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James C. Booth and Campbell Morfit.**

**Contributors**

Booth, James Curtis, 1810-1888.  
Morfit, Campbell, 1820-1897.

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Smithsonian Report.

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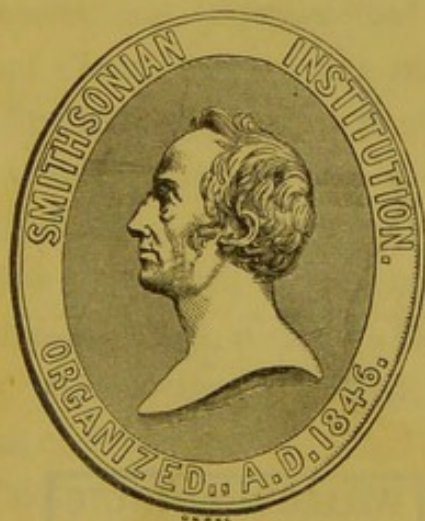
CHEMICAL ARTS.

BY

PROFESSOR JAMES C. BOOTH,

AND

CAMPBELL MORFIT.



WASHINGTON CITY:  
PUBLISHED BY THE SMITHSONIAN INSTITUTION.  
1851.



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## PREFACE.

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THE following Report has been prepared under the direction and at the expense of the Smithsonian Institution, from articles in various Journals of Science and the Arts, published during the last few years, in the English, French, and German languages; and, among these, we acknowledge our indebtedness chiefly to the Chemical Gazette, issued in London, and to the excellent Report on Practical Chemistry, by Dr. Elsner, of Berlin. We have freely exercised discrimination in the selection of subjects, and have omitted much that we found on Applied Chemistry, because novel views need in many cases further confirmation to render them reliable in practice, and, if presented too early to the artisan, may be productive of more evil than good. We have kept in view the benefit of the practical man, the manufacturer or maker, and, while we have not avoided scientific terms when more convenient, we have generally used modes of description intelligible to every one.

American Patents relating to the Chemical Arts have been generally omitted, because they are published annually in the Reports of the Patent Office, which are widely distributed throughout the United States, and therefore accessible to all.



We have confined ourselves to such foreign improvements in the Chemical Arts, whether patented or not, as we believed the American artisan might avail himself of, frequently offering critical remarks on them, and sometimes pointing out where improvements were likely to be made.

We trust that the work will prove useful to that portion of the public more exclusively interested in the arts, and not less acceptable to men of science, as exhibiting the contemporaneous advancement of science and art.

J. C. B. and C. M.

PHILADELPHIA, JULY, 1851.

# CONTENTS.

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	PAGE
CLASSIFICATION OF THE CHEMICAL ARTS.....	9
TABULAR VIEW OF THE CHEMICAL ARTS.....	16
 I. CALORICS.....	17-25
1. FUEL AND FURNACES.....	17
Pungernite.....	18
Coal.....	18
Reverberatory Furnace.....	20
Portable Blast Furnace.....	20
2. WARMING AND VENTILATION.....	21
3. PYROTECHNY.....	22
New Composition for Gunpowder.....	22
Gun-cotton, its Danger.....	22
———, Composition.....	23
Charcoal for Gunpowder.....	24
Pure Oxygen.....	24
Preventing and Extinguishing Combustion.....	24
 II. PLASTICS.....	26-38
1. VITRIFICATION, OR GLASS-MAKING.....	26
Bohemian, Optical, Colored and Aventurine Glass.....	26
Hæmatinone and Ruby-glass.....	27
Hydrated Silicic Acid.....	28
Artificial Brilliants and Gems.....	28
Grinding and Cutting Glass.....	28
Diamond Carbon and Coke.....	28
Silvering Glass.....	28
2. SEMIVITRIFICATION, OR POTTERY.....	29
Fire-clay from Fusible Clay.....	30
Porcelain.....	30
Fluxes for Porcelain.....	31
Aventurine Glaze for Porcelain.....	31
Red Pigments for Porcelain.....	32
Gray Enamel for Porcelain.....	33
Cement for Pottery and Glass.....	33
3. HYDROPLASTICS.....	33
Hydraulic Cement.....	34
Plaster hardened.....	36



	PAGE
Artificial Siliceous Stone.....	37
Asphalt and Mastic.....	37
Steam Cement .....	38
III. METALLURGY.....	39-90
Preparation of Carbonic Oxide.....	39
1. PYROMETALLURGY .....	40
<i>Iron</i> .....	40
Waste Gases of Blast Furnaces .....	40
Arsenic and Vanadium in Iron-ores.....	41
Alkalimetric Test for Iron-ores.....	41
Limit of Carbon in Cast, Steel, and Bar-iron.....	42
Reduction of Iron-ores in Retorts.....	42
Bar-iron from Cast-iron.....	43
Steel     "     " .....	44
Steel from Bar-iron.....	45
<i>Copper</i> .....	45
Alkalimetric Test for Copper.....	46
Reduction of Copper-ores.....	47
<i>Lead</i> .....	49
Alkalimetric Test for Lead.....	49
<i>Tin</i> .....	50
<i>Zinc, Mercury and Arsenic</i> .....	51
<i>Antimony and Bismuth</i> .....	53
<i>Silver and Gold</i> .....	53
Reduction of Chloride of Silver.....	55
Parting Gold and Silver.....	56
Production of Gold.....	59
Toughening Gold .....	60
<i>Platinoid Metals</i> .....	61
<i>Nickel and Cobalt</i> .....	62
<i>Alloys</i> .....	62-68
Table of Bronzes .....	63
——— German Silver .....	64
Soldering.....	69
2. HYDROMETALLURGY .....	69
Plating by Gold and Silver.....	71
Galvanic Gilding and Silvering .....	75
Platinizing and Coppering.....	79
Bronzing.....	82
Etching.....	84
Photography.....	85
IV. CHEMICS.....	91-126
1. SALINES.....	91
Water and Solution.....	91
Sulphur and Sulphuric Acid .....	94
Common Salt, Soda-ash, and Chloride of Lime.....	97



# CONTENTS.

7

	PAGE
Potash tested for Soda.....	101
Alum.....	102
2. METALLOSALINES.....	103
Vitriols.....	103
Zinc-white and White-lead.....	105
Prussiates.....	109
Chromates.....	111
3. FINE CHEMICALS AND PHARMACEUTICS.....	113
Inorganic Compounds.....	114
Alkaloids.....	117
Prussic Acid.....	121
Chloroform.....	122
V. KALISTICS.....	127-156
1. TEXTILE FABRICS.....	127
Fibre, Cotton, Hemp, &c.....	127
Bleaching.....	129
Mordants.....	131
Dye-stuffs, Madder, &c.....	133
Testing Indigo.....	138
Dyeing.....	140
Color-printing.....	142
Inks.....	143
2. SHEET FABRICS.....	144
Tanning.....	145
Caoutchouc.....	148
Guttapercha.....	150
3. ADHESIVES.....	152
Varnishes.....	153
Cements.....	155
VI. OLEICS.....	157-171
1. OILS AND FATS.....	157
Chandlery, Wax, &c.....	160
2. SAPONIFICATION.....	162
Perfumery.....	162
3. ILLUMINATION, Gas, &c.....	165
Burning Fluids.....	170
VII. SITEPSICS.....	172-190
1. PREPARATION OF STARCH AND SUGAR.....	172
Tests for Sugar.....	173
Refining Sugar.....	175
2. FERMENTATION.....	179
Alcoholometry.....	181
Wines.....	183
3. CULINARY ARTS.....	184
Water and Beverages.....	184



	PAGE
Cooking Meat.....	187
Preservation of Food.....	189
VIII. BIOTECHNICS .....	191-205
Ripening of Fruit.....	191
Influence of Mineral Manures.....	193
Organic Manures.....	197
Ashes of Plants.....	200
Lactometry.....	202

# CHEMICAL TECHNOLOGY.

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## CLASSIFICATION OF THE CHEMICAL ARTS.

THE arts are those processes by which the products of the mineral, vegetable, and animal kingdoms are modified, in a greater or less degree, in order to adapt them to the wants of man. These processes are based on either mechanical or chemical principles; and while in a large proportion of them mechanics are almost exclusively employed, in an equally large number mechanical operations are merely subservient to chemical action. Hence, a twofold division of the arts is both practicable and convenient. The former is designated as Mechanical Technology, or Practical Mechanics; the latter, Chemical Technology.

Among the chemical arts, many are conducted on a large scale, and are properly termed chemical manufactures; but chemical technology is more comprehensive, embracing less extended processes, and even a few in which chemistry finds a limited application. Thus, the making of alum and glass, the reduction of iron ores, the extraction and refining of sugar, are all manufactures conducted on a vast scale. On the other hand, phosphate of soda and chrome yellow are made on a limited scale; small quantities of nickel, of tannin, and perfuming oils, are extracted and refined; and yet, as their preparation is wholly governed by chemical principles, these processes belong to chemical technology. While some writers incorrectly limit the subject to chemical manufactures, others confine it to the first valuable products obtained. Thus, while the preparation of alum and copperas are acknowledged



chemical arts and manufactures, their extensive application to organic fibre to give permanency to dyes, and the whole art of dyeing and calico-printing, would be excluded. This is manifestly wrong, if the definition of the arts which we have given be correct; and we cannot exclude those arts of a chemical nature, which more immediately flow from any one branch of manufacture, especially when we consider that such collateral arts are often necessary to the economy of a particular branch of manufacture.

Emanating from chemistry, chemical technology has been usually treated as a branch of that science, and has been correctly designated "applied chemistry." Its recent expansion, however, by the aid of chemistry, allows of its establishment as an independent branch of knowledge,—a science, capable of a classification, not on the principles of chemical science, but evolved from itself, by a comparison of its subjects with each other. The main principle which should govern such classification is the object in view or the product to be made, and, with this, the secondary arts necessarily or usually connected with it. Thus, the making of soap, being an important art, and an extensive manufacture, necessarily includes the extraction and purification of oils and fats, while perfumery and chandlery seem to follow in its train in a natural order. The following is an attempt at such a classification of the subjects in chemical technology, and is the result of some years' experience in lectures on the chemical arts, delivered by the writer before the Franklin Institute of Philadelphia. Doubtless, it will be found imperfect, but it is fair to offer as an apology, the difficulty experienced by the chemist in separating in his mind the composition and properties of bodies from their connection as objects of manufacture, and in breaking down long-cherished associations of purely chemical characteristics.

Chemical affinity may be regarded as the force employed in the chemical arts; fuel and water, as the principal agents used to modify or direct this force; and the crude productions of the mineral, vegetable, and animal kingdoms, as the materials



subjected to action. The air performs less important functions, as a direct agent; but, in conjunction with fuel, it is indirectly an indispensable agent, in developing heat by the union of its oxygen with the carbon and hydrogen of fuel. Fuel is, however, the true agent in this case, practically considered, because it can be handled, weighed, and measured, by the artisan, and is indispensable in the reduction of metallic ores. We therefore regard fuel as the source of heat in the arts; and since the larger proportion of the more important technical processes are more or less controlled by heat, it must be viewed as the principal agent or modifier of affinity. Hence the sources and management of heat should be the first subject treated of in a classified narration of technical processes. It may be followed by its application to the warming of buildings, which, in its manifold aspects of economy, convenience, safety, and the health of man, embraces the forms of apparatus in which it is employed, and the subject of ventilation.

More naturally connected with fuel than with any other department of the arts are the means of obtaining and of extinguishing fire: the preparation of those mixtures of combustibles with condensed forms of oxygen, such as gunpowder, and other projectile and destructive agents, together with their allied compositions for ornamental displays of fire. These may be embraced under the term *Pyrotechny*.

The whole of the first subject, included under the term *Calories*, admits of the three subdivisions or groups: Fuel and Furnaces, Warming and Ventilation, and *Pyrotechny*.

One of the simpler applications of heat to modify mineral substances, is the fusion of sand and alkali to glass, which is highly plastic when sufficiently heated, and in that state receives the form which it retains on cooling. Another application is to the semi-fusion or baking of clay-ware, which, having been previously plastic by admixture with water, and having then received its form, is heated to a point below perfect fusion to give that form permanence. Allied to these is another plastic art: the making and use of cements and mortars, including plaster-



casting, and making artificial stone. All these are embraced under the general term of *Plastics*; of which glass-making is Pyroplastics; cements, Hydroplastics; while the art of potting partakes of the character of each.

Another important but more complex application of fire is to *Metallurgy*, wherein fuel is both the source of heat and the chief means of reducing ores to the metallic state. It will be observed, that, while the fluxing of ores naturally connects metallurgy with the pyroplastic arts of glass and pottery, the construction of furnaces and moulds indicates its dependence upon hydroplastics. Modern chemistry has enriched metallurgy with a new department, Galvanoplastics, and with a variety of processes in which the metallurgic treatment of ores is effected by solutions. We may, therefore, conveniently divide the subject into Pyrometallurgy and Hydrometallurgy. For the present, it is proper to regard Photography as a branch of the latter, with which it stands in intimate connection.

Metallurgy and plastics, having each their branches, in which aqueous action plays a conspicuous part, are thus naturally linked with a long series of arts in which water is the prime agent in modifying and directing the force, affinity; and the connection is still further established by the fact, that the substances acted on are mostly confined to those of the preceding classes, alkali, earth, and metal. The arts in the present class, having for their chief object the preparation of simple chemical compounds, acid, oxide, and salt, and being conducted on purely chemical principles, have received the general term of *Chemics*. Water is the medium of action, the solvent for acid and alkali, in which they exert their powerful and contrary effects; the solvent for salts, in which they are decomposed and resolved into new and useful compounds. The manufacture of sulphuric acid, usually regarded as the keystone of the more purely chemical arts, and its use in transforming common salt into the alkali soda, introduces a series of various connected and derivative arts, conducted on a large scale, whose elements are to be found in plastics, and which may constitute a convenient division of chemics, called



Salines, or the saline arts. While we have seen the arts of the preceding class extract the metals from their ores, the next division of chemics subjects them to such treatment in solution, as to convert them into many useful compounds, such as pigments, salts employed in dying tissues, &c. This group constitutes the Metallosalines. The making of fine chemicals and pharmaceutic preparations is connected intimately with the preceding saline arts, being conducted in a similar manner, but on a smaller scale, and with greater nicety; it also depends chiefly on the products of those arts as its means of action, and partly on them for materials to be acted on. This forms, therefore, the third group of the chemic arts.

It may have been observed that the arts of the preceding classes are chiefly devoted to the preparation of tools whereby to work upon, vessels wherein to operate upon, or materials wherewith to modify the various crude productions of organic and partly inorganic nature, in order to adapt them to the manifold wants of man, whether to minister to his comfort or luxury. Clothing, food, and the comforts of life are therefore mainly embraced by the following technical processes. The most extended application of the chemical products derived from the preceding class, is to the ornamenting and modification of tissues, which embraces the beautiful and varied arts of dyeing and calico-printing, or ornamenting Textile fabrics. With these are linked the kindred arts of making Sheet-fabrics, paper, leather, &c., as well as working in caoutchouc and gutta percha. To modify and ornament fibrous, sheet, and solid tissues, varnishes and cements are employed, and are classed under the general term Adhesives. The principal subjects of this class being the ornamenting of woven fabrics, it has received the name *Calistics*, (*καλος*, and *ιστος*, *loom*.)

The use of soap for general purposes of cleansing, and chiefly of cleansing textile fabrics, follows the preceding in a natural sequence, and serves to group a series of arts, rather allied by unity of material on which they operate than by unity of object in view. They include the extraction and purifica-



tion of oils and fats, the preparation of soap, and the various articles of the perfumer; and, lastly, Illumination, which includes chandlery, the manufacture of gas, with the various substances and apparatus which afford light, such as burning-fluids, lamps, and jets. *Oleics* is an appropriate term for the class.

After the arts which supply man with clothing and minister to other external wants, those which afford him nourishment follow, and may be conveniently grouped under the term *Sitapsics*, (*σιτος*, food, and *ἑψω*, cook, prepare.) The extraction of farinas and sugar, with the refining of the latter, are followed by their modification under the singular process of fermentation and conversion into alcohol, which, in its turn, is readily changed into vinegar during the acetous fermentation. The various culinary arts form another convenient group of the domestic arts, embracing the preparation and preservation of food.

The whole series of chemical arts may be closed by chemical agriculture, or the art of directing and controlling the growth of plants and animals, whence its name *Biotechnics*, (*βίος*, life, *τεχνη*, art,) in order to render their products, in quantity and quality, most suitable to the demands of the arts or the more immediate wants of man. To effect this, the influence of the air, water, and soil, of mineral substances and manures, on the growth and productions of plants, must be studied; the composition of their ashes, under different circumstances of growth and product, examined; the influence of food and other circumstances on the growth of animals and of their parts, such as hair, horn, fat, &c., must be investigated. These important observations in organic life constitute a true art, as yet in its infancy; and it is of a chemical character, so far as it is pursued with a chemical object in view, (the quantity and quality of organic product,) and by chemical agency, (minute, practical analysis.) We may consider it under the several heads,—of the chemical changes observed in the formation of useful products in plants and animals, including the peculiar chemical character of such products; of the in-

fluence of mineral and organic manures on the special products of plants, and of various conditions on the products of animals; and the examination of the ashes of organized bodies, with a view of supplying such as may be required for obtaining special products. These subjects are most conveniently grouped in this manner at the present time; but as the art becomes more fully developed, the very different nature of plants and animals, and the different influences exerted upon each domain of organic life, will cause their separation.

The following is a tabular view of the arts, classified in accordance with the principles above laid down.

JAMES C. BOOTH.

PHILADELPHIA, 17th March, 1851.



*Tabular View of the Chemical Arts.*

CLASS.	GROUP.	PRINCIPAL SUBJECTS.
I. Calorics.	1. Fuel and Furnaces.	{ Coal, wood, coke, &c. { Reverberatory, blast furnaces, &c.
	2. Warming and Ventilation.	Stoves, hot air, steam, water.
	3. Pyrotechny.	Matches, gunpowder, fireworks.
II. Plastics.	1. Pyroplastics.	Glass, enamel.
	2. Pottery.	Brick, earthenware, porcelain.
	3. Hydroplastics.	Lime, mortar, gypsum.
III. Metallurgy.	1. Pyrometallurgy.	Reductions of ores by fire.
	2. Hydrometallurgy.	Galvanoplastics, photography.
IV. Chemics.	1. Salines.	Oil of vitriol, soda, nitre, alum.
	2. Metallosalines.	Metallic salts, pigments.
	3. Pharmaceutics.	Inorganic, organic.
V. Calistics.	1. Textile fabrics.	Bleaching, dyeing, calico-printing.
	2. Sheet fabrics.	Paper, leather, caoutchouc, gutta percha.
	3. Adhesives.	Resin, varnish, glue.
VI. Oleics.	1. Oils and Fats.	Extraction and fining, &c.
	2. Saponification.	Soap, essences, perfumery.
	3. Illumination.	Chandlery, gas, burning fluids, lamps, jets.
VII. Sitepsics.	1. Farina, &c.	Starch, flour, sugar.
	2. Fermentation.	Alcohol, wine, beer, vinegar.
	3. Culinary arts.	Preparation and preservation of food.
VIII. Biotechnics.	1. Physiology.	Plants and animals, ashes.
	2. Manures.	Putrefaction, mineral manures.
	3. Products.	Milk, fat, bone, horn.

## I. CALORICS.

THIS general division of the chemical arts receives consideration from its principal subject, fuel, being the more important of the two chief agents employed in these arts to modify affinity, to break up existing, or to form new combinations. We cannot conveniently divide the arts according as they are acted upon by fuel or water, for these two prime agents are often employed simultaneously in a single process. While, therefore, the first classes of the arts are chiefly controlled by the action of heat, they are not exclusively so; and, again, those which follow, although depending mainly on solution, are likewise more or less influenced by temperature.

### 1. FUEL AND FURNACES.

The various kinds of fuel employed in the arts may be most conveniently divided into two groups: those consisting chiefly of carbon, which burn without flame, and those containing both carbon and hydrogen, which burn with flame. The division is convenient, since flaming fuel is better adapted to certain arts, and flameless fuel to others; and in any particular art requiring one of these species, it is rarely a matter of moment which one of them is employed, the selection being usually one of economy or convenience. The following are the varieties of fuel:

<i>Flameless.</i>	<i>Flaming.</i>
Anthracite,	Bituminous coal,
Coke,	Wood,
Charcoal.	Rosin and Gas.

To each of these may be added artificial fuels, which may be made to burn either with or without flame.

The furnaces employed in the arts are the boiler furnace, or that employed to generate steam in a boiler, in which, flaming fuel being generally used, the fire is maintained by a



simple draft of air; the kiln, as the lime and brick kilns, to which flaming fuel is best adapted, and where the body to be heated may or may not be brought in contact with the fuel; the crucible furnace, in which a crucible containing the body to be melted or acted on is either surrounded by and in contact with flameless fuel, or in the glass and pottery furnaces, being at a distance from the fire, is heated by flame alone; the reverberatory furnace, in which the substance to be acted on is placed on a hearth and the flame from the fire place is deflected upon it by the low arched cover of the furnace; the blast furnace, in which the fuel, metallic ore, and flux being mingled in an upright shaft, an intense heat is obtained by forcing in a large amount of air by bellows driven by machinery. Although these are in general the different kinds of furnaces employed, yet their forms are constantly subject to variation, according to the special object in view and according to the theoretical notions of the manufacturer. Thus, when anthracite is used to generate steam, it is usual to drive a larger amount of air upon it by a fan-blast than could be supplied by a simple draft. Since the employment of anthracite in the iron blast-furnace, it has been found more advantageous to give greater width to the boshes.

*Pungernite*.—This new combustible, found by Bulganne in the Silurian formation of Russia, burns freely, but yields less carburetted hydrogen and heat than coal. Petzold's analysis (Athenæum, 1850) gives:

Organic matter.....	65.5
Silica.....	13.6
Ox. iron and alumina.....	2.3
Carbonate of lime.....	17.0
Carbonate of magnesia.....	0.2
Water.....	1.2
	<hr/>
	99.8

*Coal*.—For a full view of the statistics of coal, we refer to the excellent work of Mr. Richard C. Taylor, who points out the various deposits of this mineral on the surface of the globe,



and, as far as practicable, their extent and value. For the evaporative power of coal, consult the papers of Dr. Fyfe, in the *Philosophical Magazine*, and the extended observations on American coals by Prof. W. R. Johnson, printed by order of Congress.

For full analyses of a large number (47) of coals, anthracite, bituminous, and brown coals, as well of turfs and a few woods, we refer to the *An. Rep. of Liebig, Kopp, &c.*, p. 350, 1847-8. The same work, p. 353, gives the results of practical experiments, together with analyses of many English coals (30), conducted under the direction of De la Beche and Playfair. They determined, 1. The practical evaporative power, the number of pounds of water at  $212^{\circ}$  converted into steam by 1lb fuel. The average was 8.695lb water evaporated, the range being from 7 to 10. 2. The practical value after deducting the coal left in the ash. 3. The evaporative power calculated from the reduction of litharge by Berthier's process. 4. Weight of the fuel per cubic foot of stowage, from direct measurement. 5. Ditto, calculated from specific gravity. 6. Percentage loss by attrition. 7. Evaporative power, calculated from 2 and 4. We refer for these details to the paper in the *Mechan. Mag.* 1849.

Vaux's analyses of Engl. Coals, see in *Journ. Fr. Inst.* (3) xvii. 197.

Whoever witnesses the enormous amount of fine coal thrown in heaps near the anthracite mines, regarded as valueless and allowed to be washed away by streams, must have regretted the waste of a quantity of fuel which will never be recovered. Many patents have been issued in England with the view of saving fine culm, by mixing it with adhesive combustibles, such as coal, tar, &c., and pressing it into blocks. A late patent proposes mixing dried and ground spent tan with rosin-oil, or melted rosin, and compressing into blocks. (*Lond. Journ.* Sept. 1850.) Another patent (*L. J.* Oct. 1850) uses, also, refuse tan and peat with coal-tar, &c. But all these processes would seem to be ineffectual at our anthracite mines, because not sufficiently economical in comparison with the



price of coal. It is to be hoped that a process will yet be devised, by which the fine dust and waste may be rendered equal in value to the pure anthracite, or even superior to it for some purposes where more flame is required.

The use of plaster and other like cements, to unite fine coal into block or masses for fuel, as proposed by Hollands and Whittaker, (Lond. Journ. p. 39, 1849,) is objectionable, since it does not "add fuel to the fire," but 10 per cent. ashes, in addition to the larger amount of ash usually in fine culm.

*Reverberatory Furnace.*—The air is often admitted to the sides, &c. of a reverberatory, by leaving interstices for it to enter. Portions of melted matter dropping down, often choke these interstices; to prevent which, A. Dalton proposes making the upper part project over the openings. (Lond. Journ. xxxvii. Aug.)

