in one lump, and in this form they lie for several hours, until the clay has attained, by partial drying, the proper hardness for successful moulding. Then they pass to the moulder.

Each moulder sits at a low bench, with the simplest possible form of a lever press before him, merely an arm from which an iron "stopper" depends. He also has an iron mould, in two parts, hinged together. The interior of this mould is covered with whatever emblems or letters it is intended that the pipe shall bear in relief upon its surface. Taking up a tip of clay and touching it lightly with oil to prevent its sticking, he lays it in one half of the mould and runs through it a long steel needle, which makes the stem. Then he closes the mould, pushes it into the little press, and brings down upon it the "stopper" that forms the bowl of the pipe. As he pulls the mould out again a sharp swinging knife automatically pares off smoothly the excess of clay squeezed out at the top of the bowl.

All this is done very rapidly. The roller can turn out 334 tips in an hour, and the moulder, who makes \$16 a week, must, if he works ten hours a day for six days, mould 256 pipes an hour, or a little over $4\frac{1}{4}$ a minute, for his wages are only twenty cents a gross. It must be understood that the moulder's dozen is 16, not 12, and his gross 192 instead of 144. That is the liberal allowance made for breakage, loss in baking, and other reductions from the full tale of finished pipes.

After standing on trays in freely circulating air ten or twelve hours, to give them still more hardness, the pipes next pass to the trimmers, girls who take off the mould seam and polish the stem of each pipe with a bit of wood, for which they get five cents a gross, and at this price make from one-third to one-half as much as the moulders. Another period of waiting must now pass, varying in duration from one to four days, according to the weather, and when the pipes are finally dry enough for baking they are filled into seggars—great rough stone crocks—and so stacked up, 300 gross or more at a time, in a kiln, where they are gradually raised to a white heat and kept at it until their baking is completed, say in about twelve hours. There is then nothing more to be done with them, after they cool sufficiently to be handled, excepting to pack them in boxes and send them to market, if they are the ordinary "T D" pipes, or any variation upon that pattern. Unless, perhaps, it may be deemed desirable to give them an extra fancy touch by dipping the ends of their stems in a mixture of saffron tea and milk to make them smooth and color them temporarily a pretty yellow just where the smoker's lips will touch the stem—provided he does not begin by breaking that yellow part off, as most clay pipe smokers do.

Sometimes clay pipes are intended to color like meerschauts. To achieve that they are soft baked, and then covered with a coating of white shellac varnish, which colors brown when the pipe is smoked. There are infinite varieties of clay pipe designs, and the success of manufacturers, particularly in this country, depends in a great degree upon their taste and originality in bringing out new patterns. One factory in Glasgow, Scotland, which is reputed the largest in the world, is credited with having brought out no less than 600 different designs; and another, in Baltimore, Md., is said to have 130 separate styles. The fancy styles are produced at a little more cost in wages to the manufacturer than the plain "T D" pipes, which are the acme of cheapness and plainness. The manufacturer sells a 3-gross box of completed pipes at from \$1 to \$1.20. His gross does not consist of 192, as the moulder's does, but of the orthodox 144. Of course, a great deal of breakage must be expected among such fragile articles, but there can never be so much that a very liberal profit is not left to the retailer.

THE WORLD'S PRODUCTION OF PRECIOUS METALS.—THE WORK OF THE MINT.

THE report of the Director of the Mint for the year ended June 30, 1882, gives the total gold coinage for the year as 11,266,003 pieces of the value of \$89,413,447.50, being nearly \$11,000,000 more than on any previous year. About one-half of the coinage was in eagles, one-third in half-eagles, and the remainder in double-eagles. The silver coinage consisted of \$27,772,075 in silver dollars and \$11,313.75 in fractional coin, a total of \$27,783,388.75.

Of the minor or base-metal coins 46,865,725 pieces, of the value of \$644,757.75, were struck. The demand for five-cent nickel pieces was large, and 4,400,775 pieces, of a value of \$220,038.75, were struck during the year. The remainder of the minor coinage consisted principally of one-cent pieces.

Gold bars of the value of \$37,505,120.04 were manufactured, \$12,147,674.90 of which were of fine gold for depositors at the New York Assay Office. Fine silver bars of the value of \$7,769,898.15 were also made, chiefly at the same institution.

The production of gold for the fiscal year is estimated at \$31,500,000, and of silver \$44,700,000, a decline of \$5,000,000 in gold and an increase of \$2,600,000 in silver upon the estimated production for the previous fiscal year.

The consumption of the precious metals in the United States for use in the arts during the year is estimated at \$12,000,000 of gold and \$7,000,000 of silver, of which \$7,000,000 of gold and \$6,000,000 of silver were of domestic production. There was issued from the New York Assay Office for the use of manufacturers \$1,500,000 more of gold, and \$800,000 more of silver bars than in the preceding year.

The total coin of the country is estimated to have been at the beginning of the year, \$439,776,753 gold, and \$171,459,766 silver, a total of \$611,236,519, and at the close of the year \$500,776,753 gold, and \$199,459,766 silver, total \$700,236,519, a gain of \$61,000,000 in gold coin, and \$28,000,000 in silver. The gains from coinage, less recoinage, were \$88,814,091 in gold, and \$27,651,816 in silver, and by the imports of United States silver coin \$517,778, but the export of United States gold coin was \$25,008,619 greater than its import, and including \$2,700,000 used in the arts, reduced the gain in gold coinage to about \$61,000,000. Of the total metallic circulation \$148,000,000 belonged to the Treasury, \$112,000,000 to the National Banks, and \$141,000,000 was in general circulation.

In twenty of the chief mining countries of the world the production was, of gold \$107,773,157, and of silver, \$97,659,460, which was an increase of \$1,500,000 of gold and \$3,000,000 of silver over the production of 1880. The coinage executed at the mints of the fifteen principal countries of the world during the year 1881 was, of gold \$136,337,333, and of silver, \$100,705,824, a total of \$237,043,157, an increase of about \$5,000,000 over the coinage of 1880.

The circulation of thirty-four countries, embracing nearly all of the civilized portion of the earth, is given as, paper \$3,825,220,078, gold \$3,353,673,748, and silver \$2,620,769,835, a total specie circulation of \$5,974,443,583, and of paper and specie \$9,799,663,661.

CORUNDUM—ITS VARIETIES AND USES.

OF this important and interesting mineral there are three sub-species: *telesia*, *adamantine spar*, and *emery*.

