

come into the story. What, then, is left for it? A collection of anecdotes and a series of episodes. In point of fact this is the view actually taken by Socrates. His utter want of care and consistency appears most clearly in his vacillation as to the relations between ecclesiastical and political history. At one time he brings in politics, at another he excuses himself from doing so. He has not failed to observe that church and state act and react upon each other; but he has no notion how the relation ought to be conceived. Nevertheless his whole narrative follows the thread of political—that is to say, of imperial—history. This indeed is characteristic of his Byzantine Christian point of view; church history becomes metamorphosed into a history of the emperors and of the state, because a special church history is at bottom impossible. But even so one hardly hears anything about state or court except great enterprises and anecdotes. Political insight is wholly wanting to Socrates; all the orthodox emperors blaze forth in a uniform light of dazzling splendour; even the miserable Arcadius is praised, and Theodosius II. figures as a saint whose exemplary piety turned the capital into a church. If in addition to all this we bear in mind that in his later books the historian's horizon is confined to the city and patriarchate of Constantinople, that he was exceedingly ill informed on all that related to Rome and the West, that in order to fill out his pages he has introduced narratives of the most unimportant description, that in not a few instances he has evinced his credulity (although when compared with the majority of his contemporaries he is still entitled to be called critical), it becomes sufficiently clear that his *History*, viewed as a whole and as a literary production, can at best take only a secondary place. One great excellence, however, cannot be denied him, his honest and sincere desire to be impartial. He tried also, as far as he could, to distinguish between the certain, the probable, the doubtful, and the untrue. He made no pretence to be a searcher of hearts and frequently declines to analyse motives. He has made frank confession of his nescience, and in certain passages his critical judgment and sober sense and circumspection are quite striking. He writes a plain and unadorned style and shuns superfluous words. Occasionally even there are touches of good humour and of trenchant satire,—always the sign of an honest writer. In short, the rule to be applied in the criticism of Socrates is that his learning and knowledge can be trusted only a little but his goodwill and straightforwardness a great deal. Considering the circumstances under which he wrote and the miseries of the time, it can only be matter for congratulation that such a man should have become our informant and that his work has been preserved to us.

Finally, it is to be noted that Socrates was either himself originally a Novatianist who had afterwards joined the Catholic Church, or that whether through his ancestors or by education he had stood in most intimate relations with the Novatianist Church. In his *History* he betrays great sympathy with that body, has gone with exactness into its history in Constantinople and Phrygia, and is indebted for much of the material of his work to Novatianist tradition and to his intercourse with prominent members of the sect. Both directly and indirectly he has declared that Novatianists and Catholics are brothers, that as such they ought to seek the closest relations with one another, and that the former ought to enjoy all the privileges of the latter. His efforts, however, had only this result, that he himself afterwards fell under suspicion of Novatianism. For bibliography, see SOZOMEN. (A. HA.)

SODIUM AND SODA. Sodium is one of the two principal alkali metals, regarding the general properties of which the reader is referred to CHEMISTRY (vol. v. p. 524) and the introductory portion of POTASSIUM (vol. xix. p. 588). In combination sodium is a generally diffused and most abundant element. The salt dissolved in sea water consists chiefly of chloride of sodium (NaCl), and according to Dittmar's calculation (see SEA WATER) the oceans of the world contain of sodium calculated as chloride not less than $36,000 \times 10^{12}$ (i.e., 36,000 million million) tons, whilst of potassium calculated as sulphate the amount in sea water is 1141×10^{12} (1141 million million) tons. From sea water have been deposited the enormous beds of rock salt found in many parts of the world (see SALT). Sodium carbonates are also widely dispersed in nature, forming constituents of many mineral waters, and occurring as principal saline components in natron or trona lakes, as efflorescences in Lower Egypt, Persia, and China, and as urao in Mexico, Colombia, and Venezuela. The solid crusts found at the bottom of the salt lakes of the Araxes plain in Armenia contain about 16 per cent. of carbonate and 80 of sulphate of soda. In New Granada there occurs a double salt, $\text{Na}_2\text{CO}_3 + \text{CaCO}_3 + 5\text{H}_2\text{O}$, known as gay-lussite. In Wyoming, California, and Nevada enormous deposits of

carbonates, mixed in some cases with sulphate and with chloride, occur. About Szegedin in Hungary and all over the vast puszta (steppes) between the Theiss and the Danube, and from the Theiss up to and beyond Debreczin, the soil contains sodium carbonate, which frequently assumes the form of crude alkaline crusts, called "szekso," and of small saline ponds. A purified specimen of such Debreczin soda was found to contain as much as 90 per cent. of real carbonate (NaCO_3) and 4 of common salt. Natural sulphate occurs in an anhydrous condition as thenardite (Na_2SO_4) at Tarapaca, Peru, and in the rock-salt deposits at Espartinas near Aranjuez, Spain. Hydrated sulphates occur at several localities in the province of Madrid and in other provinces of Spain, and at Mühligen in Aargau, and copious deposits of glauberite, the double sulphate of sodium and calcium, are met with in the salt-mines of Villarrubia in Spain, at Stassfurt, and in the province of Tarapaca, Peru, &c. A native nitrate of soda is obtained in great abundance in the district of Atacama and the province of Tarapaca, and is imported into Europe in enormous quantities as cubical nitre for the preparation of saltpetre (see NITROGEN, vol. xvii. p. 518). Cryolite, a fluoride of aluminium and sodium, $\text{AlF}_3 + 3\text{NaF}$, is extensively mined in Greenland for industrial purposes. These form the principal natural sources of sodium compounds,—the chloride as rock salt and in sea water being of such predominating importance as quite to outweigh all the others. But it is questionable whether taken altogether the mass of sodium they represent is as much as that disseminated throughout the rocky crust in the form of soda felspar (i.e., as silicate of soda) and in other soda-containing rocks. From this source all soils contain small proportions of sodium in soluble forms, hence the ashes of plants, although they preferably imbibe potassium salts, contain traces and sometimes notable quantities of sodium salts. Sodium salts also form essential ingredients in all animal juices.

Considered industrially, by far the most important bodies are the carbonates, the sulphates, and caustic soda (sodium hydrate), the manufacture of which forms the basis of the soda industry. Immense quantities of these bodies are used in the manufacture of soap and glass, and under the name of "washing soda" or "soda crystals" the consumption of the hydrated carbonate for domestic washing is also very great. There are indeed few chemical industries in which soda in one form or another does not play an important part, and the combinations of economic value into which it enters are numberless. It will be convenient to treat of the manufacture as a whole by itself, after speaking of sodium and its salts in their chemical relations.