*Portable Blast Furnace.*—Barron Brothers' blast furnaces require special notice, on account of the economy of time and fuel which their use exhibits, although the peculiar method of using the blast claimed for them has hitherto been applied only to small portable furnaces, used by jewellers, brass-founders, &c. This peculiarity consists in having the twyers of much larger dimensions than usual, and fitted with a straight pipe projecting some inches from the outside of the furnace, the size and projection proportioned to the size of the furnace. The blast, of moderate tension, issues from a nozzle a little less than the diameter of the pipe, into which it does not enter, but terminates just outside of it. The blast being urged, enters the pipe, and drawing in with it a body of surrounding air, with which it becomes mingled by the length of the pipe, enters the furnace as a broad current of air. The peculiar effect of the arrangement is shown by taking out the pipe, passing the nozzle into the twyer as in ordinary furnaces, and closing the twyer around it with clay. When thus circumstanced, there will not be melted more than from one-half to one-fourth of metal in a crucible put in the furnace, as will be melted when arranged as above described. The small portable blast furnaces are of four different sizes, adapted to



smaller or larger operations, whereby, as well as on account of the form of the furnace and the mode of blast, great economy of fuel is attained. They are accompanied by a table with cast-iron top, beneath which is a bellows worked by the foot, and through which three jets rise which can be adapted to the tuyers of any of the furnaces. We give this detailed description, because our practical acquaintance with them in the operations of the laboratory enables us to give a most favourable opinion of their excellence; and, having seen them in operation in the hands of practical melters, for fusing, soldering, &c., we can speak of their general practical value in the arts. The enterprising originators of these furnaces are about applying the same principles to larger cupola furnaces for melting iron, and to other furnaces, large and small, for various metallurgic operations. They are made by Barron Brothers, No. 6 Platt street, New York.

## 2. WARMING AND VENTILATION.

Little has been added to our stock of knowledge on these subjects during the last few years; but, if we were to apply what we already know, doubtless general health would be greatly benefited. Our public places of assemblage and our dwellings are heated to a tropical temperature, by air, the dust of which has been subjected to dry distillation by passing over a red-hot iron surface, and produced fumes of empyreumatic oils and tarry matters, which we endeavour most sedulously to prevent escaping, by barring up all avenues and chinks communicating with the external air, except those accidentally produced. In ventilation, there is still less attempted. It may be that masons and carpenters design to leave behind them, when their work is completed, a generally diffused system of ventilation, by half-filling the places in walls with mortar, and putting in green wood, which shrinks and cracks in every direction; but it is hardly necessary to say that this fanciful kind of ventilation is not based on very sound principles. It is sad to reflect on the badly heated and not ventilated school-rooms in the now widely diffused public-



school system, where some hundred thousand children in the United States, breathing a pestilential air, are shrivelled by a parching heat, and doubtless lay the foundation of life-shortening diseases. The remedy should be applied by the architects; but, since few of them have properly attended to this subject, those who engage their services should oblige them to defend us from internal inclemency of the weather by suitable arrangements for heating and ventilation, as well as from external inclemency, in the buildings they construct. Beside the essays of Reid on warming and ventilation, there is a small work in Weale's Rudimentary Series, published in 1850, which may be consulted. On the warming and ventilation of the Lunatic Asylum, Philadelphia, see Journ. Fr. Inst. (3) xix. 270.

### 3. PYROTECHNY.

The discovery of the properties of gun-cotton has led to an attempt to find other compositions to replace gunpowder, one of which we notice.

*A new Gunpowder.*—Augendre has found that a mixture of 1 part yellow prussiate of potash, 1 part white sugar, and 2 parts chlorate of potassa, when separately reduced to a fine powder, and then mixed by hand in a wooden mortar, or larger quantities, moistened with 2 or 3 per cent. water, and mixed in a bronze mortar with a wooden pestle, and then granulated and dried in the usual way, will give a gunpowder which is readily fired by contact with an incandescent or lighted body. The mixed powders will act well without granulation. Its advantages are, that it is formed of substances of uniform composition, which are unalterable by dry or moist air; the powders may be kept separate, and mixed when wanted, and the mere mixture acting like the granulated powder; the force is greater than that of common gunpowder. Its disadvantages are that it inflames more readily than gunpowder; and it oxidizes iron barrels so much that its use must be confined to bronze metal.

*Gun-cotton.*—According to Marx (Pogg. An. lxxviii.) the average temperature at which gun-cotton explodes is  $199^{\circ}$ , if



suddenly raised, although it may explode at as low as  $144^{\circ}$ . By gradual elevation of the temperature, so as not to exceed five degrees per minute, the liability of explosion is considerably lessened. Care should be taken to pack it in vessels which will not convey heat interiorly, since metallic vessels may become heated to  $144^{\circ}$  by exposure to the sun's rays.

Averos (*Comptes Rendus*, xxiii.) gives the following as the results of his experiments on gun-cotton:

1. Equal parts of sulphuric and nitric acids, and clean cotton.
2. Time of exposure, 10–15 minutes.
3. The mixture may be used again.
4. The cotton should not project above the liquid.
5. It should be slowly dried, and not exposed to a heat above  $212^{\circ}$ .
6. The cotton acquires more force by impregnation with saltpeter.

Explosive paper is prepared, according to Pelouze, by dipping it for 20 minutes in concentrated nitric acid, washing it thoroughly with water, and drying it at a gentle heat. It takes fire at  $356^{\circ}$ , and explodes with great violence, leaving no residue.

Cotton has the formula  $C_{24}H_{21}O_{21}$ , and gun-cotton  $C_{24}H_{16}N_5O_{41}$ . Hence, 5 eq. water ( $HO$ ) are removed from cotton and replaced by 5 eq. nitric acid; or  $H_5$  are removed and replaced by  $5NO_4$ , thus,  $C_{24} \overset{H_{16}}{(NO_4)_5} O_{21}$ .

1 grm. gun-cotton yields by explosion 588 cub. cent. gas (at  $32^{\circ}$  and 0.76<sup>m</sup> pressure), which has the following composition by volume:

17.03	carbonic acid.
47.45	carbonic oxide.
20.41	nitric oxide.
6.75	nitrogen.
8.36	carburetted hydrogen (CH).

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100.00



*Charcoal.*—Violette has applied highly heated steam to char wood, for the purpose of making a superior charcoal adapted to the manufacture of common gunpowder. The wood being enclosed in a cylinder, concentric within another which is heated, the steam from a low-pressure boiler is highly heated in a tube-coil, in the same fire which heats the cylinder, and enters the outer cylinder at one end, from which it enters the wood and expels the more aqueous and less combustible volatile portions. A black or red coal is produced, according to the heat and length of exposure to the steam. (Lond. Journ. 50. 1849, and J. Fr. Inst. (3) xvii. 281.)

*Pure Oxygen.*—According to Poggendorff, Chevreul, and Vogel, the oxygen made from commercial chlorate of potassa always contains chlorine derived from some perchlorate in the original salt. After repeated crystallizations the chlorate will yield pure oxygen. (Buch. Rep. iii.)

*Preventing and extinguishing Combustion.*—To render combustible substances incapable of combustion, at least incapable of spreading fire, is evidently a desideratum, and various substances have been proposed at different times to effect this result. In most cases they have been solutions, which are applied to the surface of wood, &c., and penetrate it but a short depth, or not at all. Of these, silicate of potassa (soluble glass) has been most preferred. Their action is, however, limited to the prevention of inflammation from sparks falling on a surface thus prepared. R. A. Smith (Phil. Mag. xxxiv. and Amer. Journ. 2d ser. viii. 118) proposes impregnating wood, &c. with a solution of sulphate of ammonia, which, if heated, is resolved into sulphurous acid, nitrogen, &c., which would tend to extinguish commencing combustion.

The following composition, among others, has been given for extinguishing fires: a mixture of 1 part powdered sulphur, 1 part red ochre, and 6 parts copperas, added to the water of a fire engine is said, from experiment, to do five times as much execution in extinguishing fire as water alone; it also diminishes the annoyance of smoke and steam. It doubtless operates in a large measure from the evolution of sulphurous



acid, but it is probable that anhydrous sulphuric would also be evolved.

*Fire Extinguisher.*—Phillips has invented an apparatus (Rep. Pat. Inv. Sept. 1850; Chemist, 1850, and Pharm. Jour. x.) for extinguishing fires by gases incompatible with combustion. It consists of an iron cylinder, 2 feet by 8 inches, having at its bottom a shallow chamber filled with water. There is also a smaller cylinder, connecting at the side, and enclosing a brick composed of nitre, charcoal powder, and sawdust. In the brick is a vial with two compartments,—the upper containing oil of vitriol, and the lower a mixture of chlorate of potassa and sugar. A plug is fitted into the cover of the apparatus in such a position that a sudden blow may cause it to crush the vial and thus ignite the contents. An instantaneous and forcible issue of carbonic acid and oxide, steam and nitrogen follows, and this stream of vapor, directed upon the blazing fire, smothers and extinguishes it.

Experiments have proved that this arrangement is not effective in open places, where the current of air is very strong. It may, however, be serviceable in confined places, such as the hold of a vessel.



## II. PLASTICS.

### 1. VITRIFICATION, OR GLASS-MAKING.

WE offer a few points in relation to glass, plain and colored, and introduce, also, the subject of gems, as most allied to glass.

*Bohemian Glass.*—The glass of which combustion tubes are made has been examined by Ronney, and found to consist of:

Silicic acid.....	73.13
Lime.....	10.43
Alumina.....	0.30
Sesquioxide of iron.....	0.13
Magnesia.....	0.26
Protoxide of manganese.....	0.46
Soda.....	3.07
Potassa .....	11.49
	<hr/>
	99.27

*Optical Glass.*—Maes and Clémandot (Comtes Rendus, 1849), having studied the influence of borax in the manufacture of glass, have announced that the borosilicates of potassa, with lime, soda, or zinc, are eminently suited for optical purposes, owing to their remarkable hardness and transparency.

*Colored Glass.*—See an excellent essay by Bontemps, on the substances used for colored glass, in the Phil. Mag. (3 ser.) xxxv. 439.

*Aventurine Glass.*—Wöhler and others analyzed this glass, which comes from Venice; but Fremy and Clémandot have lately imitated it. (Comptes Rendus, Février, 1846.) They heated a mixture of 300 pts. powdered crystal glass (glass with a less portion of lead than flint-glass), 40 pts. suboxide



of copper, and 80 pts. iron scales (smithy slack), for 12 hours, and suffered the fused mass to cool slowly. The oxide of copper is reduced by the iron, which latter forms a silicate that scarcely tinges the glass, while the minute crystals of metallic copper, suspended in the glass, impart to it its peculiar appearance.

*Hæmatinone* is the name of a beautiful, red, opaque glass, employed by the ancients in mosaics. Analysis showing its coloring matter to be copper, Pettenkofer asserts that he has succeeded in producing it, and that it can be made in quantity. A similar glass is not unfrequently obtained in testing copper with borax by the blowpipe.

*Ruby-glass.*—H. Rose has examined gold-glass and gives the following views on it. (Verhandl. d. Berl. Acad. and Journ. f. Pract. Chem. xliii. 75.) When colorless gold-glass is gently ignited, it become ruby-red, still retaining its transparency, whether heated in oxygen or carbonic acid. The red glass fuses in the flame of the hydroxygen blowpipe to colorless drops, which do not redden again by heat. Splittberger thinks that the colorless glass contains peroxide of gold, and that this is reduced to protoxide, which precipitates and colors the glass red. Rose holds that the peroxide is not contained in the glass, because it is a very feeble base, if a base at all, and because the reddening may occur in oxygen. But as the protoxide is a base, forming salts, some of which are quite fixed at a high temperature, (as the purple of Cassius, which Berzelius regarded as stannate of protoxide of tin and protoxide of gold,) Rose assumes a protosilicate of gold in the colorless glass, from which heat precipitates the protoxide and gives the red color. He compares it to glass colored red by suboxide of copper, which is colorless after fusion and becomes red by reheating, and that this change takes place even when the colorless copper-glass is covered on both sides by common flint-glass. He further supports his view by the similar atomic composition of suboxides of copper and gold. The brownish color of gold-glass, too highly heated, he refers to a reduction of oxide of gold to the metallic state.



It should be mentioned that some chemists hold that the red color is due to the precipitation of metallic gold.

*Hydrated Silicic Acid.*—Ebelmen's neutral silicic ether (silicate of oxide of ethyl) is slowly decomposed by the moisture of the air, yielding alcohol, and hydrated silicic acid ( $2\text{SiO}_3, 3\text{HO}$ ), which resembles natural silica, scratches glass, and has a spec. grav. of 1.77. By mixing colored tinctures with the ether, the silica may be obtained of various colors.

*Artificial Brilliants.*—Those from Austrich in Paris, analysed by Köttig (Journ. f. Pract. Chem. xxxiv. 458), consist of 38.8 silica, 53 oxide of lead, and 8.2 potassa and soda, with traces of iron and alumina. They are therefore similar to paste (or strass), and exhibit much brilliancy and refraction.

*Artificial Gems.*—To make gems, Ebelmen avails himself of the two properties of boracic acid, of dissolving metallic oxides by fusion, and volatilizing at a higher heat. His process resembles the solution of substances in water and the evaporation of that water to obtain crystals. Having made a mixture of alumina and magnesia, in the same proportion as they exist in spinell, and added  $\frac{1}{2}$ –1 per cent. bichromate of potash, he added to 2 pts. of this mixture 1 pt. fused boracic acid, and exposed it in platinum resting in porcelain to the heat of the porcelain furnace of Sèvres. The product contained cavities lined with minute, rose-red, octahedral crystals, harder than quartz and infusible before the blowpipe. They had all the characters of ruby. The constituents of emerald, treated in the same way, yielded small hexagonal crystals, harder than quartz, and therefore agreeing with true emerald.

*Grinding and Cutting.*—For a full account of the emery localities of Asia Minor, see J. L. Smith, in Amer. Journ. 2d ser. x. 354, &c., and in Lond. Journ. Oct. 1850.

*Diamond Carbon.*—For an account of this curious substance, see Journ. Fr. Inst. (3) xvii. 47.

*Coke.*—According to J. Nasmyth (Ch. Gaz. vi.), common coke possesses the property of cutting glass in as clean and perfect a manner as the diamond.

*Silvering.*—Glass vessels may be beautifully ornamented by



coating one surface (the inner, if hollow) with a silvering liquid (see Hydrometallurgy), and then cutting or otherwise ornamenting the outer surface. (Thomson and Varnish, in Lond. Journ. xxxvii. Aug.)

## 2. SEMIVITRIFICATION,

Or the making of brick, earthen-ware, stone-ware, fine pottery, and porcelain. The basis of these arts is clay, which is often unmixed for brick; consists of finer and coarser clays for earthen-ware; of still better for stone-ware; of the best clays, quartz, and feldspar, for fine pottery and porcelain. The materials for all these wares, except brick, are ground fine, made into a slip with water, partially dried to a plastic state, in which state they are formed, by pressing, throwing and moulding, into the endless varieties of forms which we daily witness. A glaze is given to the surface by covering it with red lead, for common ware; with a fusible flux or glass containing lead, for the better wares; and with a glaze chiefly composed of feldspar, for porcelain. A very high heat is given to common earthen-ware, and a much higher to porcelain, sufficient to cause the ware to undergo incipient fusion. The subject presents a wide field for improvement by the application of chemical principles, although at the present time we need more of sound practice in the United States, especially in the finer kinds of clay-ware. Our common and fire bricks, and common earthen-ware and stone-ware, are already of excellent quality, and our black-lead crucibles are superior to the German, the best being made at Taunton, Mass., and Jersey City, opposite New York. We employ pots from both establishments at the United States Mint, and melt in them about 2500 oz. gold at once. Although the quality is not uniform, they are generally excellent.

Some attempts have been made to produce fine pottery (Faience, Liverpool-ware), but few have met with success; and among the latter we may mention the Pottery Company at Jersey City, and the Spring Garden Pottery, Philadelphia.



Porcelain was made at Jersey City in 1816, and a successful establishment was conducted at Philadelphia for some years, but closed in 1836. Stone-ware of good quality is made in many places, especially in New York, Philadelphia, and Baltimore, but it is not yet equal in quality to the Lambeth-ware of London. We believe the location is yet to be found, where many potteries can gain a permanent foothold; the first essential being bituminous coal; the next, good clays in some abundance; and the third, facility of communication by water or railroad. The finer qualities of clay and feldspar will bear transportation, and may even be obtained on our seaboard, from Devonshire, &c., England, at about the same cost as they are in the Staffordshire potteries. The most likely position for a potting district is in western Pennsylvania, or on a few points on the Ohio or Missouri rivers, where the first and greatest essential, fuel, is abundant.

There are few novel points of interest in these arts, which we present below. The general principles of painting and staining glass and clay-ware are so similar that they may be treated together, although we have separated them for convenience.

*Fire-clay from fusible clay.*—Gaffard gives the following method of effecting this result. (L'Institut, No. 594, p. 175; Berz. Jahresb. 1846, 293.) A good quality of clay, but not fire-clay, is mixed to a paste with muriatic acid, and, after some time, heated to boiling. The acid is run off, and the clay fully washed and dried. Clay, thus treated, was made into crucibles, in which bar-iron was fused, without their becoming softened by the heat. The acid simply extracts a large proportion of those bases (lime, iron, &c.) which tend to flux the principal part of clay, the silica and alumina; but the question of economy will influence the use of this remedy for the fusibility of clay, and it is doubtful whether the process will be adopted by manufacturers.

*Porcelain.*—An interesting series of experiments has been made by Dr. Wächter in Berlin, in which he ignited various mixtures of feldspar and kaolin, and, in connection with Dr.



Oschatz, examined the products microscopically. The result was a refutation of the usually received opinion that porcelain is a mere mixture of fused feldspar and unaltered kaolin, the latter of which is the cause of its opacity; for it was shown that it consists of a glassy mass, filled with an infinite number of minute needle-shaped crystals, which produce the opacity of porcelain.

Wilson's analysis of Berlin porcelain gave the following results:

Silica .....	71.34
Alumina.....	23.76
Oxide of iron.....	1.74
Lime .....	0.57
Magnesia .....	0.19
Potassa .....	2.00
	<hr/>
	99.60

Couper has published a series of analyses of the materials and products of English potteries, in *Phil. Mag.* (3) xxxi. 435, to which we refer for details.

*Yellow Flux for Porcelain Colors.*—Salvetat's analysis of such a flux from Sèvres, led him to make a similar one of the following composition: 88 pts. gray flux,  $3\frac{1}{2}$  pts. oxide of zinc, 7 pts. hydrated peroxide of iron, and  $1\frac{1}{2}$  pts. binantimoniate of potassa. The zinc is prepared in the dry way, and the gray flux consists of 22 pts. sand, 11 pts. fused borax, and 66 pts. red-lead. The substances are finely powdered, fused twice and cast out on an iron plate. It facilitates the fusion of colors and gives them body without altering their tone, as it is itself very pale.

*Aventurine Glaze for Porcelain.*—Wächter (*Liebig's Annalen*, 1849; *Amer. Journ.* 2d ser. viii. 440, and *Chem. Gaz.* 1849) proposes the following enamel for porcelain, in which the golden iridescence is produced by a crystalline separation of oxide of chromium from the brown ferruginous mass of the glaze:



Porcelain clay from Halle, washed over and dried .....	31
Dry quartz sand .....	43
Gypsum .....	14
Porcelain cullet.....	12

It is to be mixed thoroughly with 300 pts. of water, and then incorporated successively with aqueous solutions of

Bichromate of potassa.....	19
Protosulphate of iron.....	100
Acetate of lead.....	47

Ammonia is now added until the complete separation of the iron, and the potassa and ammonia salts then removed by washing and decantation.

*Red Pigments for Porcelain.*—Salvetat, in his elaborate and valuable paper (Ann. de Chem. et de Phys. 1849) upon the red pigments used in porcelain painting, gives analyses of the celebrated chromatic series known as Pannetier's. The shades which they impart are said to be unequalled for beauty, brilliancy, and transparency.

The series consists of eleven tints, as follows :

Orange.
No. 1, or Capucin red.
No. 2, or blood “
No. 3, or flesh “
No. 4, or carmine “
No. 5, or lake “
No. 6, or pale violet red.
No. 7, or iron “ “
No. 8, or dark “ “
No. 9, or very dark violet red.
Gray.

The flux is the same for all, and consists of silex, borax, and minium. The coloring matter of all but the orange and Nos. 8, 9, 10, is exclusively peroxide of iron; and the modifications of tint are due to a variation of the proportions, and particularly to a difference in the intensity of heat employed.



The orange contains, in addition to oxide of iron and flux, some oxide of zinc, with traces of alumina; and Nos. 8, 9, and 10 have oxide of manganese as part of their composition. The traces of alumina found in some of them do not act any important part, as its presence is not necessary in the preparation of vitrifiable pigments.

These tints are not equally permanent. The strength and blueness of tone increases with the temperature to which the pigment is subjected; the yellow tint predominating at low heats. The greatest purity is insured by using coloring matter prepared so carefully that every particle has been heated, uniformly, to the same temperature.

*Gray Enamel for Porcelain.*—Salvetat (Ann. de Chim. et de Phys. xxv. 342) has given a recipe for a new gray color for porcelain. It is more durable, and more certain and constant in its results, than the usual grays; and, on account of its agreeable tone, greater economy, and facility of preparation, has been introduced into the works at Sèvres, as a substitute for iridium gray. It is prepared by mixing together 1 pt. of platinum powder with 3 pts. of glass, formed of 1 pt. sand, 3 pts. minium, and a half part calcined borax.

*Cement for Pottery and Glass.*—Wächter describes a fusible cement for glass or pottery, which consists of 3 pts. red-lead, 2 pts. white sand, and 3 pts. crystallized boracic acid. They are well mixed in powder, fused in a Hessian crucible, poured out on a metallic plate, and ground fine. When used, it is mixed with tragacanth paste and applied to the parts to be joined, and the piece is then heated in a muffle at a low heat, not quite sufficient to melt the enamel.

### 3. HYDROPLASTICS,

Or making and using mortars, plaster casts, and artificial stone. Under this head may also be included lime and lime-kilns, hydraulic cements, asphalt pavements, and mastic used for coating walls. There is not much of novelty to offer in relation to this subject.



C. Morfit gives the composition of a fresh oyster-shell, as follows:

Water.....	2.25
Organic matter.....	0.90
Carbonate of lime.....	93.89
Matters soluble in water :	
Alumina, magnesia, and phosphoric acid with lime.....	0.70
Chloride of sodium, with traces of sul- phates of soda and lime.....	2.20
	<hr/> 99.94

*Hydraulic Cement.*—According to O. Ostermeier (Jahrb. f. Prac. Chem. xiv. 259), when finely powdered marble, limestone, or chalk, is mixed to a paste with milk of lime, it hardens rapidly, like hydraulic lime, has a feeble alkaline reaction, and resists water tolerably well. The mass is plastic and may be used to take large or small impressions. It forms a basic carbonate of lime, or, rather, a hydrocarbonate, which takes up water of crystallization. The analysis of a genuine Roman mortar from Pompeii leads to the inference that the Romans prepared their mortar from a mixture of caustic and carbonate of lime, with the addition of pulverized calcareous spar.

Kuhlmann's essay, in the Ann. de Chim. et de Phys. Nov. 1847, treats of the part performed by potassa and soda in hydraulic cement. He observes that most limestones, of whatever geological age, contain these alkalies, whence the fertility of a lime soil, and from which we can explain the alkaline efflorescence on newly-constructed walls. He states that a hydraulic cement is made when powdered chalk is moistened with a solution of silicate of potassa (soluble glass); that when exposed to the air, it gradually becomes harder than hydraulic cement; that there is formed some silicate of lime and carbonate of potassa. When chalk, mixed with water to a dough, is brought in contact with a solution of soluble glass (of soda or potassa), it becomes so hard in a few days as to scratch some marbles, exhibits a close grain, and admits of a fine



polish. Only 3-4 per cent. of silica, absorbed by the chalk, impart these properties. This material is well adapted to sculpture and various ornaments. Plaster of Paris (sulphate of lime), treated with soluble glass, is similarly silicated, and even plaster casts become hard and smooth on the surface. But the solution must be very dilute, or otherwise the surface cracks and scales off. If the articles to be hardened are to be exposed to the weather, the glass must be made with potassa, and not with soda, as the latter is more apt to effloresce. (See also Journ. Fr. Inst. (3) xvii. 201.)

The carbonic acid of the air acts an important part in the induration of these compounds, by abstracting the alkali of the silicate, and thus freeing the silica, which, by contracting, promotes the solidification.

Some of the most important principles in Kuhlmann's essay were published by Fuchs, in his excellent essays on lime and mortar (Erdmann's Journ. of Techn. Chem. vi.); on the properties and constituents of hydraulic cements (Polytech. Journ. xlix. 271); on soluble glass (Polytech. Journ. xvii. 465), &c.

A good essay on the action of carbonic acid in hydraulic cements, by Villeneuve, will be found in the Lond. Journ. Sept. 1850.

Prechtel gives the following simple mode of making hydraulic cement. Common burned lime is slacked with a solution of copperas, instead of with water, and then mixed with sand. (It may also be used without sand.) It hardens readily in the air or under water, and becomes very hard. Experiments made with it on a large scale proved very satisfactory. When freshly prepared, it has a greenish color, from the segregation of protoxide of iron, passing into peroxide, when its color is yellowish; and to this oxidation Prechtel ascribes its hardening property. Sulphate of lime is also formed at the same time, and probably a double carbonate. (Polytech. Notizbl. 1846.)

A slag, from an iron furnace, which forms, with lime, a hydraulic cement, has been found to consist of:



	<i>Jacobi.</i>	<i>Grashof.</i>
Silica.....	40.12.....	40.44
Alumina .....	15.37.....	15.38
Lime .....	36.02.....	33.10
Protoxide of manganese.	5.80.....	4.40
“ iron.....	1.25.....	1.63
Potassa .....	2.25.....	2.07
Sulphur.....	0.70.....	0.76
	<hr/>	<hr/>
	101.51.....	97.78

From these results, Elsner has deduced the formula  $2(3\text{CaO}, \text{SiO}_3 + \text{Al}_2\text{O}_3, \text{SiO}_3) + 3\text{CaO}, 2\text{SiO}_3$ .