Telesia exhibits a great variety of colors. It is pearl gray, bluish white, lavender blue, sky blue, azure or indigo blue, and then is the sapphire of jewelers; or it is peach, crimson, cochineal, and very rarely carmine red, and is then called oriental ruby; hence it passes into violet colored, forming the oriental amethyst; when yellow or reddish yellow it is denominated oriental topaz; when yellowish green, oriental chrysolite; and when of a deep, somewhat brownish green, it is named oriental emerald. The colors are, for the most part, uniformly distributed, but sometimes two or more occur in the same specimen.

It occurs in small, rounded pieces or crystallized in a slightly acute rhomboid or double trihedral pyramid (its primitive figure), of which the obtuse angles measure 94° and the acute ones 86°.

1. Sometimes the acute solid angles, or the summits of the pyramids, are replaced by planes perpendicular to the axis, situated either above or below, or exactly corresponding with the short diagonal.

2. Sometimes the edges of the base of the primitive rhomboid are each of them replaced by a plane parallel to the axis, thus separating the two pyramids by a hexahedral prism with rhombic planes: when the prism is long the terminal pyramids often entirely disappear.

3. Sometimes the flat angles of the primitive pyramids that rest on the common base are replaced by two new planes, thus rendering the pyramids enneahedral as long as any of the primitive faces remain, but when these are obliterated forming a dodecahedron, composed of two hexahedral pyramids united base to base. This modification is often combined with No. 1, in consequence of which the summits of the dodecahedron are more or less truncated.

4. The acute angles composing the solid angle at the summit of the primitive rhomboid are sometimes replaced by secondary planes so inclined to the axis as to form a very obtuse secondary rhomboid.

The variety in the form of a hexahedral prism (No. 2) appears sometimes to contain within it a similar prism, but of a different color. The crystals are small and very small, rarely middle sized. It is commonly more or less transparent, passing into translucent. The luster of the transparent kinds is shining and vitreous; of the translucent kinds generally glistening. When those crystals, in which the summits of the primitive rhomb are replaced by secondary planes, are translucent, the planes just mentioned present that varying luster which is called *chatoyant*; and if these crystals are cut *en cabochon*, or in the form of an ellipse, taking care that the summit of the ellipse shall be situated exactly under the point corresponding with the summit of the rhomboid, there will then be produced the appearance of a star with six rays. Such stones are highly valued by jewelers, and are called star-stones.

The fracture of the blue varieties of *telesia* is conchoidal, passing into foliated; that of the other varieties is foliated. The fragments are indeterminate angular. Its hardness is only inferior to that of the diamond, and the blue varieties are uniformly somewhat harder than the others. It gives fire with steel, but not very easily. By collision it becomes luminous like quartz, and the light from the red varieties is a very deep fire color, or cherry red. Its mean specific gravity is about 4, but it varies from 3.907 to 4.161.

It is infusible *per se* before the blow-pipe, but when finely pulverized is soluble in borax, and partially in potash. Its extreme hardness, and the powerful affinity that exists between alumina and silice, render it difficult to analyze. According to Bergmann, sapphire is composed of 35 silice, 58 alumina, 5 lime, and 2 oxide of iron. An improved analysis of the same gem was made by Klaproth (by means of caustic potash), with the following results: Alumina 98.5, lime 0.5, oxide of iron 1. Finally, Mr. Chevreux succeeded, by the help of borax, in decomposing this stubborn mineral, and his analysis of the sapphire and ruby may, perhaps, be looked upon as the most correct of any. In the sapphire he found, silice 5.25, alumina 92, iron 1; and in the ruby, silice 7, alumina 90, and iron 1.2. There was a loss of 1.75 in the former and 1.8 in the latter in the process of decomposition.

Telesia occurs in veins in granite and syenite. It is found in the kingdom of Pegu and the island of Ceylon in the East Indies. It seems to have been found by Count Bournon, in the province of Forez, in France, and has been met with elsewhere in that country. It is said, also, to have been discovered in Portugal and Bohemia, and in the north of Italy by Professor Pini.

All the varieties of *telesia* are valuable in jewelry, but rubies, if not very small, bear a considerably higher price in proportion to their weight than sapphires or any of the other varieties. It is said that the light violet-colored pieces may be rendered colorless by being heated in a charcoal crucible, without impairing any other of their properties, and that such pieces are often sold for diamonds.

The color of *adamantine spar* is grayish or greenish white, or yellowish green, or sapphire blue, or purplish red, or reddish brown. It occurs massive, disseminated and crystallized in the same figures as *telesia*. The crystals are middle sized and large. Externally they are for the most part dull and rough, internally they are translucent, semi-transparent, and sometimes, though very rarely, transparent. Their surface is often covered by strongly-adhering spangles of mica and grains of magnetic iron ore, which last is sometimes found disposed through the interior of the crystals. Its internal luster is shining or glistening, between vitreous and resinous. The terminal faces of some of the crystals are chatoyant like *telesia*. Its longitudinal fracture is straight foliated; its cross fracture is small and imperfectly conchoidal. Its fragments are rhomboidal. Its hardness is considerably superior to that of quartz, and the blue and red varieties are the hardest. It gives fire with steel, but not very easily. It becomes luminous by friction in the same manner as *telesia*. Its mean specific gravity is 3.931, varying on the one hand as far as 3.875, and on the other to 3.981.

Adamantine spar, in its chemical properties, agrees with *telesia*. The component parts of that from Bengal are, according to Klaproth: silice 5.5, alumina 89.5, iron 1.25; loss in decomposition, 3.75. The analyses of specimens from the Carnatic, Malabar, China, and Ava, by this and other chemists, differ slightly from the above.

It occurs in veins in granite and syenite and other primitive mountains in India, China, and Ava. From its extreme hardness, it is in great request in the East for polishing steel, and for cutting and polishing gems. The European lapidaries, however, prefer diamond powder on account of the greater rapidity with which it works.

The color of *emery* is intermediate between greenish black and bluish gray. It occurs massive and disseminated; when in a mass it is generally incrustated with magnetic iron

ore, pyrites, and mica; the latter substance generally penetrates the whole mass, giving it, when broken, a silvery appearance. It possesses a glistening or glimmering luster. Its fracture is fine grained, uneven, passing into even splintery. It is about equal in hardness to *adamantine spar*, cutting flint and rock crystal with great ease. It is heavy, and not easily frangible. When most free from iron it consists, according to Tennant, of about: silice 3.4, alumina 92, iron 4.6.