Sodium, in German *Natrium* (symbol, Na; atomic weight, 23.053; O = 16), is a univalent metal. It occurs nowhere in nature in an uncombined condition, and was first isolated in 1807 by Sir Humphrey Davy through the medium of voltaic electricity. It is prepared by distillation of an intimate mixture of carbonate of soda with charcoal. The process is quite analogous to that followed in making metallic potassium (POTASSIUM, vol. xix. p. 590), but much easier of execution, and free from certain dangers which attend the preparation of the other. The distillation is conducted in cylindrical iron retorts protected against the fire by means of fireclay tubes fitting closely round them. In the charge is included a certain proportion of chalk, which, giving off carbonic acid, aids in driving over the metallic vapour and protects the distillate against oxidation. The metal cast into the form of cakes or ingots is protected from the air by a coating of paraffin and secured in closely fitting soldered-up tinned-iron boxes. Metallic sodium is very similar in properties and appearance to potassium. The principal points of difference are its pure white colour

its specific gravity (0.9735 at 13° 5 C.), and its fusing point (95° 6 C.). In thin layers its vapour is colourless, but dense fumes have a purple tint. It decomposes water violently, but the hydrogen evolved does not take fire, although the reaction is more dangerous than the corresponding phenomena developed by potassium, because it leads frequently to most violent explosions. Yet the process serves in practice for the preparation of pure soda hydrate. In this operation a piece of sodium is placed in a silver basin standing in a shallow cold-water bath. Drop by drop water is added—the metal between the additions being allowed to expend its energy—till the desired quantity of hydrate is formed. The process, in short, is so conducted that, except at first, the metal never touches water in any other form than that of a strong soda lye. Sodium is largely made for use as an agent in the manufacture of aluminium and magnesium, and as a reagent in laboratory operations. The metal does not affect carbonic oxide at any temperature; it acts on hydrogen as potassium does; but the compound is less stable. On ammonia gas it acts, as in the parallel case of potassium, with the formation of NH_2Na , only the reaction is less energetic. Sodium has less powerful affinity to oxygen than potassium; in dry air or oxygen it burns into the dioxide Na_2O_2 —a product obtainable also by heating the nitrate or nitrite. A white solid soluble in cold water, forming a hydrate, $\text{Na}_2\text{O}_2 + 8\text{H}_2\text{O}$, is obtainable in crystals, the solution of which is strongly alkaline. With acids it yields sodium salts and peroxide of hydrogen. Sodium tetroxide (Na_2O_4) is not known to exist.

Caustic Soda (NaHO) is prepared from carbonate by means of caustic lime, just as caustic potash is made from its carbonate (see POTASSIUM). The analogy between the two caustic alkalis is so perfect that we need only summarize the points of difference between them. Compared with caustic potash, caustic soda is less easily soluble in water, less caustic, less energetically basilous, less prone when fused in air to pass into peroxide, hence less destructive to platinum, iron, nickel, and silver vessels.

Sodium Chloride (NaCl) occurs in nature in a nearly pure state. Absolutely pure salt is made from commercial salt by precipitating from a solution the lime and magnesia by pure carbonate of soda, filtering, neutralizing with pure hydrochloric acid, concentrating by evaporation, and then precipitating the pure salt by a stream of hydrochloric acid gas. The crystalline precipitate is collected over glass wool, washed with pure fuming hydrochloric acid, and dried by heating in a platinum basin. It forms non-hygroscopic crystals, free from combined water, having a specific gravity at 16° C. of 2.162 (Stolba), and according to Carnelley fusing at 776° C. The solubility of pure salt in water is almost independent of temperature; 100 parts of water dissolve—

at 0°	14°	60°	100°	100° 7 (boiling)
35.52	35.87	37.25	39.61	40.53

parts of NaCl.

Regarding its commercial relations, &c., see SALT.

Chlorate of Soda (NaClO_3) is a salt of some industrial importance, from its use in the manufacture of aniline black. It may be made from the potash salt (a) by decomposing this with hydrofluosilicic acid (which precipitates the potassium as fluosilicate and yields a solution of chloric acid), and neutralizing the chloric acid solution with soda, or (b) by double decomposition with bitartrate of soda $\text{NaHC}_4\text{H}_4\text{O}_6$ —the cream of tartar ($\text{KHC}_4\text{H}_4\text{O}_6$) separating out almost completely, whilst the chlorate of soda remains in solution. According to Weldon, it is best manufactured from caustic soda by the direct action of chlorine, the two salts NaCl and NaClO_3 being separated by crystallization. Chlorate of soda forms cubes which often exhibit tetrahedral faces; 100 parts of water dis-

solve at 0° 81.9, at 20° 99, and at 100° C. 233 parts of the salt. Hence it is much more soluble than the potash salt, on which account it is preferred for aniline black printing.

Sulphate (Na_2SO_4) is the most largely produced of all soda salts in manufacturing operations, although it is regarded principally as an intermediate product. The anhydrous salt readily combines with water into a crystalline soluble compound, $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$, known as Glauber's salt. This forms large transparent monoclinic crystals, and is characteristically prone to form supersaturated solutions. 100 parts of water dissolve—

at 0°	11° 67	25° 05	32° 73	33° 88
12.17	26.38	99.48	322.1	312.1

parts of $\text{Na}_2\text{SO}_4 + 10\text{H}_2\text{O}$,
5.02 10.12 28.11 50.65 50.4 parts of Na_2SO_4 .

As the temperature rises beyond about 33°, the solubility decreases (Gay-Lussac). Glauber's salt, when exposed to dry air, especially in summer heat, gradually falls into a powder of anhydrous sulphate. It is much less volatile than the chloride. The thiosulphate, $\text{Na}_2\text{S}_2\text{O}_3$ (commercial hyposulphite of soda), and soda salts of other lower sulphur acids, are reserved for SULPHUR.

Of all sodium compounds, except common salt, the carbonates are by far the most important, both industrially and chemically. These comprise the following.

Normal Carbonate, Na_2CO_3 .—The anhydrous salt usually presents itself in the form of a white opaque porous solid, specific gravity 2.65 (Karsten). According to Carnelley, it fuses at 818° C. (dull red heat) into a colourless liquid. On fusing it loses some of its carbonic acid, and at a bright red heat it volatilizes appreciably. The porous salt absorbs water from the air; when moistened with water it gives off heat and unites into crystalline hydrates, of which the important compound is

Decahydrate, $\text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O}$.—This salt, known as soda crystals or washing soda, forms large transparent monoclinic rhomboidal prisms or double pyramids. The salt dissolves readily in water, forming strongly alkaline solutions, which emulsionize fats, though less readily than is done by caustic lyes. 100 parts of water dissolve—

at 0°	15°	20°	30°	38°	104°
21.33	63.20	92.82	273.6	1142.2	539.6

of crystals,
6.97 16.20 21.71 37.24 51.67 46.47 of Na_2CO_3 .