See essays by Elsner on Puzzolan, &c., in Journ. f. Pract. Chem. 1844–1845, and on slags of blast-furnaces as hydraulic cements, in Verhandl. d. Gewerbv. f. Preussen, 1847. Those slags, decomposable by muriatic acid, are chiefly applicable to cements. The best method of testing them is to pulverize a piece very finely, and pour over it strong muriatic acid. If it become gelatinous in a short time, it is adapted to the purpose. A slag which was proved to be good for making the cement, had the composition: Silica, 40.12; alumina, 15.37; lime, 36.02; protoxide of manganese, 5.80; protoxide of iron, 1.25; potassa, 2.25; sulphur, 0.70 = 101.51.

Plaster, or gypsum, may be boiled or deprived of its moisture by highly-heated steam, as described by Violette. (See Lond. Journ. p. 424, 1849.) See the apparatus for charring described in the present Report, under Pyrotechny, which is varied for adaptation to gypsum.

*Plaster hardened by Salts.*—Boiled plaster, when mixed with a solution of alum, becomes remarkably hard, as shown by Elsner, (Verh. d. Gewerbv. in Preussen, 1843.) A solution of 1 pt. borax in 9 pts. water has the same effect (Keating.) Gay-Lussac observes that raw, unboiled plaster in fine powder becomes similarly hard when mixed with solutions of carbonate and bicarbonate, sulphate and bisulphate of potassa, and even caustic potassa. Soda salts, nitrate and muriate of potassa, are ineffective.



*Artificial Marble.*—Bouisson's patent is only for hardening plaster casts, by immersing them in a solution of alum, after being previously heated to about  $84^{\circ}$  for several hours. Elsner observes, from his experiments, that previous heating is wholly unnecessary.

*Indurated Plaster.*—Objects in plaster of Paris may be rendered like marble by coating them, one or more times, as may be necessary, with a liquid prepared as follows: 2 pts. of stearine and 2 pts. of Venitian soap are mixed with 20 to 30 pts. of cold solution of caustic potassa; and after a half-hours' ebullition, 1 pt. of pearlash is added, and the heat continued for a few minutes. Cold ley in sufficient quantity to produce perfect fluidity is then stirred in, and the liquid set aside for several days under cover. (Archiv. der Pharm. lvi.)

*Artificial Silicious Stone.*—Siemen's patent, taken out for this purpose, in Bavaria, in 1845 (Kunst u. Gewerbebl. 1847), makes silicious stone in the following manner: 100lb of caustic soda in solution is evaporated to 80 quarts, and 1lb silica added for every quart. The solution is effected under a pressure of 4–5 atmospheres. This solution, mixed with quartz sand, hardens to a stone which strikes fire with steel. For building-stone, millstones, &c. 1 pt. of the solution is mixed with 2 volumes of fine silica, and to the whole are added 10–15 pts. sand of different degrees of fineness, and sometimes 5–6 pts. coarse sand or gravel in addition. When the stones are air-dried, they are kept for several days in an apartment heated to  $104^{\circ}$ . They become quite hard in 5–6 days.

*Asphalt, Mastic.*—Asphalt pavements and floors have been successfully tried; roofs of an asphalt mastic have also been tried, and it is also proposed to employ it as a covering for bridges, roads, &c. (Lond. Journ. xxxvi.) The materials usually added to asphalt softened by heat are ground asphalt rock, limestone, sand, &c. Being put on a pavement or floor, in the softened state, the surface may be highly ornamented by inserting pieces or pebbles of various stones of different colors, producing designs in mosaic work, which, when well done, are said to be very durable. The experiment of such



foot-pavements in Philadelphia have not been very successful ; probably owing to want of experience in those who constructed them, or possibly to some defect in the composition. In some instances, the asphalt covering is worn through in the course of a few years ; in others, especially where exposed to the almost constant action of the summer's sun, the asphalt, becoming slightly softened, has been gradually pushed down the slope of the pavement, and appeared like a cascade of lava falling over the curbstone. An experiment made by J. C. Cresson, at the Philadelphia gas-works, some years since, with coal tar boiled down to pitch and thickened with sand, seemed to promise success. It was spread on a wooden floor, exposed to the weather and traversed frequently by carts, and yet showed few signs of complete abrasion, although subjected to so trying a test.

*A Steam Cement.*—An English cement of this kind, analyzed by Varrentrapp, consisted of 2 pts. litharge, 1 pt. fine sand, and 1 pt. fallen lime. After mixing the powder with oil or varnish, it should be used at once, as it soon becomes hard. It is used for stopping up joints in steam-engines.

### III. METALLURGY.

METALLURGY embraces those chemical processes by which metals are extracted from their ores, as well as those by which the crude metal is refined or purified, and may be extended to embrace further operations which have in view the production of alloys, or other modifications, which still present the metallic character. The extension of chemical technology has evolved new processes for extracting metals from their ores, and for producing metallic surfaces and other effects, without the employment of fire, which was an element in former metallurgic processes. These processes being chiefly due to the employment of chemical agents, or the metals themselves in aqueous solution, a distinct branch of metallurgy has arisen, which we term hydrometallurgy, in distinction from the more ancient pyrometallurgy. We have thrown the metals into groups, dependent on their similar mode of occurrence or similar treatment, beginning with iron, which is the most important, and which is exclusively obtained by the reduction of its oxide. Fuel affords heat for breaking up chemical affinities already existing in the native compounds of the ores, and is at the same time the reducing agent for oxides. As ores are never found in a pure state, but always accompanied by foreign matter, this matter is removed by the addition of a flux, which fuses with the foreign matter to a glass or slag (cinder), and is then removed from the metal.

On ancient metallurgy and mining in Britain, see an article by J. Phillips, in *Phil. Mag.* April, 1849, and *Amer. Journ.* (2) viii. 96-102, 258-263.

*Carbonic Oxide.*—Filhol gives a convenient and economical method of obtaining this gas (*Journ. de Pharm. et de Ch.* viii. 99), which consists in gently warming a mixture of 1 pt. sugar or starch with 4 pts. by weight of oil of vitriol, and passing the generated gas through milk of lime or potassa, to absorb



carbonic and sulphurous acid. 20 grm. cane-sugar yield 2 litres gas, of which about  $\frac{1}{3}$  is carbonic acid. We give this method of obtaining carbonic oxide, on account of its importance as a reducing agent, in order that experiments may be instituted with it.

### 1. PYROMETALLURGY,

Or the operations upon metallic ores by fire.

*Iron.*—Wrightson's examinations of ores and iron from Staffordshire, and of the influence of the hot-blast, see in Chem. Gaz. vii. and viii. and Journ. Fr. Inst. (3) xvii. 201.

For one of the most able investigations into the operations of the blast furnace, by Bunsen and Playfair, see Journ. Fr. Inst. (3) xvii. 268, 338, 387; xviii. 24, 136, 218. On the manufacture of iron in South Wales, see Journ. Fr. Inst. (3) xix. 339.

*Application of the Waste-gases of Blast-furnaces.*—The masterly investigations of Bunsen on the working of blast-furnaces, above cited, have shown, that, under ordinary circumstances,  $\frac{4}{5}$  of the heat produced is lost. The use of the waste-gases, proposed and executed in Germany, has been successfully carried out in Pennsylvania and other States, in many furnaces, especially where anthracite is employed, and, we believe, without serious detriment to the working of the furnace; therefore, with greater economy of fuel, where boilers and an engine are employed for blowing. Mr. S. Colwell, of Philadelphia, succeeded so perfectly in abstracting the waste-gases, that, while the furnace was fully charged and doing its usual work below, we have stood upon the charge with impunity, without feeling the heat or observing the stifling sensation of carbonic acid and other gases from the combustion. It is surprising, therefore, to observe that the experiments in Wales have turned out unfavorably, as reported in the Journ. Fr. Inst. (3) xx. 277, and we think the remarks of a collaborator just.

While on this point, we cannot forbear mentioning the white



deposit (often abundant) formed on the boilers and in the flues from the combustion of the waste-gases. A deposit of this kind, from the Conshohocken furnace of Mr. Colwell, was analyzed in the laboratory of one of us, by Mr. W. Fisher and Mr. J. Colwell, and proved to be almost wholly carbonate of potassa. From the Lebanon furnaces of the Messrs. Coleman, Mr. W. Fisher reports that the white deposit was chiefly sulphate and muriate of potassa. The quantities deposited may admit of their application in the saline arts.

*Vanadium in Iron.*—Deck and Wöhler (Ch. Gaz. vi. 298), who examined the refining slag of Staffordshire, which has the reputation of imparting ductility to iron when mixed with it, found that it contained silicate of vanadic acid with minute portions of molybdenum, chrome, and the usual quantities of silicates and of phosphoric acid.

*Arsenic in Iron.*—Schafhäütl has shown the almost constant presence of arsenic and phosphorus in cast-iron, steel, and bar-iron, and connects their observation with the late discovery of both these elements in mineral waters, their ochreous deposits and iron-ores. He attributes the quality of the Danemora iron, and of the Low Moor iron (England) to their content of arsenic, and the quality of some Russia iron to its content of phosphorus. (Journ. f. Pr. Chem. xl. 304.)

*Alkalimetric Test for Iron.*—According to Marguerite (Technologiste, 1846), the iron is dissolved as protoxide, and converted into peroxide by a measured quantity of permanganate of potassa of known strength, and the total conversion is known by the liquid assuming a rose-red tint. The test liquid is obtained by fusing a mixture of 1 equiv. chlorate of potassa, 3 eq. caustic potassa, and 3 eq. binocide of manganese, extracting with a little water, treatment with muriatic acid, until a violet-color appears, and then filtering through asbestos. 1 eq. permanganate of potassa is equal to 10 eq. protoxide of iron. The iron test-liquid is prepared by dissolving 1 grm. pure iron-wire in 20 cubic centimetres pure muriatic acid, diluting with 1 litre water and the permanganate dropped from a graduated tube until the liquid assumes a permanent rose-red



color. The number of measures used corresponds exactly to 1 gm. of iron. The iron-ore to be tested is dissolved in muriatic acid, and any peroxide it may contain is reduced to protoxide by adding crystallized sulphite of soda.

To this test it may be objected that it is difficult to prepare the permanganate with any degree of uniformity, and that if an excess of sulphate be added, the test-liquid would probably not indicate the amount of iron with exactness.

*Carbon in Cast, Steel, and Bar-iron.*—Karsten has endeavored to determine the limits in the amount of carbon, which separate cast-iron, steel, and bar-iron from each other, proceeding on the assumption that their characteristic properties are due to their content of carbon. He first determined the carbon in a single cast-iron by various methods, from which it appears that combustion with a mixture of chlorate of potassa and chromate of lead, or separation by chloride of copper or chloride of silver, yielded the best results. In the white iron from sparry ore, the amount of carbon was 5.586. When iron contains as little as 2.3 per cent. carbon, it still exhibits the properties of cast-iron, especially its precipitation of graphite (making gray iron) when cooled slowly. It is not forgeable when containing 2 per cent., and this property seems to begin with a percentage of 1.9, when it forms steel. The steel is not, however, capable of being welded, and is barely capable of it when the proportion is reduced to 1.75. A percentage of 1.4 to 1.5 indicates the maximum of combined strength and hardness. When the quantity is reduced to 0.5 it is a very soft steel, and forms the proper line of demarcation between steel and bar-iron. These limits are higher with a purer iron, and lower when it contains silicium, phosphorus, and sulphur.

On the *protection of iron from oxidation* by coating it, see Journ. Fr. Inst. (3) xix. 209.

*Reduction of Iron-ores.*—Sir F. C. Knowles' patent for reducing iron-ores consists in heating pure ores in retorts, and passing into them carbohydrogen from the coking of bituminous coal, or carbonic oxide from the combustion of coals. The



ore, when reduced, is transferred to and worked in puddling-furnaces. If steel be the object, the iron is suffered to remain in the retorts a longer time. Although there is every reason to believe that both bar-iron, steel, and cast-iron can be made in this manner, yet we may doubt the economical value of the project, except on a limited scale, for special purposes, and with the best ores. Iron must still be made by the older processes from poorer ores, which are much more abundant than the richer. For details of the patent, see Journ. Fr. Instit. (3) xx. 65.

*Cast changed to Bar-iron.*—Stirling's processes for the conversion of cast into bar-iron are deserving of consideration. To a given weight of cast-iron, about  $\frac{1}{20}$  to  $\frac{1}{5}$  as much scrap-iron is added, most conveniently by putting the scrap-iron into the hollows, which it is designed to fill by cast-iron run directly from a blast-furnace. The pigs are then puddled as usual, taking care that the whole be thoroughly melted. The stream of cast-iron may also be run upon the hearth of a reverberatory, containing scrap-iron, heated to a point below welding; the heat is raised until both are incorporated, and the metal is then run into a puddling-furnace. With better qualities of cast-iron, from  $\frac{1}{10}$  to  $\frac{1}{3}$  of scrap-iron may be used. In order to obtain a malleable iron, harder, less fibrous, and more granular than usual,  $\frac{1}{2}$  or 1 per cent. of tin is added to the malleable iron mixtures above described. Bismuth, antimony, and arsenic will produce a similar effect. Such hard iron is said to work well, while hot, under the hammer, in the squeezer, between the rolls, and in the smithy. Zinc may be employed in the form of calamine. About the same quantity of copper also gives additional hardness to iron. Black oxide of manganese, in the proportion of  $\frac{1}{2}$  to 1 per cent. of the mixed malleable iron, gives a more steely character to it, hardening the iron and facilitating the puddling process. (Rep. Pat. Inv. July, 1850.)

*Bar made from Cast-iron.*—Prof. Miller's (Ch. Gaz. vi.) analyses show that iron made by cementation contains more carbon than good bar-iron, but much less than it did before



this process. The decrease is not in the (graphitic) carbon insoluble in acids, but in the chemically combined portion.

*Steel from Cast-iron.*—The conversion of cast-iron into steel is desirable, if it can be effected rapidly and economically; for articles might be cast directly from a blast-furnace or a cupola, and then steeled to a greater or less depth, without altering their form, inasmuch as only a small quantity of carbon, a small percentage of the weight, is required to be removed. For a large number of purposes, this steeling need not proceed to a great depth, especially where toughness of body is not a requisite.

Attempts have been recently made to effect this decarbonization of cast-iron by burning off a part of the carbon in cast-iron, since it is known that the intermediate qualities of steel between bar and cast-iron are due to its intermediate state of carbonization. Riepe's process (Lond. Journ. Oct. 1850) is a modification of the process for decarbonizing cast-iron in a puddling-furnace by regulating the heat in the finishing process, and adding iron towards the latter part of the process. He also proposes imbedding cast-iron in clay and keeping it at the welding heat of steel, to effect the same purpose; and still further, the oxidation of castings by atmospheric air. The process of making malleable castings is also based on the same general principle. Such processes, as far as we know, can only produce inferior qualities of steel, although they may possibly produce a material having exactly the due quantity of carbon; for as the metal is subjected to a comparatively small amount of working, a considerable proportion of the impurities, silicium, phosphorus, sulphur, metals, &c. will remain in the mass and deteriorate the quality of the metal. The superior quality of steel is mainly due to a more or less perfect removal of injurious constituents, while, at the same time, much iron is oxidized and removed. By any of the processes yet known, it is impossible to avoid labor and loss of iron in making steel, and these seem to be in direct proportion to the quality of steel to be made. Late examinations by Miller of castings rendered malleable by cementation,



(Proc. Brit. Assoc. 1849, Amer. Journ. (2) vii. 276, and Journ. Fr. Inst. (3) xvii. 71), seemed to prove that not only carbon, but even silicium had been extracted. This startling assertion needs further investigation; for, should it be confirmed, the present modes of making bar-iron and steel may eventually give place to, or be modified by, processes of cementation.

*Steel from Bar-iron.*—It would be an important addition to the metallurgy of iron, if we possessed a rapid, economical, and efficient method of partially converting wrought-iron into steel; for iron may be more conveniently forged than cast into many forms, and, if they were then steeled externally, or at certain required points, would possess a core of tough metal with an exterior capable of being hardened. Hence, patents have issued and processes been proposed to effect this object; but we may conclude that the experiments have not been successful, since they have not come into general use. Charcoal, mixed with a little borax, salammoniac and saltpeter, has been proposed (Lond. Journ. xxxvi. 26) as a material to imbed articles forged of iron. As prussiate of potash has a marked effect in converting iron into steel, a bed of charcoal imbued with a solution of the prussiate might answer the desired end. The greatest difficulty lies in limiting the depth of the transformation into steel, since the depth seems to depend on the length of cementation, so that large and small pieces cannot be cemented at the same time in the same bed.

2. *Copper.*—This metal, one of the next in value to iron, is chiefly furnished by Cornwall, England, where, as in most other localities, it occurs in the form of pyrites, or sulphuret of iron and copper. The same ore has recently been found at Perkiomen, on the Schuylkill River, near Philadelphia, in a good vein. The native copper formations at Lake Superior are truly gigantic; but if past experience be our guide, they will continue to yield profitably during a lengthened period of time, only when veins of pyrites shall have usurped the deposits of the native metal.

*Copper and Arsenic, their general diffusion.*—(Moniteur Industriel, 1846,—Dingler's Journ. ciii.) Walchner finds that



very small quantities of copper and arsenic are contained in all iron-ores, in ochres, ochreous deposits from springs, marls, and meteoric masses. It may be proved by dissolving them in pure muriatic acid, passing sulphuretted hydrogen through the solution to saturation, and suffering the precipitate to settle in a stoppered bottle. See also Buchner, Jr., on the content of arsenic, copper, and tin in the mineral waters of Bavaria. (*Gelehrte Anzeigen d. K. B. Acad. d. Wissenschaften*, No. 75, 1847; *Schafhäutl Untersuch. d. Eisenerze*, *Dingler's Journ.* lxxiv. 303.)

*Pelouze's Alkalimetric Test.*—This method, both exact and rapid, depends upon the perfect precipitation of copper from its ammoniacal solution by sulphuret of sodium, and the exact point is indicated by the change from a deep-blue to a colorless solution.

One gramme of the substance to be tested is dissolved in 7–8 cubic centimetres of nitric acid, the solution diluted with water, and, after precipitating any silver that may be present with muriatic acid, treated with 20–25 cubic centimetres of caustic ammonia. A precipitate of lead or tin may be filtered off. 110 grms. of crystallized sulphuret of sodium are then dissolved in 1 litre water, and poured into a graduated alkalimetric tube. To a boiling solution of 1 gm. pure copper in nitric acid, treated with excess of ammonia, this test-liquor is added, carefully noting the number of measures required to decolorize the solution; suppose, 31 measures. Treat the solution of the substance to be tested, in a similar manner, and suppose it requires 30 measures to decolorize it. It contains, in this case,  $\frac{30}{31}$  copper, of the quantity employed. That is, multiply the quantity of the substance to be tested (say 10, 20, or 100 grains) by the number of measures employed with pure copper, and divide by those employed for the other solution. Then, if 20 grs. had been used, multiply the quotient by 5, to bring the result to a percentage, &c. The test should always be performed with a boiling solution. The precipitate is  $5\text{CuS}_2 + \text{CuO}$ . (See the *Technologiste*, Avril, 1846.)



*New Method of Reduction from Copper-pyrites.*—In Rivot and Philipps's method, the pyrites is roasted to oxidize the greater part of the sulphurets, the roasted ore fused in a reverberatory with silicious matters, lime, and fine coal, to convert the oxide of copper into a silicate,—and metallic copper precipitated from the fused mass by dipping in iron rods. After 3–4 hours the slag is said to retain only 0.4–0.6 of one per cent. copper, and the iron bars lost 1–6 kilogr. for 12–42 kilogr. of copper obtained. On this process, Elsner remarks that it is the method of precipitation long since adopted with lead-ores, and he corrects the chemical explanation. For in roasting such pyrites, part of the sulphur passes off as sulphurous acid, and part remains, forming sulphates of the oxides of iron and copper, mixed with some unaltered pyrites. In the subsequent fusion there is formed protosilicate of iron and lime, and copper-stone, or impure sulphuret of copper; from which last, the metallic iron precipitates copper while it is converted into sulphuret of iron. (For a detailed account of this method, see Journ. Fr. Inst. (3) xvii. 60.)

*Fluxing.*—Considerable difficulty being often experienced in fluxing refractory copper-ores, many substances have been proposed to facilitate their fluxion, such as sulphate or carbonate of baryta, to which a recent patent adds galena. (Lond. Journ. Oct. 1850.)

*Extraction of Copper.*—Mitchell, Alderson, and Warriner have patented a process (Ch. Gaz. vii.) for extracting copper from ores by one, or, at most, two roastings and fusions. It is applicable to sulphurets alone, or mixed with oxide, carbonate, and sulphate, or with sulphurets of other metals. The finely-powdered ore is calcined in a reverberatory furnace, and well stirred during the operation in order to promote oxidation. After cessation of sulphurous acid vapors, the heat is to be increased, but not high enough to agglutinate the mass. In this way all sulphate of copper, which may have been formed, is decomposed. If magnesia is present, the hot ore must be raked into water and leached for the separation of magnesia salt.



The ore is now converted into regulus by fusion with lime and old slag, in a metal furnace; if the proportion of copper is less than 25 per cent., a second roasting of the ore is also advisable, previous to its treatment in the "metal" furnace.

The regulus is to be mixed with a quantity of sand equalling the amount of contained oxides of copper and iron; also with sufficient lime and old slag to promote fluxing. Charcoal—say one-tenth of the weight of sand and flux—is also added, and heat applied. After fusion, an additional portion of coal is well stirred in and the heat increased and continued for a short time. By this operation the silicate of copper, at first formed, is reduced, while the silicate of iron remains untouched.

It is doubtful whether, in working copper-ores, mixed to only 8 per cent., the metal can be extracted by these few operations without loss of copper; for, in the ordinary process, the sulphur left after roasting serves to collect the metal more perfectly from the slag.

*Phosphorus in Copper.*—Percy and James (Ch. Gaz. viii.) have given the results of a series of essays which go to prove that the presence of phosphorus in copper improves its soundness in casting; an effect also produced by small proportions of arsenic. They found that even as much as 2.4 per cent. of phosphorus did not impair the tenacity or malleability of the copper. It seems also to exert a protective influence against the corrosive action of sea-water.

*Coating Iron with Copper.*—Pomeroy's patent (Lond. Journ. Oct. 1850) proposes to make sheet-copper similar to sheet-tin, by which a stiffness is imparted to the copper, which is desirable in many processes of the arts. After cleansing the surface by acid-water and heat, the sheet-iron is dipped into water containing clay suspended in it, and then dried, when it is plunged for a moment of time into melted copper. The sheet metal may then be rolled. The chemical reason given for the use of a clay bath to protect the iron from oxidation, viz. the ammonia in the clay neutralizing the acid left on the iron from the acid bath,—is erroneous.



*Action of Salt-water upon Copper.*—Dr. Percy has determined by experiment (Athenæum 1849, Ch. Gaz. vii.), that the presence of phosphorus and iron in copper, even in the proportion of 2.41 of each in the 100 parts, scarcely impairs either its tenacity or malleability. Copper, alloyed with a little phosphorus, was also found to resist the action of salt-water much better than other specimens of copper.

Grains.

Electrotype copper, after 9 months' immersion in sea-			
		water, lost per sq. inch	
			1.4
Selected copper	"	"	1.1
Copper containing phosphorus	"	"	0.0
Copper from the "Frolic"	"	"	1.12
Dockyard Copper, No. 1	"	"	1.66
" " No. 2	"	"	3.0
" " No. 3	"	"	2.48
" " No. 4	"	"	2.33
Muntz's metal	"	"	0.95

3. *Lead.*—Nearly all the lead of commerce is obtained from galena, or sulphuret of lead. One of the most extensive formations of oxidized lead (carbonate) is in Mine à la Motte, Missouri, where millions of pounds of metal have been extracted from white-lead.

The total amount of lead-ore raised in Great Britain, in 1849, was 78,964 tons, which yielded 54,853 tons of metal; of this amount, England produced about three-fourths. The average yield of the ores of Great Britain is  $69\frac{1}{2}$  per cent.

*Shot.*—David Smith, of New York, has patented a plan for making shot in a comparatively low tower, by forcing or drawing an upward current of air through it, so that the descending shot will be brought in contact with as much cooling air in 50 feet as it ordinarily does in descending 150 feet or more.

*Alkalimetric Test.*—Domonté has described (Technologiste, 1846) a method of testing lead quantitatively, similar to that of Pelouze for copper (see above). The substance to be tested is dissolved in nitric acid, the solution, diluted with water,



treated with excess of potassa to redissolve oxide of lead, and then with a measured quantity of sulphuret of sodium solution, until all the lead is thrown down as sulphuret. The solution of sulphuret of sodium employed for the copper-test (30 cub. centimetres of which precipitate 1 grm. copper) is diluted with 3 times its volume of water for the lead-test. Tin, antimony, and arsenic have no influence in this reaction, as they are not precipitated by sulphuret of sodium from a strongly alkaline solution. Iron, nickel, and cobalt rarely occur in galena, and zinc is thrown down white after all the lead is precipitated. This test does not show the presence of bismuth, which precipitates with the lead and is estimated with it.

It may be remarked, that, although iron forms neither a frequent nor large constituent of good galena, yet it is frequently present, in quantity, in less pure ores of lead. But still the test may be used. For after solution of the lead in potassa, and decantation of the greater part, the residue may be diluted and filtered, leaving iron, nickel, and cobalt on the filter.—*J. C. B.*

4. *Tin*.—Thus far, mere traces of tin have been found in the United States, but its value in the arts leads us to wish that it may yet be discovered in workable quantities. It is associated in minute quantity with nearly all the rutile and tungsten found in the United States.—*J. C. B.*

Kersten has recently analyzed several kinds of tin; No. 1 from the Altenberg Zwitterstock, and No. 2 Peruvian.

