercut. The lower part has four rows of circles united to the vessel at those points alone where the circles touch each other. All the other examples have the lower portion covered in like manner by a network of circles standing nearly a quarter of an inch from the body of the cup.<sup>1</sup>

The art of glass-making no doubt, like all other art, deteriorated during the decline of the Roman empire, but it is probable that it continued to be practised, though with constantly decreasing skill, not only in Rome but in the provinces. Some few existing vessels, as two chalices of coarse blue glass in the British Museum, may perhaps be referred to this period, but the most remarkable production was mosaic for the decoration of churches. Examples of such decorations may be still seen in Rome dating from every century through the dark ages; and, though glass for mosaic was certainly made at Constantinople, and perhaps also at Ravenna, it is probable that it was also made in Rome. Glass was largely used in the immense windows of the churches built between the 3d and the 10th centuries. The first mention of coloured glass in a church window occurs in the time of Pope Leo III. (795–816); but probably it was used at a much earlier period.

<sup>1</sup> An example connected with the specimens just described is the cup belonging to Baron Lionel de Rothschild; though externally of an opaque greenish colour, it is by transmitted light of a deep red. On the outside, in very high relief, are figures of Bacchus with vines and panthers, some portions being hollow from within, others fixed on the exterior. The changeability of colour may remind us of the "calices varicolors" which Hadrian sent to Servianus.

Some of the Roman artificers in glass no doubt emigrated to Constantinople, and it is certain that the art was practised there to a very great extent during the Middle Ages. One of the gates near the port took its name from the adjacent glass-houses. St Sophia when erected by Justinian had vaults covered with mosaics and immense windows filled with plates of glass fitted into pierced marble frames; some of the plates, 7 to 8 inches wide and 9 to 10 high, not blown but cast, which are in the windows, may possibly date from the building of the church. Glass for mosaics was also largely made and exported. In the 8th century when peace was made between the caliph Walid and the emperor Justinian II., the former stipulated for a quantity of mosaic for the decoration of the new mosque at Damascus, and in the 10th century the materials for the decoration of the niche of the kibra at Cordova were furnished by Romanus II. In the 11th century Desiderius, abbot of Monte Casino, sent to Constantinople for workers in mosaic. The grounds of the Byzantine mosaics were usually either of gold or silver, a thin leaf of the metal having been enclosed between two layers of glass.

We have in the work of the monk Theophilus, *Diversarum Artium Schedula*, and in the probably earlier work of Eraclius, about the 11th century, instructions as to the art of glass-making in general, and then as to that of producing coloured, gilt, and enamelled vessels, which these writers speak of as being practised by the Greeks. But we look almost in vain for existing specimens of such works. Perhaps the only entire enamelled vessel which we can confidently attribute to Byzantine art is a small vase preserved in the treasury of St Mark at Venice, a very clever reproduction of which was exhibited by the Murano Glass Company at the Paris exhibition of 1878. This is decorated with circles of rosettes of blue, green, and red enamel, each surrounded by lines of gold; within the circles are little figures evidently suggested by antique originals, and precisely like similar figures found on carved ivory boxes of Byzantine origin dating from the 11th or 12th centuries. Two inscriptions in Cufic characters surround the vase, but they, it would seem, are merely ornamental and destitute of meaning. The presence of these inscriptions may perhaps lead to the inference that the vase was made in Sicily, but by Byzantine workmen.<sup>2</sup>

Of uncoloured glass brought from Constantinople several examples exist in the treasury of St Mark at Venice, part of the plunder of the imperial city when taken by the crusaders in 1204. The glass in all is greenish, very thick, with many bubbles, and has been cut with the wheel; in some instances circles and cones, and in one the outlines of the figure of a leopard have been left standing up, the rest of the surface having been laboriously cut away. The intention would seem to have been to imitate vessels of rock crystal.

Probably at Alexandria, one of the great seats of glass-making, the art survived the conquest of Egypt by the Saracens, for a glass disk serving as a weight has been met with in Egypt bearing the date 96 of the Hegira, corresponding with 715 A.D. (see memoir by Mr E. T. Rogers, *Journal of the Royal Asiatic Society*, vol. x. pt. 1). Numerous later examples leave no doubt that the manufacture of glass continued to exist in Egypt, though perhaps in a

<sup>2</sup> The Sano Catino at Genoa, supposed throughout the Middle Ages to have been an emerald but really composed of green glass, is a shallow hexagonal dish rather clumsily formed and finished by cutting. It was perhaps originally a paten, and was taken at the capture of Cusarea in 1101. At Reichenau in the Lake of Constance, is (or was) preserved a slab of transparent green glass 2 feet wide by 13 inches high and 3 inches thick, which was also supposed to be an emerald. According to tradition it was sent to Charles the Great by the empress Irene.

languishing condition. In the 11th century, however, we find in the life of St Odilo, abbot of Fulda (*ob.* 1049), mention of a "vas pretiosissimum vitreum Alexandrini generis," and in the same century Nasir Ibn Khusrû (*Safarnamah*, published by Royal Asiatic Society), who visited Jerusalem in 1060, says that pictures of our Lord and others in one of the churches of that city were covered with plates of glass. No examples of ornamental vessels dating from this period have, however, come down to us. But we have many very remarkable examples of the skill of Egyptian and Syrian glass-workers in the 13th and 14th centuries,—large bottles, basins, and lamps, very striking objects from the free use of enamel and gilding in their decoration. This is, as in most objects of Eastern art, chiefly composed of inscriptions written in large characters ornamentally treated; but figures of birds, lions, sphinxes, &c., may be found, especially on vessels made in Egypt. Although there may have been some indigenous practice of the art of glass-making in the East,—for in the cup of Chosroes I. of Persia (531–579) preserved in the Bibliothèque Nationale at Paris are medallions of coloured and moulded glass,—the arts of gilding and enamelling, as we see them exhibited in the Syrian and Egyptian works of the 13th and 14th centuries, were probably derived from the Byzantines. Damascus was also the seat of a like manufacture. In inventories of the 14th century, both in England and in France, mention may frequently be found of glass vessels described as of the manufacture of Damascus. That city was taken by Timur in 1402, and we are told by Clavijo, who visited his court in 1403–1406, that he carried off to Samarcand "men who made bows, glass, and earthenware, so that of these articles Samarcand produces the best in the world."