(Löwel). According to this observer, the dissolved salt from 38° C. upwards assumes the form of lower hydrates, hence the diminution in solubility at higher temperatures. A saturated solution, when evaporated down by heat, deposits a granular salt of the composition $\text{Na}_2\text{CO}_3(\text{H}_2\text{O}$ or $2\text{H}_2\text{O})$. The decahydrate, when exposed to dry air even at ordinary temperatures, loses water, with the formation of monohydrate, $\text{Na}_2\text{CO}_3\text{H}_2\text{O}$. It also readily takes up carbonic acid with the formation of

Bicarbonate, NaHCO_3 .—Its formation may be thus formulated— $\text{Na}_2\text{CO}_3 + 10\text{H}_2\text{O} + \text{CO}_2 = 2\text{NaHCO}_3 + 9\text{H}_2\text{O}$. The bicarbonate remains as a crystalline mass, while the liberated water runs off with more or less of dissolved carbonate and the saline impurities which may be present. Bicarbonate forms small four-sided monoclinic plates with a feebly alkaline taste and reaction. 100 parts of water dissolve—

at 0°	20°	40°	60°
6.90	9.60	12.70	16.40

of NaHCO_3 .

(Dibbits). From about 70° C. upwards the solution gives off carbonic acid with formation of *Sesquicarbonate*,— $2\text{Na}_2\text{O} + 3\text{CO}_2 + 4\text{H}_2\text{O} = \text{Na}_2\text{CO}_3.2\text{NaHCO}_3 + 3\text{H}_2\text{O}$. This salt, found in nature as trona or urao, forms in its pure state crystals which do not lose water in the air. At 20° C. 100 parts of water dissolve 18.3 parts of the salt calculated as anhydride, $2\text{Na}_2\text{O}.3\text{CO}_2$. Both bicarbonate and sesquicarbonate when heated dry break up readily (below redness) into normal carbonate, water, and carbonic acid.

Other salts of soda which are of importance on account of their acid constituents—nitrate, silicate, phosphate—are dealt with under NITROGEN, SILICA, PHOSPHORUS.

The estimation and analysis of alkalis are sufficiently dealt with at the close of the article POTASSIUM.

Soda Manufacture.

The ancients probably did not know soda in other than its native forms, and till about the end of the 18th century potash was, of the two alkalis, the more abundant and generally used substance. Indeed it was not till well into that century that the chemical distinctions of the alkalis were established; they were previously spoken of indifferently as nitrum, natron, kali, alkali, and soda, names simply meaning a fixed alkali. Soda has properly a separate history only from 1736, when Duhamel established the fact that common salt and mineral alkali have the same base,—a body different from the salt of tartar or vegetable alkali. Yet soda, from both mineral and vegetable sources, had long previously been used in Europe, the Arabs having probably brought into Spain a knowledge of the alkali and its sources. Apart from the trona and soda lakes, &c., already alluded to, the only source till the close of the 18th century was the ashes of certain plants which grow on the sea-coast and in salt-impregnated soils. These plants, principally species of *Salsola* and a few other genera of the natural order *Atriplicaceæ*, on incineration yield an ash containing in some cases about 50 per cent. of carbonate of soda. The ash of these plants, fluxed by red heat into a pasty mass and broken into convenient lumps, forms the barilla of commerce, which in former times was a product of the first importance on the shores of Spain, Sicily, Sardinia, and other coasts of the Mediterranean. In 1834 as much as 12,000 tons of barilla were introduced into England from Spain alone, and, in spite of the cheapness of artificial soda, the manufacture of barilla is still—or at least was till recently—carried on at various localities on the Mediterranean. On the west coasts of Scotland and Ireland large amounts of impure soda carbonate were obtained from the kelp burned from certain sea-weeds; but the introduction of artificial soda early extinguished that industry, although in connexion with the production of iodine and other products a small quantity of sea-weed soda continues to be made in Scotland till the present day.

The increasing price of potash salts and the discovery of Duhamel led to strenuous attempts to produce the carbonate from common salt. In 1775 the French Academy of Sciences offered a prize of 2400 livres for a practical method of converting salt into soda. But it was never awarded, although the problem was soon triumphantly solved. Indeed in that same year Scheele succeeded in making soda from common salt by means of litharge. Several claims were made for the prize, the first being based on a process invented by a Benedictine monk, Malherbe, in 1778, which was worked with some success for several years. Some time about or before 1787 De la Méthérie proposed a plan for calcining with charcoal the sulphate prepared from chloride,—an impracticable proposal, because nearly all the resulting product is sulphide.¹ But this proposal has historical importance, because from the published account of it Le Blanc received in 1787, according to his own statement, the first suggestion of his process,—probably the most valuable and fertile chemical discovery of all times. Nicolas Le Blanc, born at Issoudun (Indre) in 1753, was private surgeon to the duke of Orleans. He was a chemist as well as a surgeon, and the prospect of the Academy prize attracted his attention to the soda problem. He added to the sulphate and charcoal mixture proposed by De la Méthérie a certain proportion of chalk, and by fluxing the mixture in crucibles succeeded in effecting the desired transformation. The chemist D'Arcet and his assistant Dizé, having recognized the soundness of the process, the duke of Orleans, early in 1790, agreed to provide a capital of 200,000 francs for working the process. In September 1791 the National Assembly granted Le Blanc a patent for fifteen years, and under the superintendence of Le Blanc himself, with Dizé and Henri Shée, the steward of the duke of Orleans, a work was established at Saint Denis. But on the fall and execution of his patron Le Blanc, and all others owning and working soda processes, were ordered to resign them to the state for the public benefit, he receiving the miserable compensation of 4000 francs. In 1800 his works were reconveyed to him, but in 1806, broken in hope, health, spirit, and resource, he perished by his own hand in a workhouse.