Emery is chiefly procured from the islands of the Archipelago, especially from Naxos. It is also found at Ochsenkopf, in Saxony, in beds of talc and steatite, accompanied by calcareous spar and blende. It is used largely for cutting and polishing by lapidaries and workers in glass, steel, etc. The *emery* is stamped to powder and sorted into finenesses by bolting through sieves of different degrees of fineness. For delicate purposes it is sorted by elutriation. It is made up into various forms with gums, resin, glue, clay, etc., according to purpose.

The substance called by Count Bournon compact corundum, and which accompanies *adamantine spar*, is probably an intermediate variety between *emery* and *adamantine spar*. Its color is a deep, purplish red, it is opaque, has a compact splintery fracture resembling a coarse jasper. It gives sparks when struck against a piece of steel, and exhibits a fiery red light by collision. It is extremely hard; specific gravity, 3.9. It generally contains, dispersed through its substance, particles of magnetic iron ore.—*Pottery and Glass Reporter*.

ON COAL TAR.*

By S. A. SADLER, Middlesbrough.

AT the request of your excellent President, I have undertaken to tell you something of what I know of coal tar,† that complex body which in the early days of gas making, and until within the last ten or twelve years, was as difficult to dispose of as it was objectionable to the touch and smell. It is not easy to conceive a more inconvenient product without an outlet; and when, as was the case, it was ever accumulating, with no single virtue, whether of quality, character, odor, or appearance, to gratify thought, fancy, or sense, it may truly and literally be said to have been the *bête noire* of gas makers. Fortunately an extraordinary change has taken place in its value. Some one found that by boiling tar in a closed vessel, and collecting the condensed vapors at different stages, spirituous, oily, and greasy products were obtained, and the undistilled residue in the vessel was found to be a solid black body, having the appearance of the original tar without its offensive stickiness and odor. This was the advent of a new industry, which developed with some rapidity until these simple products, which were used for burning in lamps, lubricating purposes, and asphaltum, became as much a drug in the market as the tar itself was previously.

I spoke of tar as a complex body. In its original condition it had baffled the researches of many; but the early tar distiller, eager to make a market, and spurred on by competition, elaborated his processes and multiplied the fractionings. Purer products resulted, and the attention of chemists was excited. Mr. Mansfield, a clever young chemist, with Professor Hofmann, discovered that the spirituous product, or naphtha as it was and is still called, was made up of several bodies, each possessing marked and distinguishing characteristics, with fixed specific gravities and constant boiling points, together with the remarkable property of combining with acids and of forming salts. It is impossible to estimate the value of this young chemist's discovery, being, as it has been since proved, the talisman which has opened the way to a world of discovery and enterprise. I regret that, while engaged in perfecting his discovery, an explosion in his laboratory cut short the career of one of the most promising of English chemists.

Mansfield's discovery in 1849 of benzole in tar—a product which was first isolated by Faraday twenty years previously from benzoate of lime, and which had caused some curiosity from its properties, which are briefly these: composition, C_6H_6 ; a colorless, mobile liquid, with a smell much like a fresh cut white turnip; boils at 89° C.; solidifies to a mass of crystals at low temperature; specific gravity 880 at ordinary temperatures; is a powerful solvent of fats and resins; very inflammable; but little affected by oxidizing agents, though readily and violently acted on by nitric acid—may be said to have been the starting-point of a long course of investigations and discoveries with tar. Here is a sample of nitro-benzole, the most important of the aromatic class, and commonly called "essence of mirbane." It has a fragrant perfume, and forms the first step toward utilizing benzole.

Toluol (C_6H_5) was next separated and examined. It is a hydro-carbon much like benzole in appearance, odor, and specific gravity, though more refractive and mobile; but having a different and fixed boiling point of 110° C. It does not solidify with cold, and is highly inflammable; it is decomposed by heat into benzole, naphthalene, anthracene, etc.; nitric acid acts violently on it, forming nitro compounds; and oxidizing agents convert it into benzoic acid. Toluol possesses (like turpentine) the singular property of rendering oxygen active; and when added to a solution of indigo, decolorizes it. Strong sulphuric acid dissolves toluol, while it has little or no action on benzole.

Xylol (C_8H_{10}) came next, although it was previously known as a constituent of wood tar. It boils at 140° C.; remains liquid with cold; has the curious property of mixing with watery vapor in the proportion of 100 to 41 parts, in which form it is not at all easy to condense. Only recently has xylol had a commercial value for color. It behaves with acids much like benzole. A sharp discussion is waging on the composition of this article; the contention being that it is a mixture of other known hydrocarbons.

Cumol (C_9H_{12}) came next—a body also known to exist in resin oil and may be obtained from cumic acid. It boils at 166° C.; smells rather like garlic; belongs to the paraffin series; forms a sulpho-acid; and is now assuming a value for color qualities it was never thought to possess. Its chief use has been for burning in street lamps, and as a solvent for rubber.

Professor Hofmann—continuing the work by a series of interesting experiments, and by methodical research mapped out by speculative chemical theory (more particularly in regard to the bases of coal tar and the chemical constitution of indigo)—discovered aniline, the very fountain of color. It is impossible to estimate the enormous value of this dis-

* A paper lately read before the North of England Gas Managers' Association.—*Jour. of Gas Lighting*.

† The paper was accompanied by a very interesting exhibition of the numerous products (in the way of dyes, scents, and oils obtained from coal tar) referred to in the course of it.

covery. This is a sample of aniline. Its properties are briefly these: When first prepared it is a colorless liquid, very soon turns yellow, then red or brown; it has no smell; is solid at low temperatures; forms salts with mineral acids; is soluble in water; and crystallizes well.

It was not, however, until 1856 that the coal tar trade felt any impetus from this discovery; and it is to Mr. W. H. Perkin that we owe the credit of utilizing it. This eminent chemist and manufacturer invented a practical process for producing mauve, or aniline purple, of which this is a sample. The intensity, novelty, and beauty of this, the first discovered tar color, not only excited the greatest astonishment and demand for it, but as it necessitated the separation of large quantities of benzole from tar, it marked quite an epoch in the history of the coal tar industry. Previously tar was not worth one halfpenny per gallon in London, while in the country gas makers gladly gave it away. Up to that time distillers simply divided the tar into naphtha, creosote, and pitch; now it had to be much more minutely fractionated, and the products rectified.

Naphtha, as it runs from the tar still, is of a reddish yellow color, has a strong odor, and is much lighter than water, having a specific gravity of about 900, water being 1,000. It is purified by repeated distillations; washed with strong sulphuric acid, with alkali, afterward with water, and then carefully distilled at various temperatures; and thus divided into several parts, each of which, by subsequent treatment, yields a fixed and definite product. These are benzole, toluol, xylol, and cumol. When treated with nitric acid in conjunction with sulphuric acid to sharpen its action, they are converted into nitro-compounds; and these, by the aid of acetic acid, iron, or zinc filings, and steaming, are again converted into aniline, toluidine, xylydine, and cumidine.