	No. 1.	No. 2.
Tin .....	97.83 .....	93.50
Lead.....	— .....	2.76
Iron .....	0.11 .....	0.07
Insoluble in muriatic acid...	1.90 .....	3.76
	<hr/> 99.84 .....	<hr/> 100.09

In No. 1, the portion soluble in acid was tin, iron, and a trace of manganese; the insoluble, bismuth and copper, with traces of arsenic, tungsten, and antimony. In No. 2, the



soluble was tin, iron, and lead; the insoluble, antimony, with traces of copper and arsenic. (Ding. Polytech. J. cviii. 25.)

*Tin Plate.*—Budy and Lammatsch propose alloying tin with  $\frac{1}{16}$  of nickel, previously to coating sheet-iron with the alloy. The advantages contemplated are, greater hardness, and less fusibility, and the greater cost is said to be compensated by a saving of one-half of the quantity of tin usually employed. (An. Rep. Liebig and Kopp, ii. 278.)

5. *Zinc, Mercury, and Arsenic.*—These three metals, being volatile, are obtained in a similar manner; the first two by distillation, and the last by sublimation.

The most important ore of zinc, hitherto worked, being calamine, both silicate and carbonate, it is mixed with lime to retain the silica and with carbon to reduce the oxide, and the mixture distilled in earthenware retorts. Blende, or the sulphuret of zinc, is abundant, but less easily and more rarely worked. The celebrated locality of red oxide of zinc and Franklinite, near Franklin, New Jersey, has attracted much attention at different times, and although the attempts to distil metal from it have been unsuccessful, it has recently been worked with renewed energy in order to manufacture the pigment zinc-white (see Metallosalines). Besides this locality of red zinc-ore, we also have a large formation of calamine in Pennsylvania, and it frequently accompanies the lead-ores of Illinois, &c.

Mercury occurs as a sulphuret, which is mixed with lime and distilled. A notable locality of the native cinnabar has been opened in California, but the superior attractions of gold-washing, or washing for gold, has prevented a fair development of the ore. The analysis of one specimen yielded upwards of 60 per cent. mercury, of another more than 30 per cent. The last was from an average of many pounds of ore. The ore presented a beautiful contrast of the red cinnabar with a white quartzose vein, and the cinnabar contained hydrated oxide of iron and bitumen.—*J. C. B.*

*Purification of Mercury.*—Ulex's method of purifying commercial quicksilver was formerly employed in Struve's



laboratory at Dresden (Archiv. d. Phar. xlv. and Polytech. Centralbl. 1847). 2lb mercury is rubbed for 10 minutes with  $\frac{1}{2}$  oz. of a solution of perchloride of iron (sp. gr. 1.48) and  $\frac{1}{2}$  oz. water, the iron solution washed off with water, and the mercury dried. If it contain more than 1 per cent. lead, the operation should be repeated. Perchloride of iron has the property of minutely dividing mercury, the iron being reduced to protochloride, and some subchloride of mercury being formed, which prevents the globules from reuniting. When other metals are present, they are more readily chlorinized than the mercury, and either washed away in solution or left as an insoluble powder. To test the purity of mercury, Ulex recommends shaking it in a clean glass tube, when, if impure, a black powder appears on the surface of the glass. In this manner  $\frac{1}{40000}$  part of lead is shown. Elsner offers as a convenient but more costly method of preparing absolutely pure mercury, to warm a solution of corrosive sublimate (chloride of mercury) in an iron vessel with iron nails.

*Mercury.*—Violette (Comptes Rendus, 1850) has proposed a very convenient method of distilling mercury by high pressure steam. It consists in placing the amalgam or metal in a cast-iron cylinder to which is attached a worm. This latter serves as a heater for the water and also as a conduit for the generated steam, which, in traversing the interior of the cylinder, heats and volatilizes the contained metal. The vapors of metal and water, becoming involved, pass over in a double current into the refrigerator, where they are condensed and separate into strata.

This plan has the great advantages of economy as to time, fuel, and labor; all danger of concussion is obviated, and as there is no escape of vapor, the workmen suffer no injury to health, as is the case by the usual process.

Arsenic is associated with ores of cobalt, nickel, copper, &c., as arseniuret of those metals, and in the preliminary operations of roasting, it volatilizes as arsenious acid, and condenses in flues and chambers constructed for the purpose. It is then mixed with charcoal and sublimed as metal, or with



sulphur and sublimed as realgar or red sulphuret of arsenic. For its diffusion, see Copper, above.

6. *Antimony and Bismuth*.—These metals are obtained by eliquation, or by heating their ores when they flow out from the gangue. We have not yet found important localities of either of these metals, although antimony is inconveniently associated with some Western lead-ores. Bismuth, occurring mostly in the native state, is simply subjected to this operation; but antimony, being generally found as sulphuret, is eliquated as such, the sulphuret being very fusible. The metal or regulus of antimony is then obtained by heating the sulphuret with iron, alkali, &c. which take up its sulphur. As it is of some importance to have it free from arsenic, various processes have been devised to effect the separation, with variable success.

*Antimony free from Arsenic*.—To effect this separation according to Liebig's method, Bensch observes that the presence of sulphuret of iron is necessary, and gives the proportions: 100 pts. crude antimony (sulphuret), 42 pts. clean iron filings, 10 pts. anhydrous glauber's salt, 2 pts. charcoal, and 2 per cent. sulphuret of iron. After fusion, 16 pts. of the regulus, containing iron, 1 pt. sulphuret of antimony, and 2 pts. soda are kept in fusion an hour, and the regulus, freed from slag, is fused first with  $1\frac{1}{2}$  and then with 1 pt. soda (without sulphuret of antimony), each time for an hour, until the slag has a light-yellow color. The passage of the antimony through the crucible is prevented by smearing it previously with moist soda, and then heating it until the soda fuses and glazes the interior.

7. *Silver and Gold*.—We place these together, from their similar metallurgic treatment, both in the ore and when purified for commercial purposes. The methods of purifying are partly by fire and partly by acid; the modes of extraction from their ores are partly by washing, partly by amalgamation with mercury, and recently liquid methods have been proposed. Native gold generally contains silver, the greater part of which is to be separated, being lost by association with a metal of far greater value; and silver, when obtained from its ores, is



generally worked for the small fraction of gold it contains. Hence, both in extracting and refining, the mixed hydro and pyro-metallurgic processes are adopted.

The processes of separation or parting are by nitric or sulphuric acid. In the former case, the gold is melted with 2 or 3 times its weight of silver, granulated by pouring into water, and then treated with pure nitric acid, which extracts not only the silver added, but also more or less of that originally contained in the gold; for gold has such a covering power that acid could not extract the silver originally present, but by adding more silver, the gold is so disseminated, that as the silver is extracted, the gold is left in a spongy state. For parting by sulphuric acid, the gold is melted with more silver than for nitric acid, granulated, and then heated with undiluted oil of vitriol in vessels of platinum or iron, whereby silver and copper are extracted and the gold untouched. This method is especially applicable to silver containing only traces of gold.

The silver dissolved out from gold is recovered either by precipitating it in the metallic state by copper, or it is precipitated as a chloride by common salt, and the chloride reduced most conveniently and neatly by zinc and dilute acid.

*Silver.*—An important series of essays on this metal, by Malaguti and others, especially with reference to its extraction from the ore, has been presented to the "Academie des Sciences" of Paris, abstracts of which have appeared in the *Comptes Rendus*, *Chemical Gazette*, *London Journal*, &c. We refer to them for the details.

*Reduction of Silver from its Ores.*—A new method of effecting this is to roast the ores with common salt, which forms chloride of silver, and to lixiviate the roasted ore with a hot solution of common salt, which dissolves out the chloride of silver. The solution is precipitated by metallic copper.

According to another method, the sulphuretted ores are carefully roasted in a reverberatory, to change them into sulphates; the sulphates lixiviated by boiling water, and the silver precipitated by metallic copper.



Dr. Percy proposes to extract silver from its ores, in the wet way, by means of hyposulphite and chloride of lime. The details of the mode are given in a paper read before the British Association, Aug. 9, 1848. (Ch. Gaz. vii.)

*Solubility of Chloride of Silver.*—According to Pierre (Journ. de Pharm. (3) xii. 237), 1 pt. chloride of silver is soluble in 200 pts. strong chlorohydric acid, and in 600 pts. of the same acid, diluted with twice its weight of water.

*Reduction of Chloride of Silver.*—According to Hornung (Journ. de Chim. Médicale, 1847), moist chloride of silver is easily reduced by metallic copper and ammonia, very little ammonia being required for the purpose. The reduced silver is well washed with water and dried.

Kessler's method of obtaining chemically pure silver is as follows (Le Technologiste, 1847): Silver alloyed with copper or lead is dissolved in the least possible quantity of pure nitric acid, the solution diluted with 20 times as much water, and a solution of protacetate of iron added as long as a precipitate ensues. The latter is washed first with acetic acid, and then with water acidulated by sulphuric acid, until the wash-water ceases to show a precipitate with prussiate of potash. The precipitation of silver is so complete, that not a trace of it can be found by common salt in the filtered liquid. The protacetate of iron also precipitates platinum, especially by warming the solution. The surface of articles on which galvanic copper is to be precipitated, and which is not easily rendered conducting by graphite, may be rendered so by imbuing it with a solution of nitrate of silver and then treating it with protacetate of iron.

Wittstein (Buch *Rep.* vol. ii.) has compared the advantages of the various processes for reducing chloride of silver, and finds that with charcoal to be the safest and most economical. 2 pts. of chloride are mixed with 1 pt. of moist charcoal, the whole pressed into a black-lead crucible, loosely covered and heated. Calcination is continued until an half-hour beyond the cessation of hydrochloric vapor. When cold, the silver is extracted by nitric acid of 1.20, 3 pts. being required



for every 2 pts. of chloride. By heating the crucible more intensely, the silver will run together, and may be separated by mechanical means. The reducing power of the charcoal is owing to its content of hydrogen.

Levol dissolves sugar in potassa lye, and boils chloride of silver in it. The chloride is reduced to a gray metallic powder, while carbonic acid is evolved (Journ. de Chim. Méd.)

C. Zimmermann employs the following method for large quantities (Gewerbvereinsbl. der Prov. Preussen, 2 Jahrg. 1847). The washed chloride is mixed with water, pieces of bar-iron of the size of a finger thrown in, and the whole stirred with wood in a stoneware or porcelain vessel. 2lb of iron are required for so much chloride as contains 8 marks of fine silver, and the reduction is completed in 2 hours. The washed and dried silver powder is fused in a clay crucible, with a mixture of equal parts of potash and dry salt.

This reduction is performed at the United States Mint, by granulated zinc and sulphuric acid, on about 1000lb of silver per day, and presents advantages which the use of iron does not. There is not a great difference in the cost between clean bar-iron prepared as above, and granulated zinc, and, of the two, the latter is freer from injurious ingredients. As in the precipitation of silver from large *parting* (quartation) operations, the exact quantities of silver cannot readily be known; and as an excess of metal will be required to insure total and rapid reduction, this excess must be removed either by sulphuric acid or by sifting. The latter would be inconvenient, and the zinc is dissolved more rapidly than iron would be. Moreover, the reduction proceeds more rapidly with zinc, since it can be readily procured in a state of fine division by granulating. In melting the fine silver into toughened bars, we use saltpeter and borax. The silver thus obtained, without attempting to procure it very pure, shows a fineness of 995–997½, and may be easily refined in the pot to 998 and 999 thousandths.—*J. C. B.*

*Parting by Sulphuric Acid.*—Pettenkofer's experiments on parting gold by oil of vitriol are of some value. In this



process, gold may be extracted from silver, even when it forms an exceedingly minute proportion in the latter, by boiling it with oil of vitriol in iron or platinum vessels, and a large amount of gold has been thus recovered from old silver, since the process was first made known. To effect the parting most completely, there should be in 16 pts. alloy 3 to 4 pts. gold, and at least 10 of silver. Pettenkofer's experiments were made in the refinery at Munich, with Kronenthaler (crown-dollars), which contain  $\frac{7}{10000}$  of gold. The parting is at first rapid until the fineness reaches 958 to 960 thousandths, when long-continued boiling (14 times) with great excess of acid raises it only to 970-972 thousandths, when it consists of 970 gold, 28 silver, and 2 platinum. No excess of acid nor repeated boiling will raise this spongy gold more than  $\frac{1}{4}$  thousandth beyond this. It may, however, be refused with nitre, alloyed with silver, and again parted by oil of vitriol. It would appear, from his experiments, that the silver is alloyed in the metallic state with the spongy gold, and not combined with chlorine, phosphorus, nor arsenic; but it powerfully resists all attempts to extract it, whether by sulphuric or nitric acid. Sulphur may be distilled over it without its forming sulphuret of silver. Treated with boiling sulphuric acid to which bichromate of potassa has been added, a considerable amount of gold is dissolved, while sesquioxide of chrome is formed; but neither silver nor platinum, which is also present, is attacked. Pettenkofer thinks that the silver is in a different state from its normal condition. The silver may be extracted by fusion with bisulphate of potassa or soda. It is probable that the great preponderance of gold assimilates the alloyed silver to itself, just as silver alloyed with platinum renders the latter soluble in nitric acid, and as platinum in gold subjects the latter to more powerful corrosion by fusion with nitre.

*Parting by Nitric Acid, or Quartation.*—Pettenkofer confirms the results of Kandelhardt and Chaudet, that the ancient proportion of 3 silver to 1 gold is unnecessary, but that  $2\frac{1}{2}$  silver to 1 gold is a far better proportion; for the gold retains



more silver when the former proportion is used, even with the use of strong acid and after continued boiling. He found further that only  $1\frac{3}{4}$  silver to 1 gold was really necessary to obtain a correct separation. We employ 2 to 1 in the United States Mint.

Pettenkofer further observes that all commercial silver, not subjected to chemical separation, contains platinum. To prove the presence of platinum in parted gold, it is alloyed with  $2-2\frac{1}{2}$  pts. silver, parted in the usual way by nitric acid, precipitated by dilute muriatic acid, filtered, the solution evaporated to dryness (at a gentle heat), the residue treated with alcohol, and the platinum precipitated from the solution by salammoniac. To determine it quantitatively, D'Arcet alloys two equal portions of the gold with silver, extracts one with nitric and the other with sulphuric acid; the excess of weight in the latter over the former is platinum.

Pettenkofer's discovery of platinum in the gold and silver is of some importance, for it serves to explain in part the refining effects of nitre on gold. By this fusion an appreciable quantity of gold is taken up by the nitre at the same time, although gold alone is slightly affected by it. After treating with water the slags resulting from toughening gold by nitre, the fine gray sediment contains alumina, silicic acid, potassa, oxides of iron, copper, lead, platinum, gold, and metallic gold.

*Cleansing Silver.*—It is said that silver or brass vessels may be cleansed by boiling them in water with calcined hartshorn in powder (30 grms. to 1 quart water), then drying them by the fire, and rubbing them when dry with woollen rags saturated with the above liquid and subsequently dried. The polish is heightened by further friction with a chamois-skin.

*Gold.*—For a full description of the Orange Grove or Vacluse gold mine, in Virginia, see Amer. Journ. 2d ser. vii. 295, with analyses of the ore by J. C. B.

*California Gold.*—Of the following analyses, 1 is by Oswald; 2 by T. H. Henry, of the small flattened grains, spec. grav. 15.63; 3 by the same, of a larger piece with irregular surface and siliceous gangue, spec. grav. 15.96.



B.	1.	2.	3.
Gold.....	87.6 ...	86.57 ...	88.75
Silver .....	8.7 ...	12.33 ...	8.88
Copper.....	— ...	0.29 ...	0.85
Iron.....	1.7 ...	0.54 ...	trace.
Silica .....	2.0 ...	— ...	1.40
	<hr/> 100.0	<hr/> 99.73	<hr/> 99.88

California gold has a dark color, from its light coating of oxide of iron; but when fused, its light color indicates a large percentage of silver. The average fineness of California gold, as determined by some thousand assays at the United States Mint, Philadelphia, is 885 thousandths, or  $88\frac{1}{2}$  per cent. pure gold, and 115th or  $11\frac{1}{2}$  per cent. silver, omitting mere traces of other metals. For Iridosmin, see below.

The gold production of Russia in 1847 was about  $17\frac{3}{4}$  millions of dollars, and supposing it to have increased 100 pounds per annum, it would amount to 20 millions in 1850. The produce of California may be estimated at 50 millions. These numbers being moderate estimates from known returns, the quantity of gold from the new sources of this metal in Russia and the United States was 70 millions, or more than 300,000 troy pounds, in 1850.

*Extraction of Gold from Ores.*—Allain and Bartenbach's process (Comptes Rendus, 1849) for extracting gold is applicable to all pyritous ores, even when the proportion of noble metal does not exceed two ten-thousandths. For working ore containing this quantity, the expense will be about \$40 for every pound of gold obtained.

The ore, after being roasted in the air, is powdered, sieved, re-roasted into a red mass, made into paste with sulphuric acid of  $66^{\circ}$ , and again roasted until the entire cessation of sulphurous fumes. Sulphur, zinc, and copper are thus largely removed. The ore is now reduced to a still finer powder, boiled with dilute oil of vitriol, and the undissolved residue digested in a mixture of 6 pts. muriatic acid of  $21^{\circ}$  and 1 pt. nitric acid of  $36^{\circ}$ , diluted with water. Copper and gold are



then thrown down by iron, the precipitate calcined to oxidize the copper, which is to be dissolved out with muriatic or sulphuric acid.

A better method for pyritous ores is to roast them partially, if not already oxidized, and to melt them in a low blast-furnace, using a siliceous ore as a flux, if necessary. A large portion of oxide of iron will thus be removed, and the gold concentrated in the remaining sulphuret of iron, which could then be worked by dilute sulphuric acid.—*J. C. B.*

On the use of chloride of lime and hyposulphites, for extracting gold from its ores, see an essay by Percy, in *Phil. Mag.* 3 ser. xxxvi. 1–8.

*Toughening Gold.*—Wolff proposes, in the *Practical Handbook for Jewellers*, to fuse the brittle gold in a new crucible, and when melted to throw in one or two pieces of sulphur of the size of a pea, to shake the crucible a little with the tongs, and to cast it rapidly into a heated mould. He also proposes to render small pieces malleable by coating them with powdered borax, and heating them in the blowpipe flame until the surface commences fusion.

Both of these methods are resorted to at the United States Mint, but the choice of either depends upon the nature of the accompanying metals that give the gold its brittle character. When there is a quantity of iron present, the gold is fused with a mixture of sulphur, potash, and soda, which will remove it by making the very fusible mixture of sulphurets of iron and alkali. If tin, arsenic or antimony be present, a good flux is a mixture of borax, soda, and saltpeter, the last for oxidizing the foreign metals into their respective acids, the soda to give base to those acids, and the borax to collect the slag. In both these cases, a sand or clay crucible is preferable to a black-lead pot, in which last the graphite acts reducingly. Where lead is present, this process may partially effect its removal; but it is more completely effected during quartation and by washing the fine gold thoroughly with hot water, after extracting the silver by nitric acid. Another method of removing lead would be to fuse the gold with a little saltpeter,



borax, and silica, whereby a fusible slag of oxide of lead would result, and might be skimmed from the surface of the gold. Palladium and platinum, not unfrequently present in California gold, are likewise removed by the nitric acid in parting silver from gold. Grains of iridosmin have been observed in California gold, in distinct particles, even after three or more fusions, and seem to have no tendency whatever to enter into an alloy; but, while casting such gold, these particles collect at the bottom of the pot, from their greater specific gravity, and, by remelting in a small crucible, and carefully casting, they may be obtained mixed with a small quantity of gold. The latter is dissolved by nitromuriatic acid, and the iridosmin obtained pure.—*J. C. B.*

8. *Platinoid Metals*.—Platinum is associated with several other metals in the platinum sand which is found in some gold-districts. They have not been found as a distinct deposit in California, but have been observed in the United States Mint in the operations of assaying and parting. These associated metals are palladium, rhodium, iridium, and osmium, to which we must add the lately discovered metal, ruthenium. They have a sufficient resemblance to be classed together, and are obtained by a similar hydrometallurgic treatment. The grains of iridosmin, alluded to under gold, have been qualitatively examined and found to contain the new metal ruthenium, as was observed by Claus in relation to the iridosmin from other localities. Palladium has been observed, and at times in sufficient quantity to render the gold brittle. The quantities of platinoid metals found in the California gold are small, about  $1\frac{1}{2}$  lb of iridosmin having been obtained from about 25 tons of the gold,  $\frac{1}{1000000}$ , but the greater part has, of course, passed into the coin, the coarser grains only being left.—*J. C. B.*

*Solution of Platinum Sand*.—To dissolve it more readily, it is fused with 3 times its weight of zinc, and the brittle mass thus obtained is powdered and sifted. It is digested with dilute sulphuric acid to dissolve most of the zinc and iron, washed with water, and then boiled with nitric acid, which



dissolves iron, copper, lead, and palladium. The finely divided platinum in the residue is dissolved by nitromuriatic acid, avoiding an excess of muriatic, which would dissolve too much iridosmin. The usual method requires 8-10 times its weight of nitromuriatic acid. (Hess in *Bullet. de l'Acad. de St. Petersbourg.*)

*Palladium.*—According to Schmidt and Johnston, it is obtained from the gold-ores of Gongo Socco, Brazil, which contain gold, silver, palladium, copper, and iron, by dissolving in nitric acid, which leaves the gold, precipitating silver from the solution by common salt, and precipitating palladium and copper from the last filtrate by metallic zinc. These two metals are then dissolved in nitric acid and an excess of ammonia added, which precipitates the ammonia-palladium salt and holds the copper in solution. By igniting the palladium salt, metallic spongy palladium is obtained, which is condensed by a hydraulic press, and hammered like platinum. 6000 oz. of palladium have been thus extracted. On this method we would observe that, unless the gold contain a sufficient amount of the other metals, these metals cannot be fully extracted. Moreover, it is doubtful whether all of the copper would be extracted from the palladium salt by ammonia; and if pure palladium be required, it would probably be necessary to repeat the solution in nitric acid and separation by ammonia.

9. *Nickel and Cobalt.*—These metals being usually found together, and each impairing the other's qualities, they are separated chiefly by hydrometallurgic treatment, after concentration by calcination of their ores and fusion. They are usually combined with arsenic, but in Mine à la Motte, Missouri, they are either sulphurets or oxides. They are nowhere abundant. Traces of cobalt, sometimes amounting to 2 and 3 per cent., may be found in nearly all the ores of manganese.—*J. C. B.*

10. *Alloys.*—Most metals will fuse together and remain united while cooling, and sometimes the compounds offer properties intermediate between those of their constituents. Thus brass is intermediate in color and toughness between copper



and zinc; so gold and silver, or either of these, with copper. But, in some instances, the properties of the alloy are different; thus bronze, although intermediate in color between its constituents, copper and tin, presents an extraordinary combination of hardness and toughness. A small quantity of tin, lead, or zinc renders gold brittle. By alloying metals, therefore, we may obtain bodies which, for all practical purposes, are so many new metals.

*Bronze.*—The following table exhibits the composition of some ancient and modern bronze and bell-metal, according to recent analyses.

Title.	Copper.	Tin.	Lead.	Iron.	Gold.	Nickel.	Arsenic.	Analyst.
1. Ancient Attic bronze .....	88.46	10.04	1.50	...	...	...	...	A. Mitscherlich.
2. Athenian bronze, of the Roman period .....	76.41	7.05	16.54	...	...	...	...	Schmid.
3. Athenian bronze..	83.62	10.85	5.53	...	...	...	...	Wagner.
4. Coin of a Macedonian king .....	87.95	11.44	...	...	...	...	...	Monse.
5. Coin of Alexander the Great .....	95.96	3.28	0.76	...	trace.	...	...	Schmid.
6. Coin of Alexander the Great .....	86.76	10.24	2.31	...	trace.	...	...	Wagner.
7. Attic coin.....	87.89	11.58	...	0.27	...	...	...	Ulich.
8. " .....	88.81	9.61	...	1.18	...	...	...	Heldt.
9. Darmstadt chime, B, above first line	73.94	21.67	1.19	0.17	...	2.11	trace.	Heyl.
10. Darmstadt chime, C, treble clef.....	72.52	21.06	2.14	0.15	...	2.66	trace.	Heyl.

See an excellent article on the alloys of copper and tin, in *Technologiste*, and in the *Lond. Journ.* Oct. 1850.

*Speculum Metal.*—(Chinese metallic mirrors.)—Copper 80.836 + Lead 9.071 + antimony 8.43 = 98.337. It contained no trace of arsenic, exhibited a brilliant polish, and did not tarnish in the air. The presence of antimony is interesting, as it is not employed for metallic mirrors, and the above metals will probably be well adapted to the mirrors of telescopes.







Chinese silver, and No. 12 exhibited a fine silver-color. Elsner ascribes the elasticity to the greater content of copper. Nos. 13, 14, and 15, analyzed by Louyet, were used in Birmingham for articles to be plated.

*Malleable Brass.*—Elsner (Newton's Journ.) has prepared malleable brass, by fusing together 60 pts. copper, and 40 pts. zinc. Great care is requisite in the heating, lest too much loss of zinc might ensue, and thus render the process unsuccessful. To obviate this difficulty, he advises the better plan of substituting a proportional mixture of brass for the zinc, and supplying the deficiency of copper.

This alloy is close-grained, of spec. grav. 8.44 at 50° F., very tough and malleable when heated. Its hardness = 4.