Le Blanc's process continued to hold the field against all competing schemes till within the last few years, and that essentially in

¹ It is well established, however, that carbonate of soda can be produced in this manner. It was Liebig, we believe, who showed that the first step in the Le Blanc process is approximately thus— $2\text{Na}_2\text{SO}_4 + 6\text{C} = \text{Na}_2\text{S}_2 + \text{Na}_2\text{CO}_3 + 5\text{CO}$, only the disulphide and the carbonate on continued heating act on each other and on the carbon to form $\text{Na}_2\text{S} - \text{Na}_2\text{S}_2 + \text{Na}_2\text{CO}_3 + 2\text{C} = 2\text{Na}_2\text{S} + 3\text{CO}$.

its original form. Owing to the raw materials employed in it and the products evolved, it became the basis of a series of important industries, and many interesting collateral processes have been grafted on the manufacture. Its origin was contemporaneous with the introduction of bleaching-powder (see CHLORINE, vol. v. p. 678), and the hydrochloric acid given off in the conversion of chloride into sulphate of soda became the raw material of that industry, the two processes being worked in conjunction. Since the days of Le Blanc many other methods for more directly manufacturing artificial soda have been proposed; but only one—the so-called "ammonia process"—has seriously threatened to supplant it.

Le Blanc's Process.—This consists of two stages. In the first stage common salt is converted into sulphate of soda by the action of sulphuric acid. At first acid sulphate of soda is produced thus— $2\text{NaCl} + \text{H}_2\text{SO}_4 = \text{HCl} + \text{NaHSO}_4 + \text{NaCl}$; but subsequently at a sufficient temperature the acid sulphate decomposes the remainder of the salt thus— $\text{NaHSO}_4 + \text{NaCl} = \text{Na}_2\text{SO}_4 + \text{HCl}$, so that all the chlorine is expelled as hydrochloric acid with formation of normal sulphate of soda. In the second stage the sulphate mixed with limestone and coal (charcoal in Le Blanc's original proposal) is calcined in a reducing flame, whereby a mixture of sulphide of calcium (CaS) and carbonate of soda is formed, oxygen being generally supposed to pass off as carbonic oxide, CO. According to Lunge, however, the gas produced consists chiefly of carbonic acid, so that the reaction should correspond essentially to the equation $\text{Na}_2\text{SO}_4 + 2\text{C} + \text{CaCO}_3 = \text{Na}_2\text{CO}_3 + \text{CaS} + 2\text{CO}_2$. The sulphide of calcium being practically insoluble in water and only very slowly acted on by a solution of carbonate of soda at temperatures under 45°C , the carbonate is extracted by systematic lixiviation with water at a temperature under that limit and is recovered from the solution by evaporation. If an excess of lime is used, more or less of the soda assumes the caustic form (NaHO). All crude soda-ash lyes contain some caustic alkali besides the following impurities—chloride of sodium, sulphate of soda, sulphide of sodium combined with sulphide of iron into a soluble green compound which occasions much trouble to the manufacturer. This solution contains also occasionally cyanide or ferrocyanide of sodium, produced by the action of cyanide on the soluble form of sulphide of iron.

Salt Cake Making.—The conversion of the salt into sulphate, called "salt cake," is effected by means of sulphuric acid of about 60 per cent. (chamber acid), and may be, and still very commonly is, carried out in reverberatory furnaces having flat soles of cast iron, attached to one end of which is a pan of the same material. The waste heat from the reverberatory furnace is utilized to heat the charge placed in the pan, where the first part of the change is effected, the reaction beginning briskly with evolution of copious fumes of hydrochloric acid immediately the acid and salt are mixed. Before the Alkali Act of 1863 hydrochloric acid was freely allowed to escape through the stalk with the smoke and fire gases, carrying destruction to the vegetation of vast tracts around the works; but now all the acid is everywhere carefully collected, both because it is a source of profit and from sanitary considerations. Hence in modern "open roasters," as these reverberatory furnaces are called, the pan and the calcining sole are separated, so that the comparatively pure and undiluted fumes from the pan can be led away and collected by themselves, leaving the mixed air, fire gases, and acid fumes from the furnace hearth to be separately dealt with. In another class of furnace, called a "blind roaster," the calcination of the half-finished sulphate is carried out in a muffle, so that none of the hydrochloric acid is mixed with air and fire gases. Certain advantages attend each class of furnace. In working these hand-furnaces there is much unpleasant manual labour, to avoid which mechanical furnaces have been devised, in which the stirring of the charge, &c., is accomplished by machinery. The first mechanical roaster actually used was patented by Jones & Walsh in 1875. In it the whole operation from beginning to end is carried out on the sole of a large cast-iron pan heated from above. Through the roof of the chamber enclosing the pan passes a vertical shaft geared to rotate, to which are attached four horizontal arms, and to these slanting rods are fixed which terminate in scrapers. These scrapers are fixed at different lengths from the shaft centre, so that when the shaft is in motion they pass through and turn over the whole of the charge strown over the sole of the pan. The acid is passed into the pan by a pipe from a tank situated above the roaster. The hot mixture of fire gases and acid fumes is led through a long pipe to cool down before reaching the condensers.

Hargreaves's Process for making sulphate without the direct use of sulphuric acid is based on the employment of sulphurous acid obtained by the ignition of pyrites aided by air and steam. In this way Mr Hargreaves may be said to get his sulphuric acid *ex tempore*. The process has only been elaborated as the result of a most extensive series of investigations and experiments carried out in conjunction with Mr Robinson, their first patent having been obtained in January 1870. The reaction on which the process depends may be thus formulated— $2\text{NaCl} + \text{SO}_2 + \text{H}_2\text{O} + \text{O} = \text{Na}_2\text{SO}_4 + 2\text{HCl}$. The salt used is rendered porous by first moistening it with water and then redrying it by passing it through a hot-air chamber

on an endless chain of plates. The salt so prepared is distributed in a range of not less than eight cast-iron cylinders, which are pervaded successively by a current of mixed superheated steam and sulphurous acid given off by pyrites. The reaction begins at about 400°C . and increases in energy with the rise of temperature, but it is impracticable to force the heat beyond 500° to 550° , as the charge then begins to fuse and ceases to be permeable by gases.

The condensation of the hydrochloric acid given off in these processes is effected by a variety of means according to the purpose in view in securing the gas. In Continental works a favourite method is to pass the gas through a range of Woulfe's bottles arranged in an ascending series,—fresh water entering the topmost and passing through the whole, till in the last and lowest, highly charged with acid, it meets the gas coming direct from the roaster. After leaving the last and highest bottle the gas is generally washed thoroughly out by passing it into a small coke tower, in which it meets a downward trickle of water. In English works Woulfe's bottles are not employed, and the gases are commonly conducted by a long range of piping, in which they are cooled, to one or a series of coke towers, in which they are exposed to an enormously extended condensing surface of water trickling over the coke, stones, or brick with which the interiors of the towers are filled.