At this point a sudden impulse was given to the trade, by the discovery of magenta, or rosaniline. It was found by mixing aniline and toluidine together, and treating them with an oxidizing agent (arsenic acid was first used, but less objectionable oxidizers are now employed), a novel red coloring matter resulted, which was called magenta, but was christened by Hofmann with the more euphonious name of rosaniline. It readily forms salts with acids. Here are some of these—the hydrochlorate, acetate, etc. New processes rapidly followed in the train of discovery for the preparation of mauve, magenta, violet, red, and scarlet, all depending in a great measure on the mixture of aniline and its homologues.

The next important step was taken when it was found that by treating magenta with an organic or fatty acid (for instance soap, which is a fatty acid in combination with an alkali) a beautiful blue dye—aniline blue—is obtained; and by substituting ethyl, methyl, and phenyl radicals for hydrogen in these preparations, by an intricate series of chemical processes all these various shades of colors are obtained. Here are samples. [Mr. Sadler then described in detail the colors mauve, ponceau, green, magenta, lilac, various blues, maroon, yellow, bronzes, olive, and the peacock shades.]

There is no shade of color which cannot now be produced from coal tar; and while it is true that a large trade is still done in extracting dyes from natural sources, the importation and fabrication of colors by the old processes is rapidly decreasing and dying out. The aniline dyes, and those of its homologues, are familiar to every one; and I fear the garb in which you see them now but very faintly shows their exquisite beauty, bewildering variety, and intensity. It would seem as though the delightful colors of the rainbow itself had been caught and applied to charm the eye. A pretty color is said to gratify the sight as much as a lovely melody delights the ear. If this be so, how gratifying it is to think that so much pleasure has been excited by the advent of the numerous family of tar colors, in whose production most here are more or less instrumental. A faint impression of the intense coloring or tinctorial power of these dyes may be gathered from the fact that 1 lb. weight will in most cases, when dissolved, make 100 gallons of vat dye.

In the meantime strenuous efforts had been made to utilize the oily distillates from the tar, and to separate its numerous component parts. Among these was one to deprive the oil of its odor. In the course of experiments in this direction, it occurred to some one to wash the oil with an alkali in solution, and the operator was rewarded by the discovery that the alkaline solution had taken up a considerable quantity of the oil, which was promptly released when an acid was added and the alkali at once neutralized. This body, which has the property of combining with an alkali—comporting itself like an acid in this and other respects—consists of carbolic acid and cresylic acid, possessing extraordinary antiseptic and disinfectant properties. Dr. Angus Smith and Mr. Crookes applied it so successfully in this direction, that the terrible cattle plague which decimated the herds of this country some twenty years ago was arrested by it after everything else had failed. A large demand ensued, and this for a time gave another fillip to the tar trade. Carbolic acid is extracted from the light tar oils by the aid of caustic soda or potash; the lye being neutralized with sulphuric acid. Carbolic acid separates from the liquor in a layer like oil. This is the common commercial product. By distillation and purifying, a colorless liquid is obtained, boiling at 182° C. without decomposition, though on cooling it deposits, or rather solidifies into a mass of white needles, whose uniform melting-point is 42° C. Though not very soluble in water, it readily absorbs moisture from the atmosphere.

These two so-called "acids" are the only products of tar which contain oxygen. They do not redden litmus paper; nor have they any corrosive action on metals. Carbolic acid is a good type of a class which stands as it were midway between alcohols and acids; and as many of the traits of the acid class are absent, I think the name is a misnomer—at any rate it is a misleading and an unscientific one—"phenol" being better. If treated with nitric acid, an important yellow dye is yielded—picric acid. This acid is largely used by dyers; and, as you will see by the sample here, it is rather effective, and I think pretty. This acid again, when heated with cyanide of potassium, gives us isopurpurate of potash—a rich purple dye. Perhaps the most important dye, however, from this source is aurin—an intense coloring material made by acting on carbolic acid with oxalic acid. Many shades, varying from brick red to orange and gold, are dyed by it; and, being a cheap article, it is used largely for common purposes, such as staining paper, printing, and the like. Salicylic acid—a medicine or drug of much importance now a days—is also prepared from carbolic acid. Cresylic acid, always found in conjunction with carbolic, is a colorless refractive liquid. Unlike its twin brother, it does not crystallize or solidify; it is less soluble in water, but behaves much the same with alkalis

and acids. Its antiseptic properties are even more strongly marked than those of carbolic acid.

Next in order of distillation comes naphthaline. Some tars contain a large percentage of this hydrocarbon; while in others it does not exist at all, or only in such proportions as to be imperceptible. This is due, to some extent, to differences in the coal used, but chiefly to the temperature employed in carbonizing. All coals yield naphthaline at a high temperature. It is the most evil product of the whole series. From the time when gas manufacturers commenced to distill coal at a high temperature, this volatile and mischievous hydrocarbon has wrought more trouble and provoked more temper than can be well described. It surcharges the tar so that it will not flow, chokes pipes, plugs taps, and is just as offensive as it is possible for anything to be. Nor does its vagaries stop here; but, having finished with the gas manager, it careers on with demoniacal energy to destroy the peace of mind, if not the body, of the tar distiller. I have suffered more by the volatile pleasantries and uncontrollable pranks of this remarkable substance than I care here to confess. It is the refined spirit of mischief; and, like its class usually is, it is fair to behold. Until within the last two years it was worse than useless, and therefore most difficult to market. A small quantity was consumed for lamp-black purposes; the bulk, however, was used up as fuel. A new era has commenced for it. By treating this refined substance with nitric acid, in a similar manner to benzole and the lighter hydrocarbons, a way is opened to a variety of useful products which are revolutionizing the dye trade. Magnificent scarlets, reds, purples, gold, orange, and yellow are now being made superabundantly from it, and at such cheap rates as the natural and original sources cannot possibly compete with. Cochineal is as sure to be displaced as have the old dye-woods, barks, and roots; and the enormous sums of money annually remitted from this country for the singular little cochineal insect will soon all be kept at home.