Glass no doubt continued to be made, as it still is, in Syria and Persia, but no very remarkable products of the manufacture are known in Europe, with the exception of some vessels brought from Persia, blue richly decorated with gold. These probably date from the 17th century, for Chardin tells us that the windows of the tomb of Shah Abbas II. (*ob.* 1666) at Kom, were "de cristal peint d'or et d'azur." At the present day bottles and drinking vessels are made in Persia which in texture and quality differ little from ordinary Venetian glass of the 16th or 17th centuries, while in form they exactly resemble those which may be seen in the engravings in Chardin's *Travels*.

India. Pliny states (*Nat. Hist.*, xxxvi. 26, 66) that no glass was to be compared to the Indian, and gives as a reason that it was made from broken crystal; and in another passage (xii. 19, 42) he says that the Troglodytes brought to Ocelis (Ghella near Bab-el-Mandeb) objects of glass. We have, however, very little knowledge of Indian glass of any considerable antiquity. A few small vessels have been found in the "topes," as in that at Manikyala in the Punjab, which probably dates from about the Christian era; but they exhibit no remarkable character, and fragments found at Brahminabad are hardly distinguishable from Roman glass of the imperial period. The chronicle of the Singhalese kings, the Mahawanso, however, asserts that mirrors of glittering glass were carried in procession in 306 B.C., and beads like gems, and windows with ornaments like jewels, are also mentioned at about the same date. If there really was an important manufacture of glass in Ceylon at this early time, that island perhaps furnished the Indian glass of Pliny; or it is possible that it really came from China. Glass is made in several parts of India—as Behar and Mysore—by very simple and primitive methods, and the results are correspondingly defective. Black, green, red, blue, and yellow glass is made. The greater part is worked into bangles, but some small bottles are blown (Buchanan, *Journey through Mysore*, vol. i. p. 147; vol. iii. p. 369).

The history of the manufacture of glass in China is obscure, but the common opinion that it was learnt from the Europeans in the 17th century seems to be erroneous. A writer in the *Mémoires concernant les Chinois* (vol. ii. p. 46) states on the authority of the annals of the Han dynasty that the emperor Ou-ti (140 B.C.) had a manufactory of the kind of glass called "lieou-li," that in the beginning of the 3d century of our era the emperor Tai-tou received from the West a considerable present of glasses of all colours, and that soon after a glass-maker came into the country who taught the art to the natives.

The Wei dynasty, to which Tai-tou belonged, reigned in northern China, and at this day a considerable manufacture of glass is carried on at Po-shan-hien in Shantung, which it would seem has existed for a long period. The Rev. A. Williamson (*Journeys in North China*, i. 131) says that the glass is extremely pure, and is made from the rocks in the neighbourhood. The rocks are probably of quartz, i.e., rock crystal, a correspondence with Pliny's statement respecting Indian glass which seems deserving of attention.

Whether the making of glass in China was an original discovery of that ingenious people, or was derived *via* Ceylon from Egypt, cannot perhaps be now ascertained; the manufacture has, however, never greatly extended itself in China. The case has been the converse of that of the Romans; the latter had no fine pottery, and therefore employed glass as the material for vessels of an ornamental kind, for table services and the like. The Chinese, on the contrary, having from an early period had excellent porcelain, have been careless about the manufacture of glass. A Chinese writer, however, mentions the manufacture of a huge vase in 627 A.D., and in 1154 Edrisi (first climate, tenth section) mentions Chinese glass. A glass vase about a foot high is preserved at Nara in Japan, and is alleged to have been placed there in the 8th century. It seems probable that this is of Chinese manufacture. A writer in the *Mémoires concernant les Chinois* (vol. ii. pp. 463 and 477), writing about 1770, says that there was then a glass-house at Peking, where every year a good number of vases were made, some requiring great labour because nothing was blown (*rien n'est soufflé*), meaning no doubt that the ornamentation was produced not by blowing and moulding, but by cutting. This factory was, however, merely an appendage to the imperial magnificence. The earliest articles of Chinese glass the date of which has been ascertained, which have been noticed, are some bearing the name of the emperor Kienlung (1736–1796), one of which is in the South Kensington Museum.

In the manufacture of ornamental glass the leading idea in China seems to be the imitation of natural stones. The coloured glass is usually not of one bright colour throughout, but semi-transparent and marbled; the colours in many instances are singularly fine and harmonious. As in 1770, cutting is the chief method by which ornament is produced, the vessels being blown very solid.

The chief source from whence a knowledge of the art of glass-making spread through Europe was probably Rome; in the Roman imperial period glass was undoubtedly made, not only in Italy, but also in France, in Spain, and in all probability at or near Cologne, and perhaps in other places near the Rhine. Whether refugees from Padua, Aquileia, or other Italian cities carried the art to the lagoons of Venice in the 5th century, or whether it was learnt from the Greeks of Constantinople at a much later date, has been a disputed question. It would appear not improbable that the former was the case, for it must be remembered that articles formed of glass were in the later days of Roman civilization in constant daily use, and that the making of glass was carried on, not as now in large establishments, but by artisans working on a small scale. It seems certain that some knowledge of the art was preserved in France and in