Black Ash Making.—The conversion of the crude sulphate or salt cake into carbonate of soda, peculiarly the process of Le Blanc, is conducted in what is termed a "balling furnace." In its simplest form this consists of a long reverberatory furnace in which the fuel occupies a lower grating at one extremity of the flat sole, on which the whole reaction is carried out. This sole has usually two beds, that more distant from the fire-bridge being a little higher than the front division; and on front and back beds two separate charges at different stages of advancement are treated simultaneously. The salt-cake is taken as it comes from the roaster, mixed with limestone or chalk (crushed to pieces not bigger than a walnut) and with coal or anthracite in the form of slack or culm. The proportions of these ingredients used in different works vary widely; but, generally stated, to each 100 parts of sulphate there are added from 100 to 140 parts of chalk or limestone and from 40 to 70 of coal. These ingredients roughly mixed are passed by a hopper into the back bed of the furnace, where they become dried and heated, while a previous charge is being finished on the hot front or working bed. When the charge on the working bed has been withdrawn, the mixture on the back bed is pushed forward and spread over the highly heated sole. During the time it is exposed to the flames the ball-furnaceman is constantly at work with a paddle or rake turning over and exposing equally the whole charge to the action of the flame. Very soon the mixture begins to soften and fuse on the surface, and by degrees the whole mass assumes a stiff pasty form. Meantime bubbles of carbonic acid gas are copiously given off, the material becoming of thinner consistence; but afterwards the charge becomes again stiff, and carbonic oxide instead of carbonic acid is evolved, which as it is given off burns in long pointed flames, called "pipes" or "candles." The copious appearance of these flames indicates the completion of the operation, and the ball of black ash must now be withdrawn without delay. The time required for working off a charge is from forty to fifty minutes.

The manual labour of black ash balling is extremely hard and trying, while it demands for its success considerable judgment and experience. On these accounts the efforts of manufacturers were early directed to the introduction of mechanical furnaces; and in 1848 W. W. Pattinson patented a rotating ball-furnace, which, however, owing to severe wear and tear, was unsuccessful. Improvements on the revolving furnace were effected by Elliot & Russell, Stevenson & Williamson, Mactear, and others, which have rendered the working of revolvers a complete success. In its general features a revolver consists of a large boiler-like cylinder of cast iron, lined internally with fire-bricks, and suspended horizontally so that it can be made to rotate about its axis. One of the two open ends communicates with a furnace, which sends its flame through the cylinder. From the other end the hot gases are led away for evaporating black-ash liquor. The cylinder is surmounted by a platform or railway from which it receives the charge through a manhole in its side. The charge is made in two separate instalments,—the whole of the chalk and two-thirds of the coal being first introduced, and the cylinder slowly rotated till a portion of the chalk has been burned to lime. Then the sulphate and the remainder of the coal, well mixed, are added, the revolver going slowly at first, but more rapidly as the end approaches, the whole balling being completed in from two to two and a half hours. The manhole door being opened, the revolver is turned round to allow the fluid black ash to pour out by it into a series of vessels placed beneath it. Under Mactear's improved process the whole of the charge is introduced into the revolver at first, and after the decomposition is complete a small proportion of caustic lime is thrown in and quickly mixed with the charge, which is thereon at once drawn.

The lixiviation of the black ash is conducted in a systematic manner so as to extract all the soda with the minimum of water. The apparatus generally employed—the Buff-Dunlop system—

consists of a series of at least four tanks each provided with a false bottom and two outlet pipes, and so arranged that the liquid part of the contents can be made to flow from any one of the tanks into any other. The method of working consists in making fresh water meet nearly exhausted ash, and the liquid, passing on through the series of tanks and becoming gradually stronger, meets ash less and less exhausted, till in the last tank of the series the watery solution in its most concentrated state comes in contact with fresh black ash. As soon as the ash in the first tank is completely exhausted the waste residue is withdrawn and a fresh charge introduced. It then becomes the last of the series, number two taking the first place; and so the work goes on in regular rotation. The lye obtained is allowed to clear in large tanks, from which it is drawn for evaporation.

Boiling Down.—The evaporation of the tank-liquor is generally effected in flat iron pans, heated from the top by the waste heat of the black-ash furnaces. So soon as a certain degree of concentration is passed, soda begins to separate out in the form of granular crystals. These are ladled out and allowed to drain for subsequent calcination and conversion into soda ash. The purity of the granular salt decreases as the evaporation proceeds, chloride and sulphate of sodium, with the sulphides of iron and sodium, separating out with the carbonate. The red liquor which remains with the salt owes its colour to the iron sulphide it contains. It is intensely caustic, containing much caustic soda. In draining from the soda it carries off with it much of the sulphide and minor impurities from the tanks. The impure soda obtained from the evaporating pans is known as black salt and consists essentially of a monohydrate, $\text{Na}_2\text{CO}_3 + \text{H}_2\text{O}$. A process for evaporation from the bottom is also worked in Lancashire and on the Continent.

Carbonating.—Salts that are fished out of the evaporating pan in the early stage of boiling down, being comparatively pure, require little treatment for finishing as soda ash. They have simply to be dried at a moderate heat to expel the water of crystallization. But with the ordinary black salt, which contains a considerable amount of both caustic soda and sodium sulphide, a special purifying and finishing treatment, called "carbonating," has to be adopted. For carbonating black salt the strong lye in the evaporating tanks is mixed with sawdust and evaporated down to dryness. The mixture is then introduced into a carbonating furnace, where the heat is gradually raised till the whole of the sawdust it contains is burnt off, and by the agency of the carbonic acid given off in its combustion the sulphide of sodium and the caustic soda present are converted into carbonate. Mechanical carbonating furnaces have been introduced, the most successful of which is that of Mactear, in which there is a rotating circular hearth acted on by scrapers or ploughs. Ordinary soda ash is at best an impure product containing always some caustic soda, which, however, considering the purposes for which it is used, can scarcely be regarded as an impurity or defect. Its value is determined by analysis and is calculated from the amount of anhydrous soda (Na_2O) it contains as carbonate or hydrate.