These colors are very striking and curious. Take this solution of naphthaline red. By transmitted light it is a charming red; now by reflected light it is a dead brick-red, and appears muddy, though in reality perfectly clear. This peculiar fluorescence is common to several of the other dyes. Here are two very marked in this respect—fluorescein and eosin. You will observe that, by reflected light, the colors are green in one case and a yellow-green in the other; now by transmitted light one is a brown solution and the other pure red. Most of the dyes have in the solid condition quite a different appearance to that when they are in solution. The colors are, however, always complementary to each other. It is a popular prejudice that the beautiful prismatic colors which appear when a thin film of tar is spread upon water reveal at once the superb dyes which are made from it. Of course this is not so; the phenomenon being simply due to the fact that a film of tar on water possesses the property of decomposing light, producing the various colors precisely as seen when a ray of light is transmitted through a prism. A more ingenious, though equally fallacious theory is that, since coal is simply highly compressed charred wood and vegetable matter, the colors obtained from coal tar are condensed sunshine absorbed by the vegetation which luxuriantly flourished in a prehistoric age, millions of years ago. It will be seen that as the sun is the source of light, and as light is a compound of all the elementary colors, the idea has the merit of being novel and entertaining, if nothing else.

Tar and color are so bound up together, that I cannot resist saying something about the latter, in a theoretic sense; and, as it is my hobby, I crave your indulgence while I "trot it round" for your criticism and information. I think it may be useful, however, in considering the numerous derivatives of tar having color properties. I purpose astonishing you at the commencement by stating that color does not exist *per se*—i.e., there is no such thing as color—and that the whole thing is an optical delusion. Different bodies have the property of absorbing certain rays of light, and reflecting others. The various colors and dyes which so much delight the vision may, after all, be only the prismatic rays from surfaces endowed with a facility for decomposing light—appropriating some while reflecting others; the rejected rays being the colors that are conveyed to the eye. Color is the name used to express the sensations we feel when light of various rates of vibration is communicated to the vision. The optic nerve records the rapidity of the vibrations set up; and the varying effect on the eye reveals the property possessed by bodies to produce different times of vibration in the light-bearing ether. When white light falls on objects that surround us, it is seldom reflected back to the eye as white light. The bodies or surfaces are illuminated by it; but they have the power of so altering it that they appear to us colored. The white light is really decomposed; certain parts are absorbed, others are reflected. These emitted rays form the color we perceive, and this is invariably the complementary color to that which is absorbed. The products of coal tar possess this property of decomposing light in an extraordinary degree; and my opinion is that its colors and dyes are simply the result of this characteristic property.

Colorless or, as it is termed, white light is said to be made up of seven colors; but any one who has seen much of the spectrum produced by passing a pencil of light through a triangular prism of glass, will agree with me that there is an infinite number of perfectly distinct colors in it. The seven colors—primary, we will call them—red, orange, yellow, green, blue, indigo, and violet, yield a countless host of tints and shades by mixing; they may also be re-combined so as to make white light. I have a little disk here painted in sections of these primary colors—violet occupying one-fourth, orange one-twelfth, the other colors each about one-eighth of the face. When it is rapidly revolved you see the colors entirely disappear. If the proportion of these colored sectors be altered, various other colors are producible. For instance if the red be removed, the color produced is green. The color thus formed is called the complementary color of the one removed; thus green is the complement of red. And as, by the removal of green from the disk, a circle of red results from the whirling combination, red is the complementary color of green. Indeed all spectral colors are complementary. Orange is complementary to blue; and *vice versa*, blue is complementary to orange. Indigo bears the same relationship to yellow, and violet to greenish yellow. Curiously, a red body reflects green rays; while, on the other hand, a green body reflects red rays. Both, therefore, gain in intensity when placed together. Indigo reflects yellow; and, inversely, yellow reflects, indigo rays. Therefore they intensify each other. All the complementary colors behave in the same way—i.e., they complete each other, and gain in intensity when placed side by side.

I have said this much on the phenomena of color, as it somewhat explains the curious and striking property of many

of the tar colors to which I have alluded. All the tar colors have, in more or less marked degree, this singular characteristic. An illustration of the prolific nature of tar is seen in the fact that while the first portion of creosote oil largely consists of naphthaline, the last part deposits an entirely different product—anthracene. It usually falls out, as the oil cools, with phenanthrene—a product as yet of no value, but interesting to chemists, who are bestowing a good deal of attention to it just now. I shall not be surprised if very soon some useful discovery concerning it is made. I know one or two eminent men who are submitting it to a crucial research. Phenanthrene is the constant companion of anthracene, and is isomeric with it, having the same composition. Its fusing and boiling points are much below those of anthracene. It forms a nitro-compound with nitric acid, and combines also with sulphuric acid. With picric acid yellow red needles are produced.

Anthracene has done more to increase the value of tar than any of the other constituents. In 1868, Mr. W. H. Perkin in England, and Messrs. Graebe and Liebermann in Germany, simultaneously, discovered that alizarine from madder, the original source of Turkey red, could be reduced by zinc dust to a product (C₁₅H₁₀) which had the same composition as, and all the other properties of tar anthracene. It was soon found that it was as easy to build up alizarine synthetically from anthracene as to produce the latter from the former by analysis. The crude deposit from the tar oils was purified, and the greasy body I have here was brought into this state, or approaching it. Pure anthracene is a very beautiful body indeed. You will observe that, although it is in reality a white flaky crystal, it has a lovely blue fluorescence in a remarkable degree. Refined anthracene was oxidized with chromic acid, or other convenient oxidizer, into anthraquinone; and then, through a process of substitution, and finally fluxed with soda, alizarate of soda is obtained. By decomposing with an acid, alizarine, or Turkey red (one of, if not the most important dye of commerce), is thus made. Like the other tar colors, it is most deceptive in the solid state; no one would imagine for a moment that there was Turkey red. Here, however, is a solution, and there are some specimens of printing and dyeing by it. Numerous shades of color, from dark blue to bright red, are obtained by varying the mode of application or the mordants used to fix the color. I should add that artificial alizarine is much more intense and reliable for dyeing purposes than the product of madder root.

Some idea of the importance of Perkin's discovery and the industry resulting from it, may be gleaned if we remember that ten years ago the importation of madder, for preparing Turkey red, represented many millions sterling per annum. Great tracts of country—in Algiers, in the South of France, along the Riviera, and in the Levant—and many thousands of people were employed in the cultivation of madder. This is all now practically defunct; the artificial alizarine being obtained purer, more readily, and, what is more to the point, cheaper. Unlike the other tar colors, which are mere imitations or mostly new colors, artificial Turkey red has the same chemical composition as the natural alizarine extracted from madder.