*Tungsten and Copper.*—Dr. Percy (Ch. Gaz. vi.), who made a series of experiments upon the subject, found that tungsten does not, as was anticipated from its peculiar nature, impart hardness to copper and protect it from oxidation. The essays with brass, German silver, and other metals, gave similar results.

*Alloy for Bearings of Axles of Locomotives.*—An alloy of 85 lead and 15 antimony is recommended to be cast in a box, and then greased in the usual way with soda, tallow, and palm oil. The part did not become warm, and the alloy prevented the lateral vibrations.

*Alloys for Bearings of Rollers, Turning-lathes, Wagon-boxes, &c.*—For heavy works, Tapp recommends 1lb copper, 3½ oz. tin, and 4½ oz. lead. The copper is first fused, the tin next added, and lastly, the lead; and, before casting, the whole is well mixed. For smaller machinery with hand-power, the best alloy is 73 pts. tin, 18 pts. antimony, and 9 pts. copper.

Fenton recommends the following alloy as having proved serviceable for bearings on English railroads: 80 pts. zinc, 5½ pts. copper, and 14½ pts. tin. It is 40 per cent. cheaper than brass, may be fused in iron pots, and is a good alloy for cocks.

See a tabulated view of many alloys, employed in the arts, in different proportions, in the Polytech. Notizblatt, 1847, &c.



*White, Malleable Alloy.*—Parkes gives the two following proportions (Rep. of Pat. Inv. July 1845):

33lb zinc, 64lb tin,  $1\frac{1}{4}$ lb iron,  $2\frac{1}{4}$ lb copper.

50 “ 48 “ 1 “ 3 “

The iron and copper are first fused together, the tin then added, and lastly the zinc. The flux consists of 1 pt. lime, 1 pt. fluor spar, and 3 pts. salammoniac. It is cast in sand or moulds. Another alloy consists of:

66 zinc,  $32\frac{1}{4}$  tin,  $3\frac{1}{4}$  antimony.

$79\frac{3}{4}$  “  $19\frac{1}{2}$  “  $2\frac{3}{4}$  “

It is fused with black flux, and, if used for sheathing ships,  $\frac{1}{2}$  to 1 per cent. arsenic should be added. The alloy may be rolled cold into thin sheets.

*Alloys for Dentists.*—The following proportions are recommended:

	1.	2.	3.	4.	5.
Gold .....	1 ... 1	1 ... 1	1 ... 1	— ... 6	
Silver .....	— ... 1	1 ... 1	1 ... 1	— ... —	
Platinum.....	2 ... 4	2 ... 2	2 ... 2	10 ... 10	
Palladium.....	— ... —	— ... —	— ... —	8 ... 8	

The gold and silver are first fused, and the platinum and palladium then added. They are fused in small crucibles and require a blast. The solder for these alloys is either pure gold or an alloy of gold and silver. (Rep. of Pat. Inv. 1845, p. 72.)

*Amalgam for Filling Teeth.*—Pettenkofer (Ann. der Chem. und Pharm. 1849) has described an amalgam used by dentists. It is very hard, adhesive, and of a grayish color; and, owing to the very slight difference of density in the soft and hard state, it occupies the same space when cool as in the plastic state. This latter condition is given by heating the amalgam to nearly the boiling point of mercury, and then triturating it, for some time, in a mortar. After cooling, it is soft and readily worked either with the fingers or tools. In a few hours, it becomes intensely hard. The following is the best process for the preparation of this amalgam. Weigh out a quantity of pure mercury, dissolve it in a q. s. of hot sul-



phuric acid, and triturate the resulting paste of sulphate with pure, finely-divided copper, diffused in water at  $140^{\circ}$ – $158^{\circ}$ . There must be sufficient copper to form a composition of 70 pts. mercury and 30 pts. copper, or enough to reduce all the mercury salt employed, and to alloy the mercury eliminated. After rubbing for some time, the amalgam is to be well washed, pressed in a leather bag, and formed into small cakes for use.

*Various Alloys.*—Stirling forms an alloy of zinc and iron, by throwing a quantity of zinc into a cupola after the metal is run out and the blast stopped, whereby an alloy is formed with the iron still adhering to the sides, fuel, &c. When the alloy contains more than 7 per cent. iron, zinc is to be added to it; when less than 4 per cent., iron is to be added, the best alloy containing from 4 to 7 per cent. iron. This alloy is used for other alloys instead of zinc. An alloy of copper and manganese is made by adding to melted copper from  $\frac{1}{2}$  to 2 per cent. of black oxide of manganese, or by mixing them beforehand and then melting, keeping the metal in either case covered with a reducing flux. A gold-colored alloy is produced by adding 1 pt. of the zinc alloy to 4 pts. of the copper alloy: it is very malleable and ductile, and takes a fine polish. The addition of  $\frac{1}{2}$  per cent of tin hardens the gold alloy, although as much as 4 per cent. may be used. To prevent heating by friction, lead may be added to the alloy. An improved German silver is made by melting 10 pts. copper, 2 pts. nickel, and 6 pts. of the iron-zinc alloy; or 8 pts. copper, 2 pts. nickel, and 4 pts. of the iron-zinc alloy. A much larger proportion of iron-zinc renders the metal too hard for rolling, but good for some casting. An excess of copper spoils the color. The nickel and copper are first melted and the zinc alloy then introduced under cover of a reducing flux. (Rep. Pat. Inv. July, 1850.)

*Fraudulent Gold.*—When gold of 12 carats or less, is alloyed with zinc instead of silver, it still retains a true golden color, and this property has caused its extensive use in the manufacture of fraudulent jewelry. (Technologiste, 1847.)



*Peruvian Gold Alloy.*—According to How (Journ. Pract. Chem. xliii.), the Peruvian gold alloy consists of gold 38.93, silver 54.828, copper 5.80.

11.—A few operations on the metals, connected with the preceding subject, are here thrown together.

*Metal Pipes and Tubes.*—An improvement consists in the employment of machinery for ramming the moulds and cores, and a measured quantity of sand being pressed into each portion of the flask and between the converging sides of the divided core-box, and for forming a core by enveloping a metal rod in a coil of wire upon which the sand is compressed. (Lond. Journ. xxxviii. Aug.)

*Cleaning Metal Castings.*—To cleanse metal castings, they are usually thrown into water acidulated by sulphuric or muriatic acid; but as some metal is removed and the surface left rough, the process is objectionable. Thomas and Delisse found by their experiments that if several organic substances were added to the acid water, the scale of dirt and oxide was removed, but the surface of the metal unattacked. Elsner found that tar added to the acid water completely cleansed an iron casting, while another piece of casting in the usual acid water was nearly dissolved. (Technologiste. See also Journ. Fr. Inst. (3) xviii. 49.)

*Enameled Iron.*—After cleaning the surface to be enameled, the enamel is laid on as a paste and burned in under a muffle. F. Walton (Lond. Journ. Arts, 1847) uses three successive layers, which are as often heated in the muffle. The first coat is made by fritting 6 pts. pounded flint-glass, 3 pts. borax, 1 pt. red lead, and 1 pt. oxide of tin. One part of this frit, mixed with 2 pts. calcined and ground bones, is ground fine with water, spread over the metallic surface as a thick paste, dried, and then heated to redness in the muffle. The second coat is made of 32 pts. calcined and ground bones, 16 pts. kaolin, 14 pts. Cornish granite, and 8 pts. potash in solution: the paste thus made is fritted for 2–3 hours in a reverberatory and then powdered. Of this frit  $5\frac{1}{2}$  pts. are mixed with 16 pts. coarsely-powdered flint-glass,  $5\frac{1}{2}$  pts. calcined and ground



bones, and 3 pts. ignited and ground flints. The mixture is then ground with water, spread over the first coat and burned in. The third and last coat (which is similarly treated) consists of 12 pts. powdered feldspar,  $4\frac{1}{2}$  pts. kaolin, 18 pts. borax, 3 pts. saltpeter,  $1\frac{1}{2}$  pt. potash, and  $1\frac{1}{2}$  pt. oxide of tin.

*Soldering Salt* (chloride of zinc and ammonium).—Vessels may be tinned with this salt without previously cleansing their surfaces. It is made by dissolving 1 lb zinc in muriatic acid, adding 22 pts. salammoniac to the solution, and evaporating to dryness; the yield is  $2\frac{1}{4}$  lb of the double salt. To use it, the salt, moistened with water, is brushed on the surface to be tinned, a little solder laid on it here and there, and the surface heated until the solder fuses, when it flows wherever the salt was put, and unites with the metallic surface. (Journ. f. Buchdrucker. 1847, No. vii.)

*Tinning*.—According to Becquerel, well-cleansed vessels of iron and copper may be tinned by dipping them into a solution of the double salt of chloride of tin and sodium, at a heat of  $160^{\circ}$  assisted by contact with zinc.

*Soldering Wrought and Cast-iron*.—Filings of soft cast-iron are melted with calcined borax, the mass pulverized and sprinkled on the parts to be united. They are then separately heated and welded together on an anvil by gentle blows. (Journ. Fr. Inst. (3) xviii. 50.)

*Welding Powder*.—To melted borax,  $\frac{1}{10}$  salammoniac is added, the mixture poured on an iron plate, and an equal weight of quicklime ground up with it. Iron or steel to be welded is first heated to redness, the mixture laid on the welding surfaces, and the metal again heated, but far below the usual welding heat. The pieces unite firmly by hammering. (Lond. Builder, 1848.)

## 2. HYDROMETALLURGY

Embraces those processes performed by liquid agents on metals, by which they are procured again from combinations in the metallic state. Some of these operations are included



in Pyrometallurgy, as they constitute some of the necessary steps for extracting metals from their ores and purifying them. The present division embraces all other liquid metallurgic processes, especially the wide-spreading branch of galvanoplastics, together with etching metals and photography.

When we say that carbon is the great reducing agent employed in metallurgy, we refer to its exclusive use from time immemorial in furnaces, both as fuel and a reducing agent; but recent experiments have shown its reducing and decomposing power even in solution. Refer, also, to the third division of Chemicals for its decomposing power.

*Deoxidation by Carbon in the wet way.*—Schonbein has ascertained that the persalts of iron and the salts of red oxide of mercury may be reduced, by agitating their solutions with finely powdered charcoal (as ignited lamp-black) to salts of protoxide of iron, and of the black oxide of mercury respectively.

On the reduction of salts of iron to the metallic state, see Journ. Fr. Inst. (3) xix. 354, and Chem. Gaz. April, 1850.

1. *Galvanoplastics.*—We have a few points to offer on the general subject of galvanoplastics, by which metals are precipitated in the metallic state by a galvanic arrangement, on surfaces previously rendered conductive. These processes, chiefly confined to gold and silver, are fast replacing the more ancient methods of plating, over which they possess great advantages, economy of time and material, convenience, facility for obtaining plating of any required thickness, &c.

*Cyanides.* Solution of metals in cyanide of potassium.—Elsner has described in the Journ. f. Pract. Chemie, vol. xxxvii. 1846, experiments on the solubility of various metals in cyanide of potassium, the general results of which he thus gives. He found that the metals employed might be divided into two groups: those which do not dissolve, as platinum, tin, and mercury, and those which dissolve. The latter are again divisible into two groups: those dissolving with the decomposition of water, as iron, copper, zinc, and nickel; and those unattended by the decomposition of water, as gold, silver, and



cadmium. Solution is effected in both cases by oxygen, but in one it is evolved from water, in the other extracted from the air. A part of the cyanide of potassium is oxidized to potassa (hydrogen escaping when water is decomposed), and the cyanogen, set free, unites with the metal; the metallic cyanide then forms a double salt with cyanide of potassium.

*Oxide of Gold.*—Figuier (Journ. de Pharm. 1847), who tested the several methods of preparing this oxide, now so extensively used in electro-gilding, has determined the best to be as follows. Dissolve 1 pt. gold in 4 pts. aqua regia, evaporate to dryness, redissolve in water, add a little aqua regia to take up the traces of metallic gold and of protochloride remaining undissolved. Evaporate again, redissolve in water, and mix with pure potassa perfectly free from chloride, until it gives an alkaline reaction with turmeric paper. Turbidity immediately ensues, when it is mixed with chloride of barium;—aurate of baryta precipitates as a yellow powder. When the precipitate begins to assume a whitish appearance, the addition of chloride of barium must be discontinued, as all the gold oxide has gone down and the alkali commenced to act upon the baryta of the chloride. The aurate of baryta is then to be washed until the waste-waters cease to be precipitated by sulphuric acid. The aurate is then heated to boiling, with dilute nitric acid, in order to eliminate the oxide of gold. By washing until the water no longer reddens litmus paper, the oxide becomes pure, and must be dried between the folds of bibulous paper by exposure to air.

*Amalgamated Zinc.*—Stoddard (Silliman's Journ. 1849) has recommended the following method of amalgamating zinc for cylinders for galvanic batteries. The zinc is heated to 450–500° and moistened with a solution of double chloride of zinc and ammonium, and mercury immediately dropped over the surface while still moist—the union is complete in a few seconds.

2. *Plating by Gold or Silver.*—Both galvanic and other methods are here included, as far as they have been recently improved.



*Plating in the cold.*—Stein (Polytec. Centralbl. 1847) mixes 1 pt. nitrate of silver and 3 pts. cyanide of potassium, adding sufficient water to make a thick paste, and rubs the mixture with a woollen rag upon a clean surface of copper, bronze, or brass. The process gives a bright silver surface, which, however, will not bear violent friction with chalk or tripoli.

Roseleur and Lavaux's method (Liebig and Kopp's Rep., and Technologiste, 1847) is the use of a bath of 100 pts. of sulphite of soda, containing 15 pts. of silver-salt. Neither of these processes yields very durable coatings.

*Plating by dipping.*—Levol employed solutions of cyanide of gold and of silver in cyanide of potassium, and articles of copper, bronze, and brass, to be gilt, were dipped into the boiling gold solution; but silver could not be gilt in this manner, and Levol proposed for it a solution of chloride of gold in sulphocyanide (rhodanide) of potassium. It was, however, shown that silver might be gilt in cyanide of gold and potassium, by wrapping it with zinc or copper wire, and then dipping it into the boiling-hot solution. Thus, to gild the inner surface of a silver cup, such wire is wound around the interior, and the boiling cyanide solution poured in. The zinc or copper renders the silver more strongly electronegative. A beautiful gilding is obtained by dissolving fine metallic gold in a solution of cyanide of potassium, and the metallic gold is obtained by precipitating its solution by copperas, or by imbuing rags with the solution and burning them to ashes. By warming the solution of cyanide of potassium with the latter, the gold is dissolved, and the solution filtered off from charcoal and ashes. Rags imbued with nitrate of silver, and burned, may be similarly used for making a solution of cyanide of silver and potassium.

*Gilding in Elkington's Liquid.*—Experiments in the Gewerbe-Institut of Berlin lead to the following proportions as the best for this liquid. Fine gold is dissolved in a sufficient quantity of aqua regia, evaporated to dryness at a gentle heat, and dissolved in 13 pts. water; 7 pts. bicarbonate of potassa



are added to the solution, which assumes a greenish color and becomes a little cloudy.

Barral (*Mémoire sur la Précipitation de l'Or à l'État Métallique*, Paris, 1846) gives his experiments; among others, the following. A bright article of silver, connected by copper wire with a piece of copper, which has been ignited and quenched in dilute sulphuric acid, is beautifully gilt, of any desired thickness, in the liquid. The bright article forms the negative, and the dull copper, the positive pole. Brought in contact with zinc, the silver is gilt more rapidly, and the action is strongest when the silver is connected with lead. The metal serving as positive pole is covered with a strong precipitate of pulverulent gold. By connecting copper with zinc, or iron with lead, the former is powerfully gilt. Bright copper is strongly gilt in connection with dull copper (ignited), while the latter is covered with a powdery deposit.

*Gilding on Iron and Steel.*—Elsner showed, in 1841, that steel pens may be heavily gilt, by first removing their blue coating by dilute muriatic acid, and then dipping them into a solution of chloride of gold rendered alkaline by carbonate of soda. Schöppler gives the following method for coating larger articles. (*Polytech. Notizbl.* 1847.) The surface of iron or steel, being brightened by the file, and coated with lack-varnish, those portions to be gilt are freed from the lacquer, etched by dilute sulphuric acid, dried, and dipped into a very dilute solution of blue vitriol until they are coated with copper. The metal is then dipped into a solution of 100 pts. gold in 13,000 pts. water, to which 370 pts. carbonate of soda are added. The gilding may be polished.

*Fire-gilding of Wrought and Cast-iron, and Steel.*—This operation, readily performed on bronze and copper by amalgamating their surface, has not been applied to iron, on account of the difficulty of amalgamating its surface; but R. Böttger has contrived the following good method of effecting it. A mixture is made in a porcelain vessel, of 12 pts. mercury, 1 pt. zinc, 2 pts. copperas, 12 pts. water, and  $1\frac{1}{2}$  pt. muriatic acid of spec. grav. 1.2. The article of iron or steel to be gilded



is introduced into this mixture, which is then heated to boiling, and in a short time is again withdrawn, covered by a shining coat of mercury. It is now ready to receive the amalgam of gold or silver for the purpose of fire-gilding (Pogg. Annal. 1846). The strongly positive zinc amalgam increases the electric tension between the positive iron and negative mercury, so as to cause their union.

*Gilding Watch-wheels.*—Ph. Plantamour prepares an amalgamating fluid for gilding wheels of watches, which, being alkaline, cleans and amalgamates the wheels at the same time, without injuring the steel pivots. Mercury is dissolved in an excess of nitric acid, and ammonia added to the solution until the precipitate at first formed is redissolved. The wheels being immersed in this solution, the ammonia dissolves fatty matters, with other impurities, from the surface, and the brass is amalgamated. While still moist, the wheels are covered with gold amalgam, put on a drum with holes for inserting the pivots, and gently heated over a spirit lamp, so that the quality of the steel is not impaired. (Comptes Rendus, xxiv. 784.)

*Silvering Mirrors.*—For Drayton's original process for silvering glass surfaces, see Lond. Journ. xxiv., or Journ. Fr. Inst. viii. 3 ser. His improvements in the same are in the Lond. Journ. for 1849, and Journ. Fr. Inst. 1850. One ounce ammonia, 2 oz. nitrate of silver, 3 oz. water, and 3 oz. spirit of wine are mixed together, allowed to stand for 3 or 4 hours, and then filtered. A quarter-ounce sugar (grape-sugar being preferred), dissolved in a half-pint of spirit of wine diluted with as much water, is added to each ounce of the filtered liquid, and this solution is employed for silvering, the article to be silvered being kept at 160°.

Meurer dissolves 5 grs. lunar caustic (nitrate of silver) in a little caustic ammonia, and adds to it a mixture of 1 drop oil of cinnamon, 2 drops oil of cloves, and 1-1½ drachms of absolute alcohol. The mixture becomes gradually cloudy, depositing a brown precipitate, which is filtered off, and the clear liquid poured upon a clean glass plate, surrounded with a rim. In the course of a few hours, it is covered with a



brilliant white coating of metallic silver. Elsner observes that it is necessary to let the liquid remain until all the brown sediment has separated, in order to avoid spots on the silver surface. Tourasse protects the back of the silver with varnish. The cost is said to be  $\frac{1}{3}$  of that of the amalgamated tin, a very thin coating of silver being sufficient. Reichardt dissolves 1 oz. lunar caustic in 2 oz. water, adds  $\frac{1}{2}$  oz. caustic ammonia, and 3 oz. strong alcohol containing 30 drops of oil of cassia, filters, and lets the whole stand 3-6 days. The liquid is poured on a glass plate cleaned by potash. He employs the oil of cloves in vapor, by dropping a little into a warmed vessel, which is turned a little to spread the oil, and is then inverted over the glass plate. The coating is made in  $\frac{1}{4}$  hour.

Silvering glass by gun-cotton has been effected by Vohl, by dissolving the cotton in caustic potassa, adding a little of nitrate of silver, and then sufficient ammonia to redissolve the oxide of silver, while the whole is kept warm. The whole of the silver is precipitated as a brilliant coating on the sides of the vessel. Other analagous nitric compounds of sugar, manna, and gums produce a like result. (*Technologiste*, Lond. Journ. 1849, and *Amer. Journ.* (2) viii. 117.)

*Speculums*.—T. Fletcher's patent (*Ch. Gaz.* vi.) for making speculums, is to take a glass which has been silvered as for mirrors, and to coat the metallic side with a varnish composed of 2 oz. shellac,  $\frac{1}{2}$  oz. lamp-black, and  $\frac{1}{2}$  pint absolute alcohol as a protective against dampness and the action of acid. As the coating becomes dry, it is dusted over with finely-powdered plumbago, and the glass is then submitted to the electrotpe process, by which means a thin coating of metal will be precipitated over the whole back.

*Galvanic Gilding and Silvering*.—(Communicated to Elsner by Mr. Brauns.)—Smee's battery is best adapted to the purpose, as it is simple in construction (consisting of platinized silver-foil, surrounded by an amalgamated sheet of zinc); requires only one liquid (1 pt. sulphuric acid to 8 pts. water); continues long in action, and gives off no gas during the operation. The cells consist of leaden vessels internally pitched. The



silver-foil is thus platinized:  $\frac{1}{2}$  oz. platinum is dissolved in nitromuriatic acid, evaporated to dryness, dissolved in 1 qt. rain water, 3–4 oz. oil of vitriol added. The silver-foil, having been dipped for a few moments in strong nitric acid, is hung on the cathode (zinc-pole), and platinum-foil on the anode (copper-pole) of a battery; the silver is covered with a gray coating of platinum.

The best silvering liquid is a solution of 1 pt. of the crystallized double salt, cyanide of silver and potassium, in 10 pts. water, to which  $\frac{1}{8}$  cyanide of potassium is added, and the whole boiled until it ceases to smell of ammonia. When the double salt alone is used, a platinum anode must be used, for a silver anode becomes coated with cyanide of silver, and impairs the conducting power. But the latter may be employed in the above liquid, because the cyanide of potassium dissolves the cyanide of silver and keeps the surface of the silver anode bright. The exhausted solutions are evaporated to dryness, and to the fusing residue a little saltpeter is gradually added to destroy cyanide of potassium.

The gilding liquid is thus prepared. 10 pts. gold are dissolved in nitromuriatic acid, diluted and filtered to remove the chloride of silver, 3 pts. common salt added, and the whole evaporated to dryness. The residue is dissolved in water, precipitated by an excess of ammonia, the yellowish-brown precipitate filtered, washed, and dissolved in a sufficient quantity of cyanide of potassium. An excess of this cyanide is then added, and the liquid is diluted with 64 pts. water. To destroy the cyanate of potassa, it is boiled until ammonia ceases to come off, and then 64 pts. more water are added. If the solution be warmed, the gilding is a beautiful matt. Exhausted gold solutions are evaporated to dryness and may be fused alone, or fused together with silver residues, and the silver extracted from the gold by nitric acid.

*Galvanic Gilding.*—Extracted from an essay by the Duke of Leuchtenberg, in the Bulletin de l'Acad., St. Petersburg, 1847. He draws attention to the special care required to precipitate gold above all other metals, and notices particularly



the following points. We must know the proportion, 1, of gold to the potassa-salts contained in the gold solution; 2, of the gilding surface to the strength of galvanic current, and the strength of the gold solution; 3, of the surface of the anode to the gilding surface, and to the content of gold in 1 decilitre-solution; 4, of the surface of the anode and of the gilding surface to the strength of the current.

The gold solution is thus made. 1 pt. gold is dissolved in aqua regia and evaporated (at a gentle heat) to dryness, the residue treated with an aqueous solution of 1 pt. caustic potassa, this mixture then with an aqueous solution of  $2\frac{1}{2}$  pts. cyanide of potassium, and 1 pt. caustic potassa, and the whole warmed and filtered.

He found that, for successful gilding, the above proportion between the gold and potassa in the solution should remain constant; and if (as when a platinum anode is used) the quantity of gold diminishes by precipitation, the force of the galvanic current must be increased by adding more cells, and increasing the surface of the anode, since this force is diminished in a dilute solution. The finest gilding is obtained when 1 decilitre of solution contains from 1 to  $\frac{1}{4}$  gramme of gold. A reddish gilding is obtained by diminishing the galvanic force, such as lessening the number of cells, or the surface of the anode, or increasing the gilding surface.

Leuchtenberg rejects gold and silver anodes, because there is not as much of them dissolved as is precipitated on the cathode, and because they become coated with cyanides. He therefore employs a platinum anode, and determines the content of gold in solution, before and after gilding, by chemical analysis, in order to ascertain how much gold has been precipitated on the cathode. This is done by evaporating a decilitre to dryness, moistening with sulphuric acid, heating to redness, and extracting by water, when metallic gold remains.

In the galvanoplastic establishment of St. Petersburg, about 18 tons (363 ctr.) of copper are annually precipitated, 300 pud of silver, and about 60lb gold, thrown down in a month.



The gilding is begun in a solution containing 0.1 gm. gold in 1 decilitre of liquid, and finished in a solution not yet exhausted, whereby the beauty of the gilding is heightened. When the solutions have been too dilute, they are evaporated in an iron kettle to dryness, the residue fused in a crucible, and the salts washed out from the metallic gold. Coke-iron batteries are employed, and the electric current so regulated, that an evolution of gas may be perceptible at the anode, but not on the gilding surface. In the latter case, the current is diminished by removing some of the cells, by lessening the surface of the anode, or increasing that of the cathode (gilding surface).

Elsner justly remarks, on Leuchtenberg's method of analyzing the solutions to determine the quantity of gold or silver precipitated, that the practical gilder could not execute a fine assay of this kind, and that the simple method of weighing the gold or silver anode before and after use will give a sufficiently close determination of the amount of gold expended.