In many soda-works the black-ash process is purposely so conducted as to produce much caustic soda, and the red liquor is then worked up into caustic soda in the following manner. It is first highly concentrated by boiling in a deep iron pan. To the concentrated solution nitrate of soda is added, which decomposes the sulphide present with evolution of ammonia and formation of sulphate, thus $\text{Na}_2\text{S} + \text{NaNO}_3 + 2\text{H}_2\text{O} = \text{Na}_2\text{SO}_4 + \text{NH}_3 + \text{NaHO}$. The evaporation is continued till practically all the water is expelled, and the heat is forced till fusion sets in. Then the remaining sulphide of sodium with the cyanide is oxidized by the nitrate, which breaks up thus— $2\text{NaNO}_3 = \text{Na}_2\text{O} + 2\text{N} + 5\text{O}$, with formation of sulphate of soda and oxide of iron. Part of the carbon of the cyanogen separates as graphite (Pauli). The fused mass is allowed to stand, when the suspended matter, including, singularly, most of the alumina, settles down, leaving a perfectly clear liquid, which is run into iron drums, where it solidifies. By means of this process, which has been principally elaborated by Herr Ph. Pauli of Höchst near Wiesbaden, a remarkably pure product can be obtained from a very dirty liquor.

Refined Alkali.—Ordinary soda ash is sufficiently pure for most purposes for which the alkali is required in bulk; but for glass making, &c., it is necessary to remove all traces of iron. For this purpose the ash is dissolved in water, and if a well-carbonated ash is under treatment it is merely well agitated and allowed to stand quietly till impurities settle. By some manufacturers a small amount of carbonate of lime is added to the settling tank to carry down the impurities. Ash containing iron salts, sulphide, and coloured impurities is treated with a small proportion of chloride of lime to oxidize the iron and cause its precipitation as hydrated ferric oxide. The settled liquor is boiled down, the crystals drained, dried, and heated in a reverberatory furnace, and finally ground for the market.

Soda Crystals (washing soda) are similarly prepared, by forming a strong solution of soda ash, allowing the liquor to settle, and running it into large coolers or crystallizing cones, in which the crystals form in from one to two weeks, according to the coolness of the position. When the crystallization is complete the crust is

broken, the mother-liquor, still holding a large amount of soda, is run off for future use, and the crystals are broken up, drained, and dried for packing and use. Soda crystals contain 63 per cent. of water, and their principal employment is for domestic washing, for which their comparative non-causticity well fits them.

Sulphur Recovery.—Of the several raw materials of the Le Blanc process, sulphur, now always used in the form of pyrites, is by far the most expensive. The sulphuric acid employed passes out in valueless combination as crude sulphide of calcium, and accumulates in huge mounds. Under the influence of rain sulphide of calcium in these heaps gradually assumes the forms of sulphide of hydrogen and hydrated oxide of calcium, $\text{CaS} + 2\text{H}_2\text{O} = \text{CaOH}_2 + \text{H}_2\text{S}$. The hydrogen sulphide combines in its turn with another quantity of sulphide of calcium into CaS_2H_2 , which being soluble in water runs off as yellow liquor to contaminate streams and give off sulphuretted hydrogen gas with its disgusting smell. By the action of atmospheric oxygen part of the CaS_2H_2 loses its hydrogen as water, and the remaining CaS_2 passes into thiosulphate of calcium, CaS_2O_3 , with simultaneous formation of polysulphides. Upon this latter tendency Mond founded his original method for recovering sulphur. He hastened the oxidation by blowing air through the moist waste till a certain proportion of the sulphide was converted into thiosulphate, and the residue into sulphhydrate CaH_2S_2 , or polysulphide. The mass is lixiviated with water, the liquor decanted off, and mixed with excess of hydrochloric acid, which produces H_2S , and in general sulphur, from the sulphhydrate and sulphides of calcium, with SO_2 and sulphur from the thiosulphate. But $2\text{H}_2\text{S} + \text{SO}_2$ decompose each other into $3\text{S} + 2\text{H}_2\text{O}$. Hence it is obvious that, if the process of oxidation is stopped at the right point, the whole of the sulphur will be recovered as such. The precipitated sulphur is mixed with water placed in a closed cylinder and fused by raising the temperature of water round it in an outer casing above the melting point of sulphur. The sulphur then runs together in the lower part of the cylinder, whence it is drawn off by a pipe and cast into rolls. The Mond process, of all the many sulphur-recovery processes yet introduced, is the best; but even it no more than pays working expenses, and enables the manufacturer to end his process with an innocuous chloride of calcium (CaCl_2) without actual loss of money.

About 1880 considerable excitement was caused by a sulphur-recovery process patented by Schaffner and Helbig in 1878, which was expected to revolutionize the soda trade. As these hopes have not been realized, we merely state the principle of the process. The soda waste is digested with a solution of chloride of magnesium, which in the first instance leads to the formation of CaCl_2 and MgS . But the latter is at once decomposed, with formation of magnesia and sulphuretted hydrogen, $\text{MgS} + 2\text{H}_2\text{O} = \text{MgOH}_2 + \text{H}_2\text{S}$. The sulphuretted hydrogen is caused to act on sulphurous acid within a solution of chloride of calcium, when the sulphur settles in a filtrable form. The liquor remaining after the expulsion of H_2S from the mixture of waste and chloride of magnesium consists of a precipitate of magnesia and a solution of chloride of calcium. By blowing carbonic acid into the mixture the following decomposition is effected— $\text{MgO} + \text{CO}_2 + \text{CaCl}_2 = \text{CaCO}_3 + \text{MgCl}_2$ —so that the magnesia is recovered in its original form and the calcium of the waste obtained as carbonate, which may again be returned to the black ash roaster. This very pretty and complete process might probably have been worked out as a practical success had the conviction not arisen that even with profitable sulphur recovery the Le Blanc process will not long be able to hold its own against the ammonia process.

Ammonia Soda Process.—This process is based on the fact that bicarbonate of ammonia, when added to a strong solution of common salt, decomposes the salt with formation of a precipitate of bicarbonate of soda and a solution of ammonium chloride (sal-ammoniac), thus $\text{NaCl} + (\text{NH}_4)\text{HCO}_3 = \text{NH}_4\text{Cl} + \text{NaHCO}_3$. The ammonia is recoverable from the sal-ammoniac by distillation with lime, and, supposing no waste to occur, is usable *ad infinitum*. From bicarbonate the normal salt is easily prepared by the application of heat— $2\text{NaHCO}_3 = \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$. Thus by theory one-half of the carbonic acid is recovered, and, supposing the quicklime for the decomposition of the sal-ammoniac to be made by heating limestone, the loss of carbonic acid is made up incidentally from that source. The only waste product which remains for disposal is the entirely innocuous chloride of calcium made in recovering ammonia by means of lime from sal-ammoniac. The ammonia process was first emanated and patented in England by Dyar & Hemming in 1833; and works on the system were established in Cheshire and some localities on the Continent, where it attracted great attention. Numerous patents, both English and Continental, followed, and many experimental works were erected, which all failed to sustain themselves in competition with the Le Blanc works. The principal difficulties to be overcome were imperfect conversion of the salt, and more especially the loss of ammonia; and it was not till 1861 that real economical success in the ammonia recovery apparatus was attained by Ernest Solvay of Couillet near Charleroi, Belgium. Works on the Solvay principle were established at Couillet in 1863; and since that date by the inventor and others, among whom ought to be men-

tioned Ludwig Mond, the process has been so perfected that its general adoption now appears to be only a matter of time. Already on the Continent it has practically displaced the Le Blanc process, but in the United Kingdom there is as yet only one establishment manufacturing ammonia soda.