Not much is known of the many oils which are named to us collectively as creosote. The separation, purification, and identification of them belong to the unsolved problems of chemistry. An important insight may be obtained into their character by distilling and fractionating them at different temperatures. Oily products are obtained, varying in color from light yellow to blood red. All are fluorescent. Creosote is made up of a multitude of constituents, and opens up a field for investigation and research that few things can excel. Excepting, however, its general employment for pickling timber, its industrial value is slight.

By continuing the distillation of tar further, a semi-fluid oil comes over. Of high gravity and dense in consistency, it is admirably adapted and used largely in the manufacture of anti-friction grease. These samples were made by an eminent manufacturer in Middlesbrough. Pitch is the residue after all this; and usually this is the end of the distillation process. For, after having cooled in the still for a while, it is run out, sometimes in moulds, oftener in bulk. In this form the greater part of pitch is used for the manufacture of patent fuel—a most important industry in France and Italy, where the coal is soft, and powders in winning. From 7 to 9 per cent. of pitch is ground up with the coal, and the whole, after gently heating, is pressed by hydraulic machinery into square lumps about 9 in. by 6 in. by 4 in. These are called briquettes; and, in this form, fuel is mainly used in the countries named. They will be familiar to most of you. I dare say fuel makers, in their specifications, are particular to state that the pitch shall melt at a temperature under 60°, and have agglomerating power. It is claimed that fuel in this form possesses 10 per cent. more heating power than the best coal. The total production of briquettes is said to be nearly 3,000,000 tons per annum; 80 per cent. of the pitch used being sent from this country.

At one of my works I have for many years run the hot pitch from the tar stills into ovens, and continued there the distillation, until nothing but carbon, or coke, was left. It is a very hard coke, and most difficult of combustion; but, like all refractory fuels, gives an intense heat. Owing to its great purity and freedom from sulphur, metallurgists like it for special purposes, such as for smelting the rarer metals, and for making pure iron. The distillate, sticky and resinous, which condenses, even in hot water, contains: first, chrysen, a bright yellow mass which when dissolved and recrystallized forms loose, shiny golden scales; and, secondly, pyrene, a colorless crystallizable hydrocarbon when freed from chrysen. Both pyrene and chrysen form nitro-products, but up to the present time have not been applied to any useful purpose. From the commencement of the distillation of tar to the end, when coke is left as a residue, ammonia is evolved all through, especially at first and at the finish. This is condensed with the other distillates, and utilized as sulphate, muriate, or carbonate of ammonia.

COLOR MATTERS FROM GAS.

A new and valuable discovery has recently been made by one of my chemists, Mr. Kendall. This gentleman has invented and patented an ingenious process by which he extracts large quantities of color matter from coal gas itself. Remembering that gas tar is the source of so much and so many dyes, it is marvelous no one before ever thought of trying gas itself as a color-source. I have here a sample of the gas color base. From it all the phenylene-diamene colors are obtained. Some specimens of these beautiful dyes are here; Bismarck brown being the chief, and in largest demand. It will enable you to form some idea of the success of this, the most recent invention in dyes, when I tell you that I am at the present time using two million cubic feet of gas weekly, and erecting plant which will shortly be completed, providing a consuming power of five million cubic

feet of gas per week for this purpose. With the object, in the first instance, of economizing fuel at my Middlesbrough works, I convert the coal into a rough gas of about 50,000 cubic feet per ton of coal. I have, through my engineer, patented a new gas generator, which is so constructed that both tar and ammoniacal liquor are caught in quantities as large as, if not larger than from coal carbonized in a retort. The generators each gasify about six tons of coal per day, and the admission of air is so dexterously controlled that the tar is not destroyed. By an arrangement of ejectors, compressors, and condensers, both tar and ammonia are eliminated from the gas and collected. The tar is, I admit, inferior in quality to that made in gas works. I am sure it will interest, though I doubt whether it will please you, to hear of this new source of tar.

While in this direction, I may inform you that Messrs. Pease, of Darlington, are now completing an extensive plant, on a French patent, which has been successfully at work in France for several years, by which they expect to catch the tar and ammonia from their coke ovens. Messrs. Baird, of Gartsherrie, the largest iron makers in Scotland, have also devised appliances whereby they condense tar and ammonia from the gases as they leave the blast furnaces. In Scotland coal and not coke is used for smelting iron, as is the case here.

What effect the advent of all this tar and ammonia into the market will have on the value of them, it is impossible to tell. For myself, I cannot say that I view the position unmoved and without trepidation. At this moment there is more tar made than is required for present known uses. Anthracene, for instance—the mainstay of the value of tar—which has for years maintained an average price of about £100 per ton, is now unsalable at £30 per ton. Carbolic acid again is even more unsatisfactorily situated, being without a market at one-fourth of the price of former years. But enough. What will happen, must. *Nous verrons.*

That coal tar—a dirty, repulsive-looking article—should have become such a prolific source of color and useful products is one of the most striking illustrations of modern scientific discovery coupled with commercial enterprise. Although of such youthful years, I have shown that it is the progenitor of a very large family indeed; and, unlike their parent, the offspring is often very beautiful, and always interesting.

Discussion followed.

Mr. Harding (Sunderland) said that last week he (Mr. Harding), by invitation, went to Messrs. Baird's works, and he there saw in active operation the process by which they obtained from the blast furnaces thirty pounds of sulphate of ammonia and fifteen gallons of tar per ton of coal thrown into furnaces. The difficulty attending condensation, owing to the gas evolved from the furnaces being twelve times the volume of the gas evolved in ordinary gas works, had been overcome; and, within twelve months, the firm would have the apparatus fitted to the whole of their furnaces. The estimated cost of fitting one furnace was £5,000, and this cost would prevent ironmasters, for many years, from carrying out the process; but the profit arising from the condensation of the gas amounted to no less than from £10,000 to £12,000 per annum for each furnace. The firm altogether had expended some £40,000 or £50,000, but they anticipated that within the next eighteen months they would be recouped quite £150,000. The sulphate of ammonia collected was, he might say, equal to any sulphate made in the United Kingdom. With regard to the tar, it made very good pitch and it had also a good oil, some of which he had now under distillation in his laboratory at Sunderland.

Mr. Sadler, in reply, said he believed that what Mr. Harding had stated was substantially correct. The Middlesbrough ironmasters looked upon the process named with very great fear. They were not involved in smelting the iron with coke, and they would be very clever indeed if they extracted ammonia and tar on their own premises.

TESTING THE COMMERCIAL VALUE OF CARBOLIC ACID.

By Dr. O. BACH.