*Matt Gilding and Silvering.*—According to R. Böttger, a matt silvering is always obtained in a *boiling* solution of washed chloride of silver, dissolved in cyanide of potassium, by a moderate and constant electric current. A matt gilding is obtained in a boiling solution of ammonia-oxide of gold dissolved in cyanide of potassium, to which a small quantity of potassa has been added. The gilding is still finer when the articles have been previously matt-silvered. (Polytech. Notizbl. by R. Böttger, 1846.) See also Elsner's experiments on matt gilding with yellow prussiate of potash, in Verh. d. Gewerbflusses f. Preussen, 1843.

*Gold and Silver recovered from exhausted Cyanide Solutions.*—To recover gold and silver from solutions of cyanide of potassium or yellow prussiate of potash, the solutions are evaporated to dryness, heated to redness, and extracted with water, when the metallic gold or silver will remain. Another method is pursued with a potassa solution of the prussiate. A silver solution is heated with muriatic acid under a draft (to carry off prussic acid), and the precipitated chloride well



washed. A gold solution is evaporated to dryness, the dry residue mixed with  $1\frac{1}{2}$  pts. saltpeter, projected portionwise into a red-hot crucible, extracted by water after cooling, the insoluble residue dissolved in nitromuriatic acid, diluted, and the gold precipitated as sulphuret by sulphuretted hydrogen; or after removing nitric acid from the solution by evaporation, and then diluting, it may be obtained purer by precipitation with copperas.

See, also, Berlin Gewerbe-Industrie u. Handelsblatt, Bd. 18.

*Platinizing Glass, Porcelain, and Pottery.*—Lüdersdorff gives the following method (Verh. d. Gewerbfl. in Preussen, 1847). A solution of platinum in aqua regia is evaporated to dryness, at a gentle heat, so that the residue appears reddish-yellow, and not brown, and is immediately dissolved in an equal weight of strong alcohol. 8 pts. of the solution are poured into 5 pts. oil of lavender, forming a clear brown liquid, containing platinum as protochloride. This solution is brushed upon the article to be platinized, and after drying burned in under a muffle. Glass and pottery is heated to low redness; porcelain to a bright red-heat. After cooling, the articles are rubbed with cotton and prepared chalk.

3. Various other metals and their compounds, beside the precious metals, have been employed for coating articles for various purposes, and we offer a few suggestions on these points.

*Copper Precipitated.*—In the usual method of precipitating copper from mine-waters by bars of iron, more iron is dissolved than necessary, as the water generally contains an excess of sulphuric acid, all the copper is not precipitated, and a portion of oxide of iron is lost from the subsequent exposure of the solution. Napier's improvement consists in acidulating the liquid with sulphuric acid, which keeps the surface clean for more energetic action, and in previously putting in saw-dust or other organic matter, which converts the persulphate present into protosulphate, so that all the iron is obtained as copperas. 1000 litres of such water are treated with 2 kilogr. sulphuric acid, and 2 kilogr. saw-dust (the last



being removed, when the peroxide is reduced to protoxide), and so much iron introduced as is chemically equivalent to the copper present in the water. In a few hours all the copper is thrown down, and the liquid, passed through a cloth to collect the copper, is evaporated to crystallize. (Rep. of Pat. Inv. 1845.)

*Iron Coppered.*—Reinsch has succeeded in giving to iron a durable and polishable coating of copper, by immersing it, after previous brightening by friction with cream of tartar and charcoal-dust, in a bath of hydrochloric acid diluted with 3 pts. of water, and containing a small portion of sulphate of copper. After being immersed a few minutes, the iron is removed, rubbed clean with a cloth, and again immersed. The supply of copper must be renewed after each immersion, and the immersion repeated until the coating is of the required thickness. (Jahrb. Pr. Pharm. xv. and Liebig and Kopp's Rep.)

*Sulphuret of Copper, a coat for Copper Vessels.*—R. Böttger describes a bluish-gray coating, which gives a fine appearance and protects from the weather. Dissolve 1 pt. of the crystallized sulphantimoniate of sodium (sulphuret of sodium and persulphuret of antimony) in 12 pts. water, heat to boiling, and dip the well-cleansed copper vessel for a few moments into the boiling solution. When the proper color is obtained, the vessel is removed, well washed, and dried by a cloth.

*Coppering Glass, Porcelain, or Clay Vessels.*—At the Exhibition of Manufactures, in Berlin and Paris, in 1844, there were vessels of glass, &c. coated with copper galvanically. Dr. Mohr published (Dingler's Journ. Bd. 103, p. 364) a process by which the coppering might be executed. He coated the vessel with copal varnish, rendered the surface conductive with gold-leaf, brass, or bronze-powder, and precipitated from a solution of blue vitriol. The work was well executed, except that, on heating a porcelain vessel thus coated, the copper was loosed from it in the form of the vessel. Dr. Elsner proposed another method (Verh. d. Gewerbver. f. Preussen, 1847), which was not subject to the same defect. The surface of the vessel was rendered matt or rough, by brushing on it



a thick paste of fluor-spar and oil of vitriol, exposing it for 24 hours to a temperature of  $59^{\circ}$  to  $68^{\circ}$ , and then washing it off with water. If the surface was not rough enough, the operation was repeated. The rough surface was rendered conductive by brushing on it well-ignited graphite powder, and then coppered by a Daniell's battery. Liquids were boiled in this vessel without loosening the copper coating. By coating a capsule with a varnish, bronzing it, precipitating copper on it, and then loosening the copper coating by heat, this copper vessel may be silvered or gilded, and found useful in the laboratory.

*Galvanic Coppering.*—For coppering smaller articles of iron, zinc, &c., a solution of cyanide of copper, dissolved in cyanide of potassium, is employed. The experiments of Rammelsberg (Pogg. Annal. vols. xxxviii. and xlii.) prove that two chemically distinct compounds exist, one consisting of 1 equiv. each of cyanide of potassium and cyanide of copper, the other of 3 equiv. cyanide of potassium, and 1 equiv. cyanide of copper. The former is difficultly soluble, crystallizes in needles, and, when treated with cold water, is resolved into white insoluble cyanide of copper: the latter is quite soluble and crystallizes in rhombs. Both salts are formed in the usual way of preparing the coppering liquid, which is made by adding cyanide of potassium to a solution of blue vitriol or verdigris, until the precipitate redissolves. For upon evaporating the solution, the needles crystallize out first, and then the more soluble rhombs.

According to Böttger's experiments, the soluble salt produces the finest coppering, and for ordinary purposes it is only necessary to digest copper-ash (a mixture of copper, oxide, and suboxide) with a concentrated solution of cyanide of potassium (1 pt. cyanide to 6 pts. water) for  $\frac{1}{2}$  an hour, at the temperature of  $190^{\circ}$ , to filter and dilute with an equal volume of water. To obtain the soluble salt, pure metallic copper (precipitated by zinc) is dissolved in a solution of cyanide of potassium. The oxides of copper give rise to the insoluble salt. (Polytech. Notizbl. by R. Böttger, 1846.)



For coppering larger vessels, the cyanide solutions are too expensive, and blue vitriol solution, acidulated with sulphuric acid, will be all-sufficient.—*Elsner*.

*Antique Bronze, or Patina*.—The following composition is said to produce the effect rapidly. 1 pt. salammoniac, 3 pts. powdered argal, and 3 pts. common salt, are dissolved in 12 pts. hot water, and 8 pts. of a solution of nitrate of copper added. (The strength of this solution is not given.—*Elsner*.) Newly made articles of bronze are coated several times with the above solution. A larger proportion of common salt gives a yellowish, and less gives a more bluish tint. (Polytech. Notizbl. 1846.)

C. Hoffmann produces a beautiful chrome-green brown, by first touching (not brushing) the surface of the bronze with a very dilute solution of nitrate of copper, containing a little common salt, brushing it off, then touching it with a solution of 1 pt. binoxalate of potassa,  $4\frac{1}{2}$  pts. salammoniac, and  $94\frac{1}{2}$  pts. vinegar, and again brushing it off. This operation is repeated several times. In the course of a week, the article has a greenish-brown hue, with a bluish-green tone in the depressions, and withstands the weather.

Elsner proposed a method, some years since, which produced an antique, almost identical with that produced naturally, on bronzes. The bronze article, with a clean surface, was dipped into dilute vinegar, and exposed for several weeks to a moist atmosphere of carbonic acid. The operation is economical, and easily executed. (Berlin. Gewerbe-Industrie u. Handelsbl. xii. 78.)

*Bronzing and Brassing*.—Brunnel, Bisson, and Gaugain, have given (Newton's Journ. 1848) a new process for brassing articles of iron, steel, lead, zinc, and their alloys with each other and with bismuth and antimony, by means of the following bath: 500 pts. carbonate of potassa, 20 pts. chloride of copper, 40 pts. sulphate of zinc, 250 pts. nitrate of ammonia. For bronzing, the zinc-salt is to be replaced by one of tin. The object to be plated, after being brightened by scouring, is connected with the negative pole of a Bunsen battery;—a



brass plate being the positive or decomposing pole. For large articles, the number, and not the size of the pairs must be increased. A coating of varnish is necessary to protect the plated surfaces from oxidation by exposure.

Salzedes's method (Ch. Gaz. vi. 227) is similar to the foregoing, but is more expensive, as it requires, in addition, the use of cyanide of potassium.

*Lead: its Reduction in the wet way.*—Sulphate of lead is a large secondary product in dyeing and other technical processes, and may be reduced, according to Trommsdorff, in the following manner. (Kunst u. Gewerbebl. d. k. Baiern, May, 1846, p. 330.) 10 pts. sulphate of lead and 1 pt. common salt are mixed with water to a paste, and bars of zinc immersed into the liquid. Grayish-black metallic lead is separated in a short time, and the solution contains sulphate and chloride of zinc. The lead is very pure. Bolley observes that the lead is left in a spongy state, and may be compressed into any required form.

*Tinning and Leading Vessels of Copper or Iron.*—According to Golfier Bessière, vessels of copper and iron may be easily and strongly coated with lead or tin, by employing soldering salt (chloride of tin and ammonium) instead of salammoniac, during the operation. It thoroughly cleanses the surface from rust.

*Iron Leaded.*—Parkes (Chem. Gaz. 1848) has given a new method for coating iron and steel with lead. The metal is to be scoured and dipped into a bath of 9 pts. of lead with 3 pts. antimony, or into one of 9 pts. lead, 1 pt. tin, and 1 pt. antimony, the surface of either of which must be covered with fused chloride of barium and chloride of sodium, or a mixture of both.

*Galvanic Zincking.*—Kiepe made some experiments on this subject, under Dr. Elsner's direction, which resulted as follows. Wrought and cast-iron was readily coated with zinc, with the aid of a galvanic battery, by employing a solution of freshly-precipitated zinc in saturated sulphurous acid water, or a solution of the double salt of chloride of zinc and ammonium.



It is only necessary to use the zincking solution dilute, and the electric current proportionally feebler. The zinc coating had the thickness of writing paper. The results with hyposulphite of zinc were unsatisfactory.

4. The arts of design may be applied to metallic surfaces by etching, and in other ways, a few hints on which, of a chemical character, we here present.

*Niello-work.*—A metallic plate of iron, copper, &c. is covered with an etching ground, the design graved through it with a point, and these portions etched out by acid. The etching ground being removed, the plate is put into a galvanoplastic apparatus, and coated thickly with metal. The whole surface is ground down, until the precipitated metal is only left in the etched lines. Copper or silver is thus precipitated on steel or copper; and several metals may be precipitated on the same plate. (Vogel in Polytech. Notizbl. 1847.)

*Etching on Copper and Steel.*—To avoid the disagreeable nitrous fumes arising from the employment of nitric acid for etching, as is ordinarily done, Schwartz and Böhme propose for steel, 10 pts. fuming muriatic acid, diluted with 70 pts. water, mixed with a boiling solution of 2 pts. chlorate of potassa in 20 pts. water. The liquid is diluted, before using, with 100 to 200 pts. water. For copper, 2 pts. iodine and 5 pts. iodide of potassium are dissolved in 4 pts. water for a strong action, or in 8 pts. water for feebler action. (An. d. Ch. u. Pharm. lxvi. 63.)

*Engraving upon Silvered or Gilded Copper.*—Becquerel (Comptes Rendus, xxvi. 153) gives an abstract of Victor's method of copying drawings upon metal, glass, or paper; and also of Poiterin's ingenious improvement, by which these drawings may be transferred in a few hours to metal plates, so that they will furnish impressions. The process in detail may be found in the Philosophical Magazine for 1848.

The drawing or writing, previously subjected to the action of iodine vapors, is gently and carefully pressed upon a highly polished daguerreotype plate. The black lines, being the only portions which are iodized, imprint the silver with a corre-



sponding picture, by converting the parts impressed into iodide. The plate, thus prepared, is galvanized in a saturated solution of sulphate of copper, connected by a strip of platinum with the positive pole of a battery of several pairs. In this way, the white portions of the picture are metallized, while the iodized or black limnings remain untouched. The immersion of the plate in the copper solution should only continue some minutes; otherwise the whole of it may become coated.

After careful washing, solution of hyposulphite of soda is applied to dissolve out the iodide of silver covering the black parts, and the plate is then heated until its surface assumes a dark-brown shade. This oxidation of the copper protects the white portions of the picture, which it covers, from the action of the mercury next used to amalgamate the exposed silver. The amalgamated plate is overlaid with several layers of gold-foil, and then heated to volatilize the mercury. The lines originally engraved by the iodine are thus gilded, and, after the loose particles of foil are brushed off, the oxide of copper is removed by a solution of nitrate of silver, and both the copper and silver, beneath, dissolved out by nitric acid. As the gilded portions are protected, the etching may be managed to any depth. The plate thus engraved furnishes impressions in the same manner as wood-cuts.

The plate must be gilt instead of silvered, if it is to be engraved after the manner of copper-plates. The process is the same as above, excepting the omission of overlaying with gold-leaf, until the application of the nitric acid, which serves, instead of heat, to remove the amalgam, and simultaneously, also, the oxide of copper. In this kind of plate, however, the depressed portions furnish the black part of the proof.

5. *Photography*, the art of obtaining representations of objects upon surfaces rendered sensitive to the action of light, is already a beautiful art, although but in its infancy. Very correct representations of animate and inanimate objects, if at rest, are taken upon a polished surface of silver, upon paper, and lately upon glass. Some of the salts of silver, as iodide and bromide, are usually employed to render the surface sensi-



tive. Few improvements have been recently made in this art, but we hope to see most colors copied by photography, and to witness its more direct application to engraving by combination with the galvanotype.

According to Schönbein (Pogg. An. lxxiii.), starch-paste, mixed with freshly-made iodide of lead, so as to give it an intense yellow color, is the most susceptible of all substances to the influence of light.

*Hyposulphite of Soda.*—Faget's process for making the hyposulphite of soda (Journ. de Pharm. 1849) yields a more uniform and purer article than that obtained by the usual methods. It consists in boiling the neutral sulphite with sulphur, by which means nearly all the soda is converted into hyposulphite. The author prepares the neutral sulphite by mixing a solution of carbonate of soda with an equal volume of the same solution previously saturated with sulphurous acid gas. The resulting compound is an alkaline bisulphite, with an excess of sulphurous acid held in solution by the water of the liquid. After the entire expulsion of this excess of sulphurous acid by boiling, sulphur is added and the heat continued.

Plessy purifies this salt by melting it in its water of crystallization, evaporating slightly, and setting aside to cool. The hyposulphite crystallizes, and the impurities remain in the mother water.

For the preparation of hyposulphite of soda, see Lond. Journ. 1849, p. 129.

*Iodine.*—Niepce de St. Victor has discovered two properties of the vapor of iodine, which promise an extension of photography. The first property is, that it will deposit upon the lines of an engraving, whether executed with printer's ink, Indian ink, ink without gum, or red-lead. Before iodizing, it is better to pass the paper through ammonia, then through water acidulated with sulphuric, chlorohydric, or nitric acid, and dry it. The second property is, its depositing itself upon the projecting parts of embossed plates. (See Chevreul's Report on this subject, in Comptes Rendus, xxv. 785.)



*Daguerreotype*.—According to Belfield Lefèvre, and Foucault, an ordinary iodized silver plate, exposed to bromine vapor, until it assumes a dark purple tint, is less susceptible, but produces the lightest and darkest parts of the picture in complete detail. (Phil. Mag. xxx. 213.)

For various improvements in the Talbotype process, see Rep. Pat. Inv. for Aug. 1850.

*Photographic Paper*.—Blanquart-Evrard's method of preparing this paper is as follows (An. de Chim. et de Phys. xx.) To produce the negative picture, the best smooth letter-paper is laid for 1 minute upon the surface of a solution of 1 pt. nitrate of silver in 30 pts. water, taking care that no air-bubbles intervene. It is now removed, suffered to drain off, laid on a glass plate and suffered to dry. It is then passed into a solution of 25 pts. iodide of potassium, and 1 pt. bromide of potassium, in 560 pts. water, so that the surface covered with silver-salt is uppermost, and after remaining in it for  $1\frac{1}{2}$ –2 minutes, it is taken out, washed in a large quantity of water, drained, laid on glass and dried. Before putting it into the camera, it is moistened on the first side with a solution of 6 pts. nitrate of silver, in 11 pts. crystallizable acetic acid, and 64 pts. water, and, after the action of light, with a saturated solution of gallic acid. The negative picture then appears.

The paper for the positive picture is laid for 2–3 minutes upon the surface of a solution of 3 pts. common salt in 10 pts. distilled water, carefully dried between blotting-paper, then passed for a few minutes through a solution of 1 pt. nitrate of silver in 6 pts. water, dried, and protected from light. The negative picture and the positive paper are laid together between two glass plates, exposed for some 20 minutes to sunlight, laid in water for some 15 minutes in a dark room, and then passed through a solution of 1 pt. hyposulphite of soda in 8 pts. water (containing also a little nitrate of silver). By the latter action, the white ground becomes clearer, and the red tints pass into a brown and lastly into black.

Horlsley prepares it thus. Fine paper is passed through a solution of 4 grm. common salt or salammoniac in 25 centi-



litres water, and dried between blotting-paper. Before use, it is brushed over with a solution of 2 grm. nitrate of silver, 0.3 grm. suberic acid, and 5 grm. caustic ammonia, dried, and put into the camera. After the lapse of 5-10 minutes, the paper is removed, washed in water containing a few drops of ammonia, then passed through a solution of 1 pt. hyposulphite of soda in 3 pts. water, dried partly between blotting-paper and lastly before a fire.

Archer (Chemist, 1850, p. 360, 450) has recommended the use of pyrogallic acid for developing the latent picture upon iodized paper. As disappointment is apt to ensue from the rapid decomposition of the acid, it is better to prepare the wash extemporaneously, as follows. To a solution of 20 gr. nitrate of silver in 1 oz. of strong acetic acid, add 3-4 gr. *pure* pyrogallic acid, immediately before using it. All risk of decomposition is thus avoided. The prepared paper is placed at once into the camera, where the light produces the picture without the necessity of a second washing. As the paper is very sensitive, the manipulations must be exact and dexterous in order to insure success. Ample directions are given in the original essays.

Blanquart-Evrard (Lond. Athenæum, 1850, 743) has proposed the employment of fluoride of potassium for imparting extreme sensibility to the iodized paper.

According to the same authority, when the paper is prepared by washing it with a liquor formed by mixing the white of two eggs with a pint and a half of whey, it is free from all inequalities, and may be kept an indefinite time without being injured. A little Narbonne honey added to the albumen, says Niepce de St. Victor, will increase the sensitiveness of the plate or paper.

*Crayon Daguerreotype.*—Mayall (Lond. Athenæum, 1850) gives the following directions for making the so-called crayon photographs:

“Take a daguerreotype image on a prepared plate, as usual, and be careful to mark the end of the plate on which the head is produced. Remove the plate from the holder before mercu-



rializing, and place it upon a sheet of glass prepared as follows. Cut a piece of thin plate-glass to the size of the daguerreotype, and affix to one side, with gum, a thin oval piece of blackened zinc, so that the centre of the oval shall correspond with the centre of the image upon the plate. Having carefully placed the glass, thus prepared, with the centre of the zinc disc upon the centre of the image, expose the whole to daylight for 20 seconds. The action of the light will obliterate all traces of the image from every part of the plate, except that which is covered with the blackened zinc. The thickness of the glass will also cause the action to be refracted under the edges of the zinc disc, and will soften into the dark parts. Mercurialize the plate as usual; the image will be found with a halo of light around it, gradually softening into the black ground, that will at once add a new charm to these interesting productions. By grinding the glass on which the disc is fixed, and by altering the size and shape of the disc, a variety of effects may be produced, which every ingenious operator can suggest for himself."

*Photography on Glass.*—See Niepce's communication in Comptes Rendus, and an extract from the same in Lond. Journ. Oct. 1850.

*Photogenic Glasses.*—Ceselli (Athenæum, 1850) gives the following direction for albumizing glass plates, so as to produce a perfectly uniform and smooth surface.

The requisite apparatus consists of a small rectangular box supported by three regulating screws. To its base is joined a movable plate of metal, which, being heated by a spirit lamp, communicates to all parts of the box an equal degree of heat. The plate is removed when the water-bath is to be used instead of the lamp. The apparatus is protected by a glass covering, to guard against heterogeneous bodies falling on the albumen. This cover is also movable; and the box being traversed by an internal channel, in this, when convenient, a thermometer may be introduced. A sliding frame receives the glass that is to be coated; this again being placed between two other plates of glass. The glasses are secured and their edges



brought to correspond by means of a tightening screw, so that the albumen, when either spreading or shrinking, may always cover the whole surface of the intermediate plate of glass. The frame is furnished on two parallel sides with a small groove to receive the albumen—which a small round-edged knife, elevated to the proper point by means of two spiral pivots cased in the sides of the box, and kept down in a parallel direction to the glass by means of a screw, serves to remove, thus producing the exact thickness of layer which is required. The frame is furnished along one of its sides with an indented ridge, to which a wheel provided with an external handle corresponds, so that the frame can be made to move with such velocity, as the operation may require.



## IV. CHEMICS.

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### 1. SALINES,

Embracing the various alkaline salts, manufactured from common salt and potash, together with water, and the more important acids.

1. *Water and Solution.*—The character of a water, as to its fitness or unfitness for manufacturing purposes, is deserving of some attention. Thus, water derived from coal-mines is often so highly charged with free sulphuric acid, derived from the oxidation of pyrites in the coal, as to corrode a steam-boiler dangerously and rapidly; and, again, some waters deposit a sediment when boiled, which incrusts the interior of a boiler, and thus acts injuriously. The deposit generally consists of sulphate of lime, and many methods have been contrived to prevent its formation. One method is, to add salammoniac to the water which supplies the boiler, whereby the pan-stone is not formed.

Incrustations in boilers may be prevented in many cases by precipitating lime from solution in the water, kept in a tank, previously to its being run into boilers, and either allowing the precipitate to settle or running it through a filter of earth and sand.

*Testing Water.*—Dupasquier proposes to test water for an unusual amount of organic matter, by a few drops of chloride of gold solution. The usual quantity does not alter the yellow tint imparted by the gold even by boiling, but when more than usual, it passes through a brownish color to bluish and violet (Comptes Rendus, Avril, 1847). To test for bicarbonate of lime, he adds a few drops of a tincture of campeachy-wood, which changes to violet from the presence of this salt, or of



alkaline carbonates. To decide between these, a little blue-vitriol solution, added to the water, gives a bluish precipitate when bicarbonate of lime is present; in the same case, chloride of calcium gives no precipitate, but gives a milkiness or precipitate if alkaline carbonates are in solution.

*Solution.*—Salts being obtained and purified from solution, we may here allude to a general principle in the purification of these and other substances, organic or inorganic, and then to the decomposition of salts, &c., by filtration, especially filtration through charcoal. After a salt or other substance has been obtained from solution by crystallization, it retains a portion of other salts, either crystallized with it, or in the mother liquor, enclosed in cavities in the crystals. Although these impurities may in general be removed by repeated crystallization, yet the same end may often be attained more readily, by washing the crystals with a saturated solution of the same substance in a pure state; for being saturated, it will dissolve no more of that substance, but will dissolve portions of others. To effect this, the crystals to be washed should be small, either made so by disturbing the liquor during crystallization or by crushing. Thus salt, nitre, sugar, &c. are obtained pure by washing them respectively with saturated solutions of pure salt, nitre, sugar, &c.

The other point, of decomposition by charcoal, we have touched upon at the commencement of hydrometallurgy, where it was shown that a metallic oxide could be brought to a lower state of oxidation by carbon; but this is probably attended with the formation of carbonic acid, whereas in the instances to be cited, the porosity of the coal separates a substance from solution, and sunders a base more or less perfectly from its acid.

Morfit and Highway, in repeating Lebourdai's process for the preparation of alkaloids by means of animal charcoal, found that the bone-black used for decolorizing the solutions, always retained a portion of the precipitated alkaloid. They extended their investigations to the refuse black of chemical factories, and obtained from that which had been used in the



manufacture of sulphate of morphin, a considerable amount of the alkaloid. It therefore follows, that the use of bone-black as a decolorizing agent, is attended with loss, unless treated finally for the separation of matters which, by precipitation, have become incorporated with it.

*Filtration through Bone-black and Charcoal.*—The experiments on the extraction of substances from solution by bone-black and charcoal are interesting; those by Weppen, in *An. der Chem. u. Pharm.* lv. 241; by Chevalier, in *Journ. f. Pr. Chem.* xxxv. 356; by Warrington, in *Phil. Mag.* xxvii. 269; by Elsner, in *Berl. Gewerbe u. Industrie-Blatt*, xx. 295.