The first essential stage in Solvay's process consists in saturating the brine with ammonia. The brine, treated with milk of lime and ammonium carbonate to precipitate magnesium and calcium salts, and of proper density, is placed in two cylindrical close iron tanks, which communicate by pipes at top and bottom with the ammonia dissolver placed between them. The ammonia dissolver is a cylindrical vessel having the same height as the tanks and provided with a perforated false bottom, down to which a tube is led through the centre of the vessel, and by this tube the ammonia gas is introduced. Coiled within the cylinder is a worm pipe, through which cold water circulates. Each brine tank is put alternately in connexion with the dissolver. Circulation from the brine tank into the dissolver is kept up by mechanical agitation. As the ammonia becomes absorbed by the brine the temperature of the liquid rises rapidly, and the cold water circulating within the coiled pipe keeps the temperature down. As soon as sufficient ammonia has been passed into the brine the stirrers in the brine tank are stopped; the sludge of lime and magnesia precipitate is drawn off as it settles at the bottom of the brine tank, or when such precipitate is abundant it is settled and withdrawn in a special decanting tank. The decanted liquor is filtered through fine cloth by pressure, and the filtrate is cooled down in a refrigerating apparatus previous to the next operation.

Treating the Ammoniacal Brine with Carbonic Acid.—For this purpose a cylindrical tower is employed, divided internally into a series of superimposed segments by diaphragms consisting of perforated dome-shaped plates. The tower is about 40 to 50 feet in height and is kept nearly full of liquid, which is introduced by a pipe half way up its side. Carbonic acid under a pressure 1.5 to 2 atmospheres is forced in at the bottom of the tower and works its way gradually upwards through the perforations in the diaphragms, thus coming into intimate contact with the ammoniacal brine. Every half hour a part of the pasty mixture of bicarbonate of soda and ammonium chloride solution is drawn off and replaced by fresh liquor. The solid bicarbonate is separated out either by centrifugal action or by a vacuum filter; as thus obtained it is still contaminated with ammonia, of which it smells. To free the bicarbonate from this impurity water is soured over it till the smell almost entirely disappears.

Conversion into Soda Ash of the bicarbonate is essential, because there is a comparatively limited demand for bicarbonate, and that salt, moreover, obstinately retains an ammoniacal odour, which lessens its value. The preparation of soda ash is attended with considerable practical difficulties, owing to the necessity of retaining the contained ammonia. The bicarbonate is first exposed to a comparatively low heat in a closed roaster, after which it is finished in a muffle furnace at a bright red heat. The gases given off are drawn by an air-pump into a washing apparatus, where the ammonia is retained, and the carbonic acid, which passes on, is conducted to the absorption tower for again impregnating the ammoniacal brine. By this process the whole of the chlorine of common salt comes away as waste in the form of chloride of calcium. To obtain that body in combination as hydrochloric acid, Solvay proposed in his patent of 1872 to employ magnesia in place of lime in the decomposition of the sal-ammoniac; the solution of chloride of magnesium remaining after the distillation is boiled to dryness, and being by the action of steam separated into magnesia and hydrochloric acid, $\text{MgCl}_2 + \text{H}_2\text{O} = \text{MgO} + 2\text{HCl}$. The magnesia theoretically works in a circle, being changed into chloride on the liberation of the ammonia from the sal-ammoniac, and recovered again as magnesia with the formation of hydrochloric acid, as above indicated. But the expense of the process has hitherto been greater than the value of the product obtained, and the one weak point of the Solvay process is the loss of the hydrochloric acid, which forms an important element in the Le Blanc cycle. The loss of ammonia calculated as sulphate in the early days of the Solvay process was as much as 9 per cent. on the carbonate of soda produced; but by successive improvements it has been reduced to not more than 5 per cent. The Solvay plant is very expensive, amounting, according to his own estimate, to £1600 per ton of soda ash produced daily; but other authorities put the capital expenditure as high as £2400 per ton worked daily.

Cryolite Soda.—Of the many processes other than those above mentioned, which have been proposed for soda-making, the only one practically employed is that in which cryolite forms the raw material. Cryolite, a fluoride of aluminium and sodium, $\text{AlF}_3 + 3\text{NaF}$, is a mineral substance found in extensive deposits at Ivik (Ivigut) ($61^\circ 34' \text{N}$, lat.) in south-west Greenland. For soda-making the mineral is treated by a process discovered in 1850 by Professor Julius Thomsen of Copenhagen. It is ignited with chalk or limestone, whereby carbonic acid is driven off and fluoride of calcium and aluminates of soda are formed— $2(\text{AlF}_3 + 3\text{NaF}) + 6\text{CaCO}_3 = 6\text{CaF}_2 + 3\text{Na}_2\text{O} + \text{Al}_2\text{O}_3 + 6\text{CO}_2$. The aluminates of soda is

separated from the artificial fluoride of calcium by lixiviation, and the solution so obtained is decomposed by treatment with carbonic acid, which produces a precipitate of alumina available for alum-making, &c., leaving a solution of carbonate of soda. About 8000 tons of cryolite are annually treated in Pennsylvania and in Denmark.

Statistics of Soda Trade.—No means exist for obtaining an accurate statement of the extent of the soda trade; and such estimates as are published can only be accepted as approximations based on knowledge of the productive capacity of existing works and the general course of trade. Speaking at the Society of Chemical Industry (London section) in January 1883, the late Walter Weldon gave the following estimate (in tons) of the soda production of the world at that date:—

	Le Blanc Soda.	Ammonia Soda.	Total.
Great Britain	880,000	52,000	432,000
France	70,000	57,125	127,125
Germany	55,500	44,000	100,500
Austria	39,000	1,000	40,000
Belgium	8,000	8,000
United States	1,100	1,100
	545,500	163,225	708,725

In these figures the whole of the products made—soda ash crystals, bicarbonate, caustic soda, &c.—are calculated in terms of pure carbonate, NaCO_3 . Assuming the fairness of the calculation, we are warranted in stating the present (1887) production of alkali, as pure carbonate, to be not less than three quarters of a million of tons annually. (W. D.—J. P.A.)