Of the various methods in use for determining the quantity of phenol in crude carbolic acid, the one which depends on its conversion into sulphocarbonate, and which was first recommended by Schoedler (*Pharm. Centralh.* xiii, 225) and afterward by Nietsch (*Ann. Chem. Pharm.* xl, 587), cannot be employed because it is too tedious, and besides it is difficult to make the mono-sulphocarbonate. Shaking the acid with caustic soda solution leads soonest to the desired end. There is, however, this difficulty in the way—if it is shaken at once with the alkali, that in thick, sirupy, and dark colored liquids, it is difficult or impossible to distinguish the separate layers, and also that the oily layer of tar does not separate readily from the layer of carbonate of soda, even when it is put in hot water, and by doing this there is formed an intermediate layer—a sort of an emulsion—between the two, so that an accurate reading is impossible.

In addition to this it very frequently happens that the acid to be tested contains a considerable quantity of water, 20 per cent or more, which must lead to false results if direct readings are made, and hence it would be necessary to estimate the quantity of water.

To avoid these evils, and to be able to carry on an estimation of the water and phenol in the same sample at the same time, I proceed as follows: I distill 50 c. c. of the acid to be tested in a retort, continuing the distillation until solid hydrocarbons begin to form in the condensing tubes. The distillate is collected in a 100 c. c. burette, graduated in one fifth c. c. with a glass stopcock soldered to the lower end. Before beginning the distillation about 25 c. c. of a saturated solution of table salt is put in the burette, and the level carefully read and noted. If the acid under examination is free from water, the distillate will float on the brine as a clear layer, while in the other case the oil, water, and brine will form an emulsion. When the distillation is concluded, the burette is corked and gently shaken, when the oil separates quickly and sharply from the salt solution. The increase in the volume of this latter gives the number of cubic centimeters of water present in the acid, and from it the percentage is readily calculated.

To determine the quantity of phenol, it is necessary to remove the solution of salt as completely as possible, for when it is subsequently shaken with caustic soda, if there is any salt present the carbonate of soda separates in flocks, making an accurate reading difficult. After removing the cork and reading the volume of the oil, the stop-cock is very carefully opened to let the brine run out. If the cock is opened too far there is danger on the one hand that some of the salt solution will stick to the side of the burette, and on the other

that some oil will be lost when it reaches the narrow part of the burette. After the salt solution has all been removed the burette is filled to the zero-point with a soda solution of about 30° B., a cork inserted, and the mixture well shaken and left to settle. If the burette is free from grease, the oil separates quickly and sharply, and by turning the burette gently about its axis once the oil or water drops that adhere to the sides can be wiped off, so that in half an hour the number of c. c. of oil that remain can be read. The difference in the volume if the oil before and after shaking with soda equals the volume of phenol, which may be easily converted into percentages.—*Ch. Zeit.*

MICROCHEMICAL REACTIONS.

By Dr. A. TSCHIRCH.

THE microscope is specially useful for recognizing the characteristic properties of objects. For instance, it is impossible to distinguish the different kinds of starch without a microscope; but one glance through the lens will tell the name of the starch. The fibers used in spinning, though differing but little microchemically, are easily recognized by their morphological characters. Many adulterations of coffee, tea, spices, etc., are easily detected in this way. The distinction of hem and flax is difficult, but Cramer has succeeded in finding a characteristic and unerring guide in the long cells with red contents that accompany the bast cells of the hemp. The width and thickness of the beard of wheat and rye differ sufficiently to enable one to decide between them.

The domain of pure chemistry also possesses an essential aid in the microscope. The hæmatine reaction which is decisive for blood stains, the distinction between the different constituents of urinary deposits, between quinine and cinchonine, and even between strychnine and atropine, is easy and certain when the crystalline forms are viewed through a microscope.

THE STARCH TEST.

The earliest microchemical reaction employed was, indisputably, the iodine and starch test discovered by Stromeyer, which vies in sharpness with the barium test for sulphuric acid in inorganic chemistry. By this means it was possible, at an early date, to obtain an insight into the *topographical division* of the starches, and to recognize the cells and cell complexes in which this reserve of nutriment occurs, and the courses that it pursues.

THE CELLULOSE REACTIONS.

The iodo-chloride of zinc reaction, which colors pure cellulose a violet blue, and the iodo-sulphuric acid reaction, which dissolves it with a blue color, belong to the most important microchemical reactions. In these we possess an easy and practical method of distinguishing vegetable fibers from animal fibers, for only the membranes of plants exhibit the properties just mentioned, and these only with certain limitations. For example, membranes that are incrustated with lignine cannot be subjected to this test until the incrusting substances have been removed by maceration with nitric acid, alkalies, or Schulze's maceration liquid.

Another valuable reaction applicable only to pure vegetable cellulose is the solubility in the ammoniacal solution of copper oxide. This reaction was discovered by Schweizer of Zurich and fully described by him, after which Cramer followed it out further and described the peculiar changes of form observed when the objects swelled up.

SCHULZE'S MACERATION PROCESS.

After the iodine reaction the next important advance was Schulze's method of isolating single elements of tissues. His maceration process consists in treating the tissue with nitric acid and chlorate of potash, its object being to isolate the separate cells by dissolving out the intervening substances. It is intermediate between macro and micro chemistry.

Some time before, Pringsheim recommended nitric acid alone for this purpose, but his suggestion did not attract any attention as the publication was not easily accessible, and Schulze's process first found acceptance and renown. In technical microscopy this maceration process may be very extensively employed, for cases very frequently occur where single elements are to be examined in larger portion of tissue. But it must not be forgotten that measurements of the diameters of cells, such as bast cells, which have been subjected to maceration cannot be relied upon, because the reagent causes the cells to swell considerably.

This reagent is very useful for separating what Jönsson calls the *ophiur* cells which are found in tea leaves, and are characteristic of a number of camellias, but are totally wanting in the leaves generally used for adulterating tea. Also for isolating the bast cells from fibers that consist more or less of bundles. In addition to isolating cells, this reagent has another valuable property, namely, of dissolving and removing the strongly colored incrustations of the cell membranes, both of natural objects like cinnamon and cinchona bark, and of roasted articles like coffee, thus making the articles lighter in color—which is very important in testing coffee, for example. Ammonia and caustic potash have the same action. Unfortunately measurements cannot be made after treatment with any of these reagents, but in most cases a knowledge of the characteristic morphological distinctions is sufficient, but in a few cases—as in textile fibers—measurements are indispensable, and here the fibers must be picked apart with a needle.

CAUSTIC POTASH.