Weppen found that 30 gr. of bone-black, boiled with muriatic acid, thoroughly washed, dried, and gently ignited, extracted the following substances from their solutions: sulphates of copper, zinc, chrome and peroxide of iron, acetates of lead and peroxide of iron, nitrates of nickel, cobalt, silver, and of both oxides of mercury, tin salt, and tartar emetic. One grain of the salt was dissolved in  $\frac{1}{2}$  oz. water. A trace of the metal remains in solution, which no excess of the black can remove, while a basic salt is precipitated on it; but those oxides whose salts are soluble in ammonia are wholly precipitated. Oxide of lead, dissolved in potassa, is precipitated. Arsenious acid in aqueous solution is but slightly thrown down: iodine is removed from its solution in water. The sulphosalts of antimony and arsenic, dissolved in sulphide of ammonium, are separated as metallic sulphides by the black. It appears to exert no influence on alkaline and earthy salts.

Solutions of bitter extracts, as of wormwood, gentian, quassia, cascarilla, buck-bean, and colocynth, are rendered bitterless when the charcoal is in the proportion of 2 : 3; Colombo extract, by an equal weight of coal; aloes, by 13 times its weight; extract of galls and solution of pure tannin, by 10 times their weight. Infusion of Peruvian bark is also sweetened. Jalap and guaiacum are wholly precipitated from their solutions.

Chevallier found that oxide of lead is easily completely precipitated from its acetate and nitrate, but not from its muriate.



Warrington found that in decolorizing beer by charcoal, the hop-bitter was also removed; and that decoctions of Peruvian bark and solutions of sulphate of quinin, and acetates of morphin and strychnin, were freed from their bitter. 12 gr. bone-black were required for 2 gr. sulphate of quinin dissolved in 2 oz. water. An infusion of nux vomica was not debitterized by animal charcoal.

Elsner found that salicin was wholly removed from solution by filtration through common bone-black, as well as that freed from lime by muriatic acid; and that the coal digested with alcohol again yielded up its salicin. Strychnin, brucin, quinin, and cinchonin are removed from their hot aqueous solutions by bone-black or well-ignited wood-charcoal. A large excess of bone-black and charcoal sweetened a concentrated decoction of nux vomica. Solutions of aloes, lupulin, quassia are debitterized, and a solution of nitropicric (carbazotic) acid by bone-black freed from lime.

Weppen further observed that a charcoal which has been used for precipitating one metal, may still be used for precipitating another. Thus, 200 gr. coal, which had been used for precipitating a solution of corrosive sublimate, were shaken with a solution with 5 gr. blue-vitriol in  $2\frac{1}{2}$  oz. water, when in a short time only a trace of copper was left in the liquid, and disappeared altogether upon adding ammonia. After washing and drying the coal, it was shaken with a solution of 3 gr. copperas, from which it soon removed all traces of iron. (Journ. f. Pr. Chem. xxxix. 318.)

2. *Sulphur and Sulphuric Acid.*—This most important of all acids to the chemist, as the source of all others, is made by burning sulphur to sulphurous acid, and oxidizing this to sulphuric by nitric acid, or the oxides of nitrogen. Exclusive regulations of the Neapolitan government have developed the important fact that pyrites (sulphuret of iron) will answer the same end as sulphur on a manufacturing scale, and we know that pyrites is a very abundant mineral.

*Sulphuric Acid.*—Peligot observed, years ago, that sulphurous acid gas, passed through moderately strong nitric



acid, is oxidized into sulphuric acid, while nitric oxide is evolved; and he proposed to burn sulphur alone without nitre, and pass the gas through the first crude acid containing nitric acid. Turner's patent is based on this fact (Rep. Pat. Inv. 1845). The lead chamber is made very low (3 ft. high), and its horizontal surface increased. The bottom is covered with crude acid of 1.5–1.6, containing 3–4 per cent. strong nitric acid. The sulphurous acid is drawn into the chamber by pumps, and in order to avoid loss, this acid and the nitric oxide are passed through three lead vessels, the two first containing the mixture of nitric and sulphuric acids, and the last sulphuric acid of 1.7. This process is said to yield 50 per cent. more oil of vitriol than the former method. (?)

Schneider (Comptes Rendus, xxv. 931) has succeeded in converting sulphurous into sulphuric acid, by means of pumice-stone peculiarly prepared, without the necessity of leaden chambers or iron retorts. We do not know how the pumice is prepared. A process was patented, many years since, for making oil of vitriol from sulphurous acid, by means of platinum-sponge, but was not successfully carried out as a manufacturing process.

Paul Gilbert Pretier has patented a process (Ch. Gaz. vi. 88) for making fuming sulphuric acid by distilling the bisulphates, as follows: Alkaline sulphates are placed in a stone retort, and acidulated by the addition of oil of vitriol. Heat being gradually applied, the distillate collected in receivers is clear and colorless.

*Pure Sulphuric Acid.*—A. A. Hayes (Silliman's Journ. 1848) takes the acid of 1.76 at that stage of the process for manufacturing the commercial article, when it is ready for transferring from the leaden evaporators to the concentrating vessels of platinum. This weak acid, while hot, is treated with nitrate of potassa, which renders it colorless by destroying the coloring matter. It also removes much of the hydrochloric acid, and converts the arsenious and sulphurous into arsenic and sulphuric acids. The remaining hyponitric acid is expelled by the addition of  $\frac{1}{300}$  of sulphate of ammonia.



The acid is then concentrated to 1.78, run off into deep, leaden vessels, and gradually cooled to 32° F. After repose, the clear portion is transvased into shallow pans and cooled down to 0°, and left until one-half of its volume has solidified, when the congealed mass is to be separated and washed with pure acid. These crystals are freed from adhering portions of sulphates and arseniates of iron and lead, by fusion in glass vessels, re-crystallization, and washing with pure acid. To obtain a strong acid, the crystals must be melted and concentrated in a platinum kettle.

According to Wackenroder (Archiv. d. Pharm. (2) lviii. 28), the crystallized hydrate of sulphuric acid  $\text{SO}_3\cdot 2\text{HO}$ , used by Hayes as the source of his pure acid, may be readily obtained by congealing sulphuric acid, rectified over sulphate of potassa at 28.4° F. Very large rhombic crystals form and give, by fusion at 71°, a liquid acid of 1.784 at 46°. The acid thus prepared resolidifies at 39°.

Bineau has constructed the following table of composition of hydrated sulphuric acid, derived partly from his direct

A	B	At 32°		At 59°		A	B	At 32°		At 59°	
		C	D	C	D			C	D	C	D
5°	1.036	5.1	4.2	5.4	4.5	50°	1.530	61.4	50.1	62.6	51.1
10	1.075	10.3	8.4	10.9	8.9	51	1.546	62.9	51.3	63.9	52.2
15	1.116	15.5	12.7	16.3	13.3	52	1.563	64.4	52.6	65.4	53.4
20	1.161	21.2	17.3	22.4	18.3	53	1.580	65.9	53.8	66.9	54.6
25	1.209	27.2	22.2	28.3	23.1	54	1.597	67.4	55.0	68.4	55.8
30	1.262	33.6	27.4	34.8	28.4	55	1.615	68.9	56.2	70.0	57.1
33	1.296	37.6	30.7	38.9	31.8	56	1.634	70.5	57.5	71.6	58.4
35	1.320	40.4	33.0	41.6	34.0	57	1.652	72.1	58.8	73.2	59.7
36	1.332	41.7	34.1	43.0	35.1	58	1.671	73.6	60.1	74.7	61.0
37	1.345	43.1	35.2	44.3	36.2	59	1.691	75.2	61.4	76.3	62.3
38	1.357	44.5	36.3	45.5	37.2	60	1.711	76.9	62.8	78.0	63.6
39	1.370	45.9	37.5	46.9	38.3	61	1.732	78.6	64.2	79.8	65.1
40	1.383	47.3	38.6	48.4	39.5	62	1.753	80.4	65.7	81.7	66.7
41	1.397	48.7	39.7	49.9	40.7	63	1.774	82.4	67.2	83.9	68.5
42	1.410	50.0	40.8	51.2	41.8	64	1.796	84.6	69.0	86.3	70.4
43	1.424	51.4	41.9	52.5	42.9	65	1.819	87.4	71.3	89.5	73.0
44	1.438	52.8	43.1	54.0	44.1	65.5	1.830	89.1	72.7	91.8	74.9
45	1.453	54.3	44.3	55.4	45.2	65.8	1.837	90.4	73.8	94.5	77.1
46	1.468	55.7	45.5	56.9	46.4	66	1.842	91.3	74.5	100	81.6
47	1.483	57.1	46.6	58.2	47.5	66.2	1.846	92.5	75.5	"	"
48	1.498	58.5	47.8	59.6	48.7	66.4	1.852	95.0	77.5	"	"
49	1.514	60.0	49.0	61.1	50.0	66.6	1.857	100	81.6	"	"



determinations of spec. grav. and composition, and partly from calculation. The 1st column, A, represents Baumé's areometric degrees; the 2d, B, contains the specific gravity; the 3d, C, the percentage of oil of vitriol, and the 4th, D, the percentage of the anhydrous acid. ( $66^{\circ}$  B. corresponds to spec. grav. 1.842). (An. de Ch. Phys. (3) xxiv. and xxvi.)

R. A. Tilghman, of Philadelphia, has patented several processes connected with salines, which possess the high merits of ingenious invention, simplicity of material and action, and the highest prospect of success. One of these processes is for obtaining sulphuric acid by the action of steam on the sulphates of baryta, strontia, or lime, at a high temperature. We refer for minutiae to Rep. Pat. Inv. 1847. See also the soda manufacture.

*Crystallized Sulphurous Acid.*—Pierre (Comptes Rendus, 1848) obtained sulphurous acid in crystals, by passing the gas, previously washed, into water already surcharged with it. The temperature must not exceed  $32^{\circ}$ . In a few hours several hundred grains will have deposited. Its formula is  $\text{SO}_2, 9\text{HO}$ . Döpping's acid, similarly obtained, has the composition (Bul. de St. Petersburg, vii.)  $\text{SO}_2, \text{HO}$ .

3. *Common Salt and its derivative Arts.*—Beside its use as salt (for preserving animal matter, &c.), common salt is largely employed in the preparation of carbonate of soda (soda-ash), according to the invaluable process of Leblanc, by which muriatic acid is obtained at the same time. The soda manufacture is therefore most conveniently arranged under these two heads, making soda with its derived salts, and muriatic acid with its derivative arts. Salt is obtained from solid rock-salt formations, by evaporation of salt-springs or brines, or of the waters of the ocean. There is a locality of solid salt found in the United States, in the south-western part of Virginia; but all the salt used is either imported from Europe or obtained from brines. In making soda-ash, the salt is first converted into sulphate of soda by sulphuric acid, whereby muriatic acid gas is given off, and the salt-cake (dry sulphate of soda), mixed with carbon and carbonate of lime, is heated and extracted



with water. The solution contains soda, and a salt of lime remains.

A. *Soda-ash*.—Practice has advanced far before theory in this manufacture, for we knew but little of the theory of the changes effected during the process until within the last few years, although the manufacture has become so expanded that England produces annually more than 100,000 tons of carbonate of soda. The process has been recently investigated, with a practical object in view, by J. Brown (Phil. Mag. 3 ser. xxxiv.), and, for elucidating the theory, by Bodo Unger (Ann. Chem. Pharm. lxi. lxiii. lxvii.) The following are two analyses by Unger, the first of the crude soda, that is, after the mixture of salt-cake, limestone, and carbon have been duly heated; the second, of the residue, after the soluble salts have been extracted.

#### 1. *Crude Soda.*

Sulphate of soda.....	1.99
Chloride of sodium.....	2.54
Carbonate of soda.....	23.57
Caustic soda.....	11.12
Carbonate of lime.....	12.90
Oxysulphide of calcium ( $3\text{CaS}, \text{CaO}$ ).....	34.76
Sulphide of iron.....	2.45
Silicate of magnesia.....	4.74
Coal .....	1.59
Sand .....	2.02
Water.....	2.10
	<hr/>
	99.78

#### 2. *Residue.*

Carbonate of lime.....	19.56
Oxysulphide of calcium.....	32.80
Sulphate of lime.....	3.69
Hyposulphite of lime.....	4.12
Hydrate of lime.....	4.02
Bisulphide of calcium.....	4.67
Sulphide of calcium.....	3.25



Hydrate of lime.....	6.67
Sulphide of sodium.....	1.78
Peroxide of iron.....	3.70
Silicate of magnesia.....	6.91
Coal .....	2.60
Sand .....	3.09
Water.....	3.45
	<hr/>
	100.31

The results of Brown and Unger agree closely, when we consider how such materials are likely to vary in composition according to circumstances, but the amount of the carbonate of lime should be halved, as Brown proved it to be caustic lime, and the half added to the caustic soda, which would bring the total amount of carbonate of soda in the first analysis to nearly 40 per cent. Brown gives it at  $35\frac{1}{2}$ .

The following table, from Brown, shows the composition of the different products of the soda manufacture.

	1.	2.	3.	4.	5.	6.	7.
Carbonate of soda....	68.91	71.61	79.64	84.00	84.31	36.47	98.12
Hydrate of soda.....	14.43	11.23	2.71	1.06	trace.	0.94	1.08
Sulphate of soda.....	7.02	10.20	8.64	8.76	10.26	....	....
Sulphite of soda.....	2.23	1.11	1.24	trace.	trace.	....	....
Sulphide of sodium..	1.31	....	trace.	....	....	....	....
Chloride of sodium...	3.97	3.05	4.13	3.22	3.48	0.42	0.74
Soda-alumina .....	1.02	0.92	1.17	1.01	0.63	....	....
Silicate of soda.....	1.03	1.04	1.23	0.98	0.41	....	....
Insoluble and sand...	0.81	0.31	0.97	0.71	0.25	....	....
Water.....	....	....	....	....	....	62.15	....

Analysis No. 1 is the salt obtained by evaporating the extract of the crude soda to dryness at  $212^{\circ}$ , and then heating in a calciner, which makes No. 2, soda-ash. Or, the extract is evaporated nearly dry, the mother-liquor drained off from the crystals; the dried residue, 3, is heated in a furnace, 4. By repeated solution, evaporation and calcination of the crystals, a better kind, 5, is produced, and by crystallizing the purer kind, *soda*, 6 results; and when this is calcined, the best product, 7, is obtained.

R. A. Tilghman applied the decomposing power of steam to



the decomposition of salt, starting from the simple equation  $\text{NaCl} + \text{HO} = \text{NaO} + \text{HCl}$ , that is, that water and salt, at a high heat, would mutually form caustic soda and chlorohydric acid. This decomposition does take place, but he found that by the assistance of alumina it was more perfect, the soda being retained by the alumina and the acid passing off. The soda is extracted by water from the alumina and the latter used again.

Tilghman also prepares Glauber's salt by heating to redness a mixture of common salt and gypsum, and passing steam through it, and then extracting by water. The Glauber's salt, mixed with alumina, is heated to redness, while steam is passed over it, and the soda then extracted from the alumina by water. (Rep. Pat. Inv. 1847.)

*Testing Bicarbonate of Soda.*—Chevalier (Liebig's Annalen, 1847) detects the presence of neutral carbonate in bicarbonate alkali, by adding starch-sugar to the aqueous solution of the latter, and heating. The mixture yellows or browns if any neutral carbonate is present.

The soda obtained from the soda-process is chiefly used for fluxing sand to make glass, for decomposing fats to make soap, or to neutralize acids. The boracic acid of the Tuscan lakes, neutralized by soda, yields the borax of commerce; and phosphoric acid, from bones, yields phosphate of soda, which is employed in dyeing and calico-printing.

B. The *muriatic acid* obtained as an incidental product in making soda-ash, besides its use for dissolving metallic oxides, is extensively employed in making bleaching salt. When muriatic acid is heated with black oxide of manganese, its hydrogen is oxidized to water by the oxygen of the oxide, and chlorine gas is set free. When this is passed into lime, chloride of lime or bleaching-salt is made, and passed for a long time into a solution of potash, the chlorate of potassa is formed.

*Chloride of Lime.*—According to Mène (Comptes Rendus, 1847), bleaching-salt may be made pure and expeditiously, by saturating slaked lime with water highly charged with chlorine.



The lime absorbs the chlorine as soon as it comes in contact with the solution; the supernatant water is immediately decanted and the application of chlorine liquor repeated, as above, several times. By exposure to a gentle heat for a short period, the moisture is driven off, and pure chloride of lime remains.

*Chlorate of Potassa.*—Calvert's process (Comptes Rendus, 1850) is to pass a current of chlorine gas through a hot ( $122^{\circ}$ ) mixture of  $5\frac{1}{2}$ –6 equivalents of burnt lime and 1 equiv. caustic potassa in water. Chloride of calcium and chlorate of potassa are the products. When the solution is saturated with the gas, it is to be filtered, evaporated to dryness, redissolved in boiling water, and allowed to cool. The use of lime saves the great loss of potassa by other processes, 22 pts. of chlorate being obtained from every 10 pts. of potassa employed.

4. *Potash* is obtained by lixiviating the ashes of trees, evaporating the solution to dryness and calcining the residue. When purer, but more carbonated, it is termed pearlash.

*New Source of Potash.*—H. Wurtz has suggested a method of decomposing green sand, with the view of gaining its potash, by fusing it with chloride of calcium. See Amer. Journ. 2d ser. x. 326, where many experiments are detailed having the same object in view.

*Potash tested for Soda.*—Pagenstecher's method is as follows (Mittheil. d. Naturf. Gesellsch. in Bern, No. 65). It is based on the fact that a saturated solution of sulphate of potassa can dissolve large quantities of sulphate of soda. About half an ounce of the potash to be tested is poured over with water, treated with sulphuric acid until it has an acid reaction, evaporated to dryness, ignited, and weighed. The powdered saline mass is then treated with 6 times its weight of a concentrated solution of sulphate of potassa, stirred, allowed to settle, and the clear liquor drawn off from the sediment by a siphon. After being again treated with a like quantity of the sulphate of potassa solution, the residue is thrown on a balanced filter (the funnel covered with a glass plate during filtering to avoid evaporation), and when the last drops have



passed through, it is weighed moist, then dried at  $212^{\circ}$  and again weighed. The difference between the two last weights is the water of the solution of sulphate of potassa, which, being of a known strength, gives the quantity of sulphate of potassa it contained. This must of course be subtracted from the weight of the dried residue, and the remainder is the sulphate of potassa made from the pearlash. If the ash were free from soda, this weight would equal that of the original sulphate evaporated to dryness, but if less, then sulphate of soda has been washed out. From this loss ( $= L$ ) the carbonate of soda in the ash may be thus calculated,

$$71 (\text{NaO}, \text{SO}_3) : 53 (\text{NaO}, \text{CO}_2) :: L : x \text{ or } x = \frac{L.53}{71}$$

It must however be observed, that the soda used to adulterate potash usually contains a large percentage of sulphate of soda.

*Nitre* is formed in artificial beds, or in some cases where nitrogenous organic matter is present, together with lime and some potash; but potash is usually added to the beds, or the extract of the soil, containing nitrate of lime, whereby nitrate of potassa is produced. Soda-salt peter is obtained from Atacama in Peru. Both nitrates are the source of nitric acid.

*Anhydrous Nitric Acid*.—Deville (Comptes Rendus, 1849) has succeeded in obtaining anhydrous nitric acid by the action of absolutely dry chlorine upon nitrate of silver. It crystallizes in brilliant, colorless, six-sided prisms; melts at  $85^{\circ}$  F. and boils at  $113^{\circ}$ , and requires to be handled cautiously, owing to its tendency to explode.

5. *Alum*.—This most important salt to the dyer, calico-printer, tanner, and others, is sometimes observed in nature in an impure state, but it is generally procured from slates, which have originally contained iron pyrites (sulphuret of iron). The pyrites by oxidation form sulphuric acid, which is more or less transferred to the alumina of the slate; and to the extracted sulphate of alumina, sulphate of potassa is added and alum generated. As sulphate of iron is obtained incidentally in making alum, it leads us to the metallic salts and pigments, or metallosalines.



## 2. METALLOSALINES.

These embrace the preparation of various metallic salts, which are chiefly employed for dyes or making pigments. We may most conveniently divide the subject into the vitriols, or sulphates of iron, copper, zinc, and manganese, with the pigments derived from them; the salts and pigments of lead; the prussiates; the chromates, and a few others.

1. *Vitriols*.—Copperas, green vitriol, or protosulphate of iron, is made directly from sulphuric acid and scrap-iron, or from calcined pyrites, or is obtained in the kindred and connected manufacture of alum. These two articles are made on an extended scale in the United States, and but little can be offered that is new in relation to them.

*Copperas*.—It may be freed from lead and copper, and at the same time all peroxide of iron reduced to protoxide, by boiling its solution with good scrap-iron, nails, &c. until it becomes light and green. By evaporating the solution, it then yields bluish-green crystals. The precipitate will contain the copper, lead, &c. (Encycl. Zeitschr. d. Gewerbehandl. 1846.)

*Preservation of Copperas*.—According to Ruspini (Journ. de Chim. Méd. vi.) the protosulphate of iron, when in crystals, may be preserved from oxidation, by pressure, desiccation between the folds of bibulous paper, and, finally, efflorescence in a drying chamber at  $86^{\circ}$ . It is to be kept in well-stoppered bottles.

*Oxidation of Copperas*.—According to Wittstein (Buchner's Repert. i.) a solution of 1 pt. protosulphate of iron in 4 pts. water, after 11 months' exposure in a loosely covered vessel, deposits  $2\text{Fe}_2\text{O}_3 + 3\text{SO}_3 + 8\text{HO}$ , and not  $2\text{Fe}_2\text{O}_3 + \text{SO}_3$ , as is generally admitted.

*Sulphate of zinc*, or white vitriol, is made directly from zinc and sulphuric acid. *Manganese vitriol* is made directly from black oxide of manganese and oil of vitriol, or it is obtained as a residue in making bleaching-salt from manganese, salt, and oil of vitriol. *Blue vitriol*, or sulphate of copper, is made



by the direct action of oil of vitriol and old sheet-copper, or by solution of precipitated hydrate of copper in the acid, or by lixiviating roasted copper-pyrites.

*Pure Sulphate of Manganese.*—Elsner thus prepares it: 1 pt. sulphur is well mixed and heated with  $5\frac{1}{2}$  pts. binoxide of manganese, so that sulphurous acid escapes, and protoxide of manganese remains. When 2 equiv. of this oxide are treated with less than 2 equiv. of oil of vitriol, so that a portion of the oxide remains uncombined, this portion removes all the iron from the sulphate, and gives a good vitriol by solution and crystallization. White vitriol may be similarly made free from iron. (Elsner, in Hoffmann's Mittheilungen, &c.)

It would be better to use a little less sulphur, so as to leave a small part of the manganese in its state of binoxide, that by peroxidizing the iron the latter may be more effectually removed. A good proportion for a good ore (containing but little silica) is 1 pt. sulphur, 6 pts. black oxide of manganese, and 5 pts. oil of vitriol. The same principle has been applied to Epsom salt, by heating the solution with a portion of magnesia itself. It is also applicable to solutions of nickel and cobalt. But in all these cases it is necessary that the iron be in the state of sesquioxide, or be brought into this state.

*Borate of Copper, a green Pigment.*—16 pts. blue vitriol, and 25 pts. borax are separately dissolved in water, the solutions poured together, and the bluish-green precipitate, washed with cold water, is first dried at common temperature and then by warmth. The dried precipitate is then heated in a hessian crucible to a low red-heat, but not to fusion, and ground. Bolley proposes it for oil and porcelain painting (Bolley, Schweiz. Gewerbebl. 1847, 28). Dr. Elsner remarks that the color varies in different experiments, and that a certain degree of heat is requisite to its production.

*Blue Sulphuret of Copper.*—Alexander and Walter give the following method of preparing it (Buchner's Repert. d. Pharm. 1847). Black oxide is prepared by precipitating blue vitriol solution by caustic soda or potassa (lime?), washing it well and drying it. A mixture of 2 pts. of this oxide, 2 pts.



flowers of sulphur, and 1 pt. salammoniac, is heated gently in a porcelain vessel, over coals, until the sulphur inflames; while burning, the mixture is stirred now and then, covered with a loosely-fitting cover, and removed from the fire for a few moments. A new portion of sulphur and salammoniac, without copper, is added, the cover replaced, and the vessel again heated. After some time the cover is removed, when much sulphur sublimes. As long as it shows a black and not a blue color, sulphur and salammoniac are added, and the vessel heated as before. When finished, it is washed with hot water, then with a little ammonia if oxide of copper be present, treated with caustic potassa or soda to remove the excess of sulphur, and, finally, washed with water, ground, and dried. Under a polishing tool it shows a beautiful steel-blue streak, and when mixed with size and brushed on paper, a steel-blue lustre on a violet-blue ground. In a medium of oil or varnish it is violet-blue.

The following simpler method was contrived in the Gewerbe-Institut of Berlin. Metallic copper is precipitated by zinc from a boiling solution of blue vitriol, and the fine powder washed and dried. 51 pts. of this copper, mixed with 3 pts. sulphur, are gently heated in a porcelain vessel, so that the excess of sulphur sublimes, but does not burn. When the heated mixture shows a sandy appearance it is finished, and, on cooling, shows a dark-blue color. The excess of sulphur is removed by potassa, and the residue well washed. If it have not acquired the desired tone, it is again warmed with sulphur, &c. It resists chemical action in a remarkable manner.

Winkelblech's method consists in rubbing together 1 equiv. lac sulphuris and 2 equiv. metallic copper, reduced from the oxide by hydrogen.