SODOM and GOMORRAH. See DEAD SEA, vol. vii. pp. 1-3; comp. PHENICIA, vol. xviii. p. 803, and LOT.

SODOMA, IL, or, more properly, **SODONA** (c. 1479-1549), Italian painter. GIANNANTONIO BAZZI (who until recent years was erroneously named RAZZI) appears to have borne also the name of "Sodona" as a family name; it is signed upon some of his pictures. While "Bazzi" was corrupted into "Razzi," "Sodona" was corrupted into "Sodoma"; and Vasari, followed by other writers on art, accounts for the latter name by giving various and explicit details which we leave undiscussed, for, if the painter did not really pass by the appellation of "Sodoma," we may fairly infer that explanations which would have been germane to that appellation are not germane to the man himself. Bazzi was born at Vercelli in Piedmont towards 1479, and appears to have been in his native place a scholar of the painter Giovenone. Acquiring thus the strong colouring and other distinctive marks of the Lombard school, he was brought to Siena towards the close of the 15th century by some agents of the Spannocchi family; and, as the bulk of his professional life was passed in this Tuscan city, he counts as a member of the Siennese school, although not strictly affined to it in point of style. He does not seem to have been a steady or laborious student in Siena, apart from some attention which he bestowed upon the sculptures of Jacopo della Quercia. Along with Pinturicchio, he was one of the first to establish there the matured style of the Cinquecento. His earliest works of repute are seventeen frescos in the Benedictine monastery of Monte Oliveto, on the road from Siena to Rome, illustrating the life of St Benedict, in continuation of the series which Luca Signorelli had begun in 1498; Bazzi completed the set in 1502. Hence he was invited to Rome by the celebrated Siennese merchant Agostino Chigi, and was employed by Pope Julius II. in the Camera della Segnatura in the Vatican. He executed two great compositions and various ornaments and grotesques. The latter are still extant; but the larger works did not satisfy the pope, who engaged Raphael to substitute his Justice, Poetry, and Theology. In the Chigi palace (now Farnesina) Sodona painted some subjects from the life of Alexander the Great; Alexander in the Tent of Darius and the Nuptials of the Conqueror with Roxana are more particularly noticed. When Leo X. was made pope (1513) Bazzi presented him with a picture of the Death of Lucretia (or of Cleopatra, according to some accounts); Leo gave him

a large sum of money in recompense and created him a cavaliere. Bazzi afterwards returned to Siena, and at a later date went in quest of work to Pisa, Volterra, and Lucca. From Lucca he returned to Siena, not long before his death, which took place on 14th February 1549 (the older narratives say 1554). He had squandered his property and died in penury in the great hospital of Siena. Bazzi had married in youth a lady of good position, but the spouses disagreed and separated pretty soon afterwards. A daughter of theirs married Barbolommeo Neroni, named also Riccio Sanese or Maestro Riccio, one of Bazzi's principal pupils.

It is said that Bazzi jeered at the *History of the Painters* written by Vasari, and that Vasari consequently traduced him; certainly he gives a bad account of Bazzi's morals and demeanour, and is niggardly towards the merits of his art. According to Vasari, the ordinary name by which Sodona was known was "Il Mattaccio" (the Madcap, the Maniac),—this epithet being first bestowed upon him by the monks of Monte Oliveto. He dressed gaudily, like a mountebank; his house was a perfect Noah's ark, owing to the strange miscellany of animals which he kept there. He was a cracker of jokes and fond of music, and sang some poems composed by himself on indecorous subjects. In his art Vasari alleges that Bazzi was always negligent,—his early success in Siena, where he painted many portraits, being partly due to want of competition. As he advanced in age he became too lazy to make any cartoons for his frescos, but daubed them straight off upon the wall. Vasari admits, nevertheless, that Bazzi produced at intervals some works of very fine quality, and during his lifetime his reputation stood high.

The general verdict is that Sodona was an able master in expression, motion, and colour. His taste was something like that of Da Vinci, especially in the figures of women, which have grace, sweetness, and uncommon earnestness. He is not eminent for drawing, grouping, or general elegance of form. His easel pictures are rare. His most celebrated works are in Siena. In S. Domenico, in the chapel of St Catherine of Siena, are two frescos painted in 1526, showing Catherine in ecstasy and fainting as she is about to receive the Eucharist from an angel,—a beautiful and pathetic treatment. In the oratory of S. Bernardino, scenes from the history of the Madonna, painted by Bazzi in conjunction with Pacchia and Beccafumi (1536 to 1538)—the Visitation and the Assumption—are noticeable. In S. Francesco are the Deposition from the Cross (1513) and Christ Scourged; by many critics one or other of these paintings is regarded as Bazzi's masterpiece. In the choir of the cathedral at Pisa is the Sacrifice of Abraham, and in the gallery of Florence a St Sebastian.

SOEST, an ancient industrial town in Westphalia, Prussia, is situated in a fertile plain (*Soester Börde*), 27 miles to the east of Dortmund and 34 to the south-east of Münster. Its early importance is borne witness to by its six fine churches, of which the most striking are St Peter's, St Mary-in-the-Fields, founded in 1314 and restored in 1850-52, and the Roman Catholic cathedral, founded in the 10th century by Bruno, brother of Otho the Great, though the present building was erected in the 12th century. This last, with its very original façade, is one of the noblest ecclesiastical monuments of Germany. Remains of the broad wall (now partly enclosing gardens and fields) and one of the gates still remain; but the thirty-six strong towers which once defended the town have disappeared and the moats have been converted into promenades. Iron-working, the manufacture of soap, hats, cigars, and bricks and tiles, linen-weaving, tanning, and brewing, together with market-gardening and farming in the neighbourhood, and trade in cattle and grain, are the leading industries. The population in 1880 was 13,985, and in 1885 14,848, of whom about 6000 were Roman Catholics.

Mentioned in documents as early as the 9th century, Soest was one of the largest and most important Hanseatic towns in the Middle Ages, with a population estimated at from 30,000 to 60,000. It was one of the chief emporiums on the early trading route between Westphalia and Lower Saxony. Its code of municipal laws (*Schran; jus susatense*), dating from 1144 to 1165, was one of the earliest and best, and served as a model even to Lübeck. On the fall of Henry the Lion, duke of Saxony, Soest passed with the rest of Angria to Cologne. In the 15th century the strife between the townsmen and the archbishops broke out in open war, and in 1444