This is likewise a very important micro-chemical reagent. It has just been mentioned that one can employ it with good effect for clarifying the tissues. While the histologist renders whole tissues and even whole organs transparent (such as embryos) by the use of this reagent, it plays a still more important part in clarifying roasted mixtures, which, if they are not sufficiently transparent after treating with Schulze's maceration liquid, are easily made so by the use of potash. There are two methods of using it; Haustein's method consists in successive treatment with caustic potash and acetic acid, while Russow's makes use of alcoholic potash; which has the advantage that membranes do not swell up to such unshapely masses in this as they do in pure potash.

STARCH IN COLORED SUBSTANCES.

Böhm was the first to show that by combining the use of potash with the iodine reaction it was possible to detect small quantities of starch in colored substances where it would otherwise escape detection, as in chlorophyll granules for instance.

THE SUGAR TEST.

One of the most brilliant achievements of micro-chemistry is Sachs' application to physiologico-histological investi-

gation of Trommer's sugar test, in which potash also plays a part. Sachs has proved that by means of this test both cane and fruit sugar, as well as other members of this group, such as dextrine, can be detected under the microscope even in the cells themselves, and with a little experience may be estimated quantitatively. The method used by Sachs is as follows: He first dips the section in copper sulphate solution, then washes it in water, and boils it for a short time in a dilute solution of caustic potash. The characteristic precipitate of red suboxide of copper is produced within the cells that contain sugar. This test, of course, requires some practice, for if the copper sulphate is not sufficiently washed out the black oxide of copper (cupric oxide) is precipitated and conceals the red oxide (cuprous oxide). On the other hand when the washing is carried too far the easily diffusible sugar passes through the cell walls by endosmosis into the wash-water, and can no longer be detected in the spot where it naturally occurs. Nevertheless we may hope, when this method is perfected, to get on the track of the migrations of the sugar, to which many of the phenomena observed in the changes in matter are to be referred.

TANNIN REACTION.

The peculiar red color that caustic potash imparts to cells that contain tannin of course leads us next to the test for tannin, which is also valued as a macro-chemical reaction.

STAINING.

The lengthy chapter of staining can only be mentioned here. It offers a well known and important aid in the study of animal tissues, and especially in the investigation of bacteria.

Most of the micro-chemical reactions known at present naturally refer only to substances that are not characterized by any chemical tests, and which are recognized only by the peculiar changes of color that they suffer when certain reagents are applied, while we are absolutely in the dark in regard to the nature of the colored substance which is formed during the reaction. There is still a large field left for investigators in pure chemistry—but for technical microscopy a knowledge of these color changes is at present sufficient.—*Chemiker Zeitung.*

POISONOUS LEAVES.

SOME of our most admired flowers, which we should least willingly banish from cultivation, are associated with green leaves of a very poisonous character. The narrow, long leaves of the daffodil act as an irritant poison; the delicate compound leaves of laburnum have a narcotic and acid juice which causes purging, vomiting, and has not unfrequently led to death. The narrow leaves of the meadow saffron, or autumn crocus, gave rise to the utmost irritation of the throat, thirst, dilated pupils, with vomiting and purging. The dangerous character of aconite, or monkshood leaves, is doubtless well known, but each generation of children requires instruction to avoid above all things those large, palm-shaped leaves, dark green on the upper surface. Leaves of coarse weeds provide an abundant quota of danger, but frequently their strong scent and bitter or nauseous taste give timely warning against their being consumed. Of all our British orders of plants perhaps the umbelliferous order contributes the rankest and most widespread elements of danger. The tall hemlock is everywhere known to be poisonous, and it is one of the most abundant occupants of the hedge. A peculiar "mousy" odor can generally be recognized on squeezing the leaves, which are deep green in color and trebly compound, the small lobes being lanceolate and deeply cut. It is said that the mousy smell can be detected in water containing not more than a fifty-thousandth part of the juice. Hemlock is both an irritant to any sore place and a general narcotic poison, producing headache, imperfect vision, loss of power to swallow, and extreme drowsiness, with complete paralysis of voluntary muscles and muscles of respiration. The water dropwort, too, a flourishing ditch plant; the water hemlock, fool's parsley, must be ranked among our most dangerous poisonous plants belonging to the umbelliferous order. The fool's parsley leaves are sometimes mistaken for genuine parsley, but their nauseous odor and darker leaves should prevent this. The nightshade order is another, with dangerous and often extremely poisonous leaves. Indeed, no nightshade can be regarded as safe; while the deadly nightshade, with its oval, uncut leaves, soft, smooth, and stalked, is in the highest degree to be avoided. Henbane and thorn-apple, again, with their large and much-indented leaves, are conspicuous members of the "dangerous classes." Holly leaves contain a juice which is both narcotic and acid, causing vomiting, pain, and purging. Even elder leaves and privet leaves may produce active and injurious irritation when eaten. With regard to treatment in cases of poisoning by leaves, if no doctor is at hand, produce vomiting till all offending matter is expelled, and, when considerable sleepiness or drowsiness has come on, give strong tea or coffee, and again bring on vomiting; then stimulate and rouse the brain in every possible mode.—*Land and Water.*

THE ASH AND ITS VARIETIES.

THE common ash (*Fraxinus excelsior*) and several of the North American kinds rank high as timber-producing trees, their wood, owing to its elasticity, being much sought after where strength and toughness are wanted. Apart, however, from their value in this respect, the different forms offered plenty of scope to the planter, some being large, noble looking trees, others comparatively small, and a few singularly grotesque. The recognized varieties of the common ash are many, some of the most distinct being the weeping kind (*pendula*) so often employed for forming arbors; of this there is also a golden form (*pendula aurea*), the bark of which is bright yellow, but in other respects, except being of somewhat weaker growth, it resembles the common weeping ash. Another kind (*F. excelsior heterophylla*), of which we append an illustration, is remarkable on account of the absence of leaflets, and instead one large, simple, deeply serrated leaf. It forms a tree nearly as vigorous as the common kind, and is often known by the name of the one-leaved ash (*monophylla*), certainly a better name than *heterophylla*, the leaves being seldom variable. Of this there is a form in which the leaf is deeply slashed instead of serrated. The cockscomb ash (*F. excelsior cristata*) has often a large proportion of the shoots curiously fasciated, especially at the points, where they spread out in a cockscomb-like manner. This is but a slow-growing tree, and frequently some of the branches die off without any apparent reason. A dwarf, bushy kind, *F. excelsior globosa*, assumes the shape of a small, round bush, and when grafted standard high has a mop-like appearance. Other varieties in addition to those