*Zinc-white.*—This pigment, to which attention is now drawn, is either the anhydrous oxide of zinc, or a hydrated oxide, or a hydrate-carbonate of the metal. It possesses a great degree of whiteness, about equal to that of white-lead; a sufficient body, and, what is of great importance, is less liable to tar-



nish than white-lead. Another important advantage cannot be overlooked: its freedom from the noxious character of carbonate of lead on those who employ it. It is less drying than white-lead colors, but in order to effect this result in a shorter time, dry sulphate of zinc (white vitriol) may be added to it, or a more drying oil may be employed. It has been too lately introduced to decide upon the relative merits of the several compounds above named, and it is even doubtful which can be produced at the cheapest rate; but it may be safely assumed, from its low equivalent (32.6,  $H=1$ ), that a given weight of zinc will produce a much larger amount of white pigment than the same weight of lead, with an equiv. = 104. On the other hand, the objections to it are, that it has far less body (covering power) than white-lead, and that it requires a large amount of oil as its vehicle of conveyance to a surface.

*Durability of Zinc-white.*—Lassaigne drew attention, in 1821, to the use of oxide of zinc instead of white-lead as a pigment. He has lately stated that an oil-painting, finished with oxide of zinc, has remained of a pure white to this day. The oil was previously treated with sulphate of zinc to render it more drying.

*Oxides of Zinc and Antimony, &c.*—It has been an object of several patents, of late, to distil ores of zinc and antimony in such a manner that the volatilized and oxidized products, white oxides of antimony or zinc, shall be separately collected and used as pigments. To avoid the cost of first obtaining the metallic zinc and then converting it into oxide, the ores are heated in furnaces of various construction, but so arranged that the products of combustion from the mixed ore and fuel are conducted into condensing chambers, where both metal and oxide are obtained. Notwithstanding the ingenious contrivances for effecting this result, none have been yet found faultless. One of the late patents on this subject (Lond. Journ. Sept. 1850) subjects copper and other unroasted ores to the action of a blast-furnace, so that the non-volatile products are obtained in the furnace, while the volatile are condensed in chambers. In this manner oxides of zinc, antimony,



and arsenic, are obtained from copper and other ores. These mingled ores are hardly likely to yield the several products sufficiently separate and distinct.

Rochaz has a good arrangement for making this pigment direct from metallic zinc by combustion. (Lond. Journ. xxxvi. 1.) Fire-clay crucibles are set each in a furnace, so that the fire plays around but not above it. The zinc being thrown in and brought to ignition, the cover of the crucible is removed and a draft of air passes over the crucible, whereby oxide of zinc is produced, forming abundant white fumes, which are carried into a large chamber, divided into compartments. The greater part of the oxide settles in these; and to prevent any appreciable quantity from passing off, the last compartment is provided with hanging bands of hemp or other fabric, which may be multiplied without interfering with the draft. He proposes to use the Belgian furnace for distilling metallic zinc from its ores, consisting of a stack of many cylindrical retorts, in order to prepare the white oxide from the ore, and varying the arrangement so that the air is admitted to the distilling metal, whereby it is converted into oxide, and condenses in chambers. Several forms of blast-furnace have been proposed, but none have been proved sufficiently to speak of their merits.

The native oxide of zinc of New Jersey has been recently employed both for making the metal and zinc-white. The former is less likely to be economically produced than the latter; and it is stated that the process for the latter is eminently successful, as it requires but 2 pts. coal to obtain 1 pt. of the pigment. Judging from the experience in Europe, we must believe this to be a great miscalculation, for it requires some 11 tons fuel to make 1 ton zinc in Belgium and Silesia, and in making the oxide of zinc, the formation of metal must precede it.

A case of the peculiar effect of zinc in producing a colic among operatives engaged in making it, is reported in the *Comptes Rendus*, and although it appears to be less deleterious than white-lead, yet it shows that its effects on workmen must also be guarded against.



*Compounds of Lead.*—When metallic lead is calcined on the hearth of a reverberatory, to which the air has free access, it is converted into litharge, or simple oxide of lead; and when litharge is still further heated in a similar manner, it is converted into a higher oxide, red-lead or minium, or orange-mineral. Litharge, dissolved in vinegar, gives rise to acetate or sugar of lead. White-lead is usually made by putting a roll of sheet-lead into an earthen pot, containing a little vinegar in the bottom, and placing a large number of such pots in fermenting matter, manure, tan, &c. The fermenting matter evolves heat, steam, and carbonic acid, and the heat slowly evaporates the vinegar. This vapor induces the lead to oxidize and form acetate of lead, which is decomposed by carbonic acid as fast as formed, and the acid transferred to the adjoining stratum of metal. In this manner the sheet is corroded through, and becomes carbonate of lead, or white-lead. Various other processes have been proposed, but the old method still retains its place.

*White-lead.*—Gannal gives a method of preparing it from granulated lead by air and water. (Journ. Fr. Inst. 1847.) See a review of the different methods in Journ. Fr. Inst. 1842, vol. iii. 3d ser. p. 30.

Disbrow Rodgers's process (Ch. Gaz. 1850) for the manufacture of carbonate of lead, consists in exposing thin sheet-lead in a steam-heated chamber, to the joint action of acetic and aqueous vapors, and of carbonic acid gas, generated from fermenting matter contained in vessels beneath. The required temperature is 80° F., and the vinegar is volatilized by the admission of a current of steam. The chamber must be dark and air-tight, and the fermenting and acid liquors renewed six times during the process, at intervals of two days. The conversion of the lead is completed in two weeks. See Review, as above.

*White-lead Pigment.*—According to Patterson (Ch. Gaz. vii.), if a warm solution of chloride of lead is mixed with clean lime-water, in such proportions that one equivalent of the lead-salt may be made to react upon half an equivalent of



lime, all the lead is precipitated as  $\text{PbCl} + \text{PbO}, \text{HO}$ , at  $212^\circ$ , or  $\text{PbCl} + \text{PbO}$  when dried between  $212^\circ$  and  $350^\circ$ . The great brilliancy and body of this white oxichloride induced the inventor to take a patent for its application as a pigment.

An excellent essay on the effects of preparing this pigment on the health of the operative, was made by M. Combes to the Academie des Sciences, and appears as a translation in the Lond. Journ. xxxvi. 184–193. We may state that in most of our establishments in the United States, the corroded sheets of lead are ground in water, whereby the greatest evils of the former mode of dry grinding are avoided.

3. *Prussiates*.—*Yellow Prussiate of Potash* is usually prepared by heating common pearlash or potash to fusion in an iron vessel, and adding to the melted mass, dried blood, hornshavings, cracklings, &c. The excess of carbon in the animal matter probably reduces the potassium, while the nitrogen and carbon form cyanogen, which unites with the potassium. The formation of cyanogen, or rather of cyanide of potassium, from the nitrogen of the air, in part at least, was clearly shown by Bunsen, in his investigations on the blast-furnace. A patent had been taken out in England for making prussiate from the air and coal, but the process was not successfully carried out.

Possy and Bossière (Comptes Rendus, xxvi. 203) have succeeded in manufacturing yellow prussiate of potash, upon a large scale, by means of the nitrogen of the atmosphere. The daily product of their works, at Newcastle-upon-Tyne, is about 1000 kilogrammes (a ton), at a cost not exceeding 2000 francs (\$400) for that quantity. The apparatus, as now constructed, will resist, for several years, the destructive action of the potassa and fire. It consists of a vertical cylinder set in refractory brick-work. The interior diameter of the cylinder is about 18 inches. The height, heated to bright redness, is about 10 feet. The cylinder, being heated to bright redness and charged with lumps of charcoal impregnated with 30 per cent. of carbonate of potassa, is kept filled with burned air, which is injected, across a heated channel, by means of a forcing-



pump. In this way the treatment is to be continued for 10 hours, so that the whole mass may be acted upon. As the coal becomes cyanuretted, and is drawn off at the bottom, new supplies must be added at the top. The heated coal is conducted along an iron gutter into a reservoir containing powdered native carbonate of iron diffused in water. The coal becomes leached, and the liquor on evaporation will yield crystals of prussiate.

Coke gives less product than charcoal; and the presence of even minute portions of water decomposes the cyanide and generates ammonia, thus decreasing the yield of salt.

*Explosion with Red Prussiate of Potash.*—During the preparation of red prussiate (ferridcyanide of iron) in a chemical work at Berlin, a violent explosion took place, without apparent cause, which dashed to pieces the wooden vessels in which the operation was performed, and shook the walls of the building. Fortunately no person was injured. The chlorine was generated in cast-iron vessels, from manganese, salt, and sulphuric acid. Muriatic acid was also evolved, which set prussic acid free from the prussiate solution. Now, an ammoniacal salt is produced by the action of chlorine on prussic acid; and by the further action of chlorine on ammonia, it is probable that the highly explosive chloride of nitrogen was produced. (Berlin. Gewerbe-Industrie und Handelsbl. xx. 141.)

*Cyanide of Potassium.*—C. Clemm (Annal. der Chem. u. Pharm. lxi. 250) gives the following details of Liebig's method, which should be observed to obtain a white and not dark-gray compound. Yellow prussiate of potash (ferrocyanide of potassium) is thoroughly dried by calcination. 8 pts. of this salt are intimately mixed with 3 pts. of fully dry carbonate of potassa in a covered iron crucible, and heated until the fused mass at a dull red-heat appears clear, and, when taken out in an iron spatula and cooled, appears white. The crucible is removed from the fire, gently struck to separate the iron, and its fluid contents (after evolution of gas has ceased) poured through a cullendered iron ladle (previously heated) into a



warm and deep vessel of silver, iron, porcelain, or stoneware, with a smooth inner surface. After cooling, the lower part of the fused mass, containing iron, may be cut off by a sharp tool. If the heat be carried to full redness, the resulting salt will have a gray color, from the separation of carbon through it.

To prepare cyanide for galvanic gilding or silvering, both the prussiate and carbonate of potash should be free from sulphate, as the consequent formation of sulphuret injures the color of both gilding and silvering.—*Elsner*.

4. *Chromates*.—Chrome yellow and other beautiful pigments and dyes are obtained from the mineral chromic iron, which is, in its purest form,  $\text{FeO}, \text{Cr}_2\text{O}_3$ , which should contain 68 per cent. of oxide of chrome. Mr. T. Garrett analyzed a specimen of the ore from Tyson's mine, Lancaster county, Pennsylvania, containing 63 per cent., which approached nearer to the formula than any published analysis. The ore at this and one or two other places forms solid veins or masses, but a great deal is obtained in the form of sand, by washing the sandy beds of the small streams flowing from a range of serpentine-rock.

B. Silliman, Jr., first observed that the green coating on the ore of Tyson's mine was a hydrocarbonate of nickel. T. Garrett found the same metal in some of the ore where the green coating had been carefully removed, and he has since proved that it contains a trace of tin. Garrett's analyses were performed in my laboratory, where he is still investigating some of the minerals of the chrome localities.—*J. C. B.*

Jacquelain's process (Dingler's Pol. Journ. cvi. 405) for the manufacture of potassa-chromate from the natural chromo-ferrite is as follows. The finely-powdered ore is to be intimately incorporated with chalk, and this mixture exposed in strata of  $1\frac{1}{2}$  inches, for 10 hours, to the heat of a reverberatory furnace. Neutral chromate of lime is thus formed, and the next step is to convert it into bisalt. This is to be done by grinding it, and, while suspended in water, adding a slight excess of sulphuric acid. To separate any protosulphate of



iron that may be present, milk of lime must be poured in and the whole left to repose. The clear supernatant liquor will, when drawn off, yield bichromate of potassa by double decomposition. This mode is said to be more economical, in time and expense, than the usual method with nitre and potash, but we must doubt its feasibility.

Tilghman's methods (Rep. Pat. Inv. 1847) differ materially from the foregoing. One requires the ignition of the chromo-ferrite with lime and powdered feldspar. The other proposes its mixture with 2 pts. lime and 2 pts. sulphate of potassa, and subsequent heating on a reverberatory hearth, in contact with aqueous vapor. For the details of the ingenious processes of this chemist, we refer to the original paper.

*A new Metal in Chrome-ore.*—Ullgren (Vetensk Acad. Förhand. 1850) has given an account of a substance noticed in the chrome iron of Röros, and which he considers a new metal. Its oxides bear a near analogy to those of iron.

*Double Chromates.*—Schneitzer (Journ. für Prac. Chem. xxxix.) has announced the existence of two double chromates. They are both of a beautiful yellow tint, and crystallizable. One, the chromate of potassa and magnesia, made by adding calcined magnesia to a strong solution of bichromate of potassa, heating and evaporating to crystallization, has the composition  $2\text{CrO}_3, \text{KO}, \text{MgO} + 2\text{Aq}$ . The other, chromate of potassa and lime, has the formula  $2\text{CrO}_3, \text{KO}, \text{CaO} + 2\text{Aq}$ .

*Oxide of Chrome.*—Barian (Berz. Jahresb. 1846, 177) prepares it by mixing 4 pts. bichromate of potassa with 1 pt. starch, igniting it in a hessian crucible, extracting carbonate of potassa by water, and again igniting the oxide of chrome. If the chrome salt had been free from sulphuric acid, the oxide will be a pure green. If it contain this acid, the salt is purified by crystallization. To test its presence, 1 pt. of the salt is dissolved in water with 3 pts. tartaric acid until carbonic acid ceases to escape, the solution treated with muriatic acid, and then tested with chloride of barium.

Wittstein's method is to ignite for  $\frac{1}{2}$  an hour 19 pts. bichromate of potassa and 4 pts. sulphur, to powder the mass



after cooling, and extract it with water. It yields  $9\frac{1}{3}$  pts. oxide of chrome. (Dingler's Journ. civ. 158.)

5. Some other pigments are prepared, partly by heat, as sulphuret of arsenic and ultramarine, and partly from solution, as sulphurets of cadmium and of antimony. Of these, we shall only notice the ultramarine, which, having been a valued pigment found in the mineral kingdom, was analyzed, and its composition imitated successfully. It is now made on a large scale, and of very different qualities in regard to color or durability.

*Ultramarine, Artificial.*—Recipes for the preparation of this beautiful blue color have been given by C. Brunner (Pogg. Annal. lxxviii. 541–561); by Prückner (Journ. f. Prac. Chem. xxxiii. 257); Dr. Winterfeld, in Polytech. Archiv. Mendelsohn, 6th year, 99, 260, 265, Berlin, 1842.

Brunner does not think that iron is necessary to produce the blue color, while Prückner and Winterfeld hold that iron is essential to the beauty of the color. Dr. Elsner, in a neat essay (Jour. f. Prac. Chem. xxiv. 385, &c.), showed that the color was due to a small content of sulphuret of sodium with sulphuret of iron, and that neither of these alone could produce it. Rolle, under Dr. E.'s direction, repeated many experiments, which strengthened his former conclusion that sulphuret of sodium and iron, though in minute quantity, are absolutely necessary to produce the color. Brunner states that the finest color is obtained by putting a thin layer of flowers of sulphur over a layer of the unfinished blue, and heating gently to volatilize the sulphur, but at the lowest heat required to burn it off. This is repeated 3 or 4 times. It increases 10–20 per cent. in weight. Elsner tried the effect of burning off sulphur repeatedly, but although the color was darkened, it did not improve its tone. Others tried it, with no more success.

### 3. FINE CHEMICALS AND PHARMACEUTICS.

A large number of fine preparations are made, on a larger or smaller scale, for the use of the chemist and the physician,



and a few for the artisan. They are alkaline, earthy, and metallic compounds, metalloidal compounds, organic acids and alkaloids, &c. These may be conveniently divided into inorganic and organic.

1. *Inorganic Bodies*.—We find a few observations in reference to some of the metalloids, &c., which are here inserted.

*Chlorine Preparation*.—Over 1 pt. bichromate of potassa in a flask, pour 6 pts. muriatic acid of 1.16, and gently heat the mixture for a few seconds by a spirit lamp. A rapid action ensues, resulting in the evolution of chlorine and the formation of water, chlorides of chrome and potassium. (Amer. Journ. c. 491.)

*Quantitative Determination*.—Cottureau proposes for this purpose a solution of protochloride of tin (of known content) colored by sulphate of indigo, to which the chlorine-liquid is added until decolorization commences. From the volume of the latter employed, the quantity of chlorine is calculated. The free chlorine changes protochloride into perchloride of tin.

*Iodine, its Extraction*.—Pass sulphurous acid into a mineral water, or other liquid, containing iodine, until it has acquired a feeble odor of the same; then dissolve it in 1 pt. blue vitriol, and, after it, 1 pt. bisulphite of soda; white or rosy subiodide of copper will precipitate immediately by boiling, or in a short time by standing. If the precipitate be mixed with 2 equiv. binoxide of manganese and heated, iodine sublimes.

*Chloride of Iodine*.—Heeren recommends the use of chloride of iodine in photography instead of bromine compounds, which are more subject to alteration, and offers the following method of preparing it. 200 gr. dilute sulphuric acid (1 acid to 5 water) are poured over 100 gr. iodine, and dry chlorine gas passed through until the increase of weight is 66 gr. which must be accurately ascertained. The chlorine should be previously passed over chalk and chloride of calcium to remove water and muriatic acid from it; and the end of the tube conveying the gas should be about a  $\frac{1}{2}$  inch above the surface of the liquid. The dark-orange liquid should be kept in a well-stoppered bottle, in a dark place. When used, 1 pt. of the



liquid is to be diluted with 32 pts. water, and will last for months.

*Bromo and Iodohydric Acids.*—Mène (Comptes Rendus, 1849) gives the following economical, easy, and safe process for making the bromohydric and iodohydric acids, which we take from Silliman, ix. 421.

6 pts. crystallized sulphite of soda are to be moistened with 1 pt. water, and 3 pts. bromine or iodine then added, and heat applied. The gases pass over pure, provided the neck of the retort be loosely plugged with asbestos, to intercept bromine or iodine vapors. The sulphite aids the bromine or iodine in the decomposition of the water, the latter taking the hydrogen, the sulphurous acid the oxygen.

*Iodide of Potassium.*—Criquelion's method (Journ. de Chem. Méd. iv.) is to mix together, thoroughly, 40 pts. calcined lime slaked in water, and 14 pts. iron filings. To this mixture add, during constant stirring, and portionwise, 94 pts. iodine. When the liquid produces only an ochrey stain upon starched paper, it is to be filtered and washed, and the filtrate precipitated by carbonate of potassa. Filter, wash, and evaporate to crystallization.

According to Wackenroder, a small amount of sulphide may be found in iodide of potassium by the evolution of sulphohydrogen with protochloride of tin.

*Iodide of Lead.*—Huraut's experiments (Journ. de Pharm. 1849) upon the comparative advantages of the several methods of preparing iodide of lead, prove that the nitrate of lead and iodide of calcium afford the best results, both as to quality and quantity.

*On the Nitrites.*—Fischer, in a paper upon the nitrites (Pogg. Ann. lxxiv.), gives processes for the preparation of several. The potassa nitrite is made by heating the nitrate to redness, separating the nitrate by recrystallization, and the free potassa by acetic acid and alcohol.

*Magnesian Lemonade.*—Massignon prepares citrate of magnesia lemonade (Journ. de Pharm. xii.) by making 5 grm. carbonate of magnesia into a milk with water, pouring it into a



strong bottle, adding 7 grm. of crystallized citric acid, and corking quickly and firmly. Flavor may be imparted by means of different syrups.

*Chromic Acid.*—Traube recommends the following method of preparing chromic acid. (An. der Ch. u. Phar. lxvi.) To heat gently 1 pt. bichromate of potassa,  $2\frac{1}{2}$  pts. water, and  $3\frac{1}{2}$  pts. sulphuric acid, decant the liquid from the sulphate of potassa which separates on cooling, and add 4 pts. more of sulphuric acid when the acid begins to separate. The liquid is heated, water being added to dissolve the crystals, then evaporated until a pellicle forms, and set aside to crystallize. The acid, dried on brick or biscuit-ware, may be purified by carefully fusing it, when sulphuric acid and bichromate of potassa form an insoluble salt of oxide of chrome; or by resolution in water, adding oil of vitriol until a precipitate appears, evaporation and slow crystallization.

*Oxide of Antimony.*—Hornung (Journ. de Pharm. 1848) gives the following economical process (a modification of Frederking's) for preparing the oxide of antimony to be used in the manufacture of tartar emetic. Mix together in an iron vessel 15 pts. finely-powdered sulphuret of antimony and 36 pts. sulphuric acid, expose to a gentle heat for 12 to 18 hours, and stir frequently. The mixture thickens at first, but afterwards liquefies upon an increase of the temperature, and finally becomes white; sulphur fuses and separates, and sulphurous acid fumes are disengaged. The heat and stirring are continued as long as these phenomena continue. When the vapor or gas evolved consists only of sulphuric acid, water is to be gradually added, and the mass washed for the removal of free sulphuric acid. The subsulphate of antimony is to be decomposed with carbonate of soda, and the resulting oxide of antimony washed. 13 pts. dry greenish-white oxide, soluble in tartaric acid, are thus obtained from 15 pts. sulphuret of antimony.

*Sulphantimoniate of Sodium.*—Van der Corput prepares this (Schlippe's) salt by intimately mixing together, in powder, 8 pts. effloresced sulphate of soda, 6 pts. sulphuret of an-



timony, and 3 pts. vegetable charcoal. This mixture is to be heated in a covered crucible, and when the fluid mass ceases to foam, it is to be boiled in a capsule with 1 pt. sulphur and q. s. of distilled water. The liquor, filtered and left to repose, deposits colorless crystals of  $3\text{NaS} + \text{SbS}_5 + 18\text{HC}$ . (Repert. der Pharm. 1848, and Chem. Gaz. vi. 268.)

*Black Sulphuret of Mercury.*—Vogler (Journ. de Pharm. 1848) prepares this salt more readily than by trituration, as follows. 4 oz. mercury are mixed with 1 oz. sublimed sulphur, washed and sieved, and the whole placed in a capacious glass vessel, and shaken for two hours. After this, another ounce of sulphur is added at intervals, and the agitation continued until every trace of mercury ceases to be visible to the eye. Two more ounces of sulphur are then added, and the mixture again shaken until the entire incorporation of the mercury with the sulphur, as may be ascertained by the aid of a lens.

2. *Organic Bodies.*—Some of the most interesting of these, to the pharmacist, are the alkaloids, and the volatile liquids chloroform and collodion.

*Separation of Cinchonin from Quinin.*—O. Henry's process (Journ. de Pharm. 1849) for determining the proportion of cinchonin in sulphate of quinin is based upon the difference in solubility, in cold water, of the acetates of the two alkaloids. 10 grm. of the mixed sulphates are mixed with 4 grm. acetate baryta, triturated with 60 grm. water, slightly acidulated with acetic acid, strained and filtered. Two volumes of alcohol of  $35^\circ$  are added to the filtrate, and then sulphuric acid in excess. After filtration, add ammonia, and boil: the cinchonin precipitates while the quinin remains in the alcoholic liquid.

*Quinidin.*—This new alkaloid, according to F. L. Winckler (Buch. Rep. xlviii. 385), occurs, with quinin, in one of the new barks most resembling Huamalies. It is crystallizable, soluble in alcohol, and slightly so in water. Its sulphate is so similar in appearance to the sulphate of quinin, that it is difficultly distinguishable from the former.

*Quinoidin.*—After preparing quinin and cinchonin from



Peruvian bark, a resinous mass, quinoidin, remains, which has been supposed to be a mixture of resin, &c. with quinin and cinchonin, or a modification of these alkaloids.

Roder (Mittheilungen des Schweizer Apothekervereins, i. 31) gives a method by which he obtained upwards of 40 per cent. of quinin, and 10 per cent. of cinchonin, from different samples of quinoidin. Of the residue, about 30 per cent. was resin. The process is as follows. A solution of a  $\frac{1}{2}$  pt. protochloride of tin, in 2 pts. water, is added to 4 pts. alcohol (.865) holding 1 pt. quinoidin: resin precipitates. Ammonia is poured into the decanted supernatant liquor, and the resulting precipitate drained, washed, dried, and exhausted with alcohol. The treatment is repeated with half the quantity of tin-salt first employed, and the clear liquids again precipitated by ammonia. The precipitates, washed, dried, and displaced as before, yield a tincture which, when neutralized with dilute sulphuric acid and evaporated, drops crystals of sulphate of quinin. The cinchonin remains in the filtrates from the tin and quinin precipitates.

Winckler (Journ. für Pract. Pharm. xv. 281) detects the presence of crystallized sulphates of quinin and cinchonin in quinoidin, by the use of hyposulphite of soda, which immediately precipitates hyposulphite of quinin, in a white crystalline form, and hyposulphate of cinchonin as four-sided needles, from their solution in hydrochloric acid. Both salts disengage sulphuretted hydrogen and sulphurous acid upon treatment with concentrated sulphuric acid. Dilute sulphuric acid converts them into sulphates, with evolution of sulphurous acid and elimination of sulphur. The amorphous alkaloids, or quinoidin, when saturated with muriatic acid, do not yield these precipitates. (Ch. Gaz. vi. 122.)

*The Bark of Adansonia Digitata.*—Dr. Duchassaing, a physician at Guadaloupe, employs this bark with great success in intermittent fevers. (Comptes Rendus, xxvi. and Ch. Gaz. vi.) It is without action upon the nervous system and improves the digestive powers. It is used in decoction made by boiling 1 oz. of bark in a litre of water, and evaporating to one-third;



and this quantity has served to cure even where quinin had failed. The bark is abundant in the French colony of Senegal.

*Test for Opium.*—Hensler (L'Union Medicale, 1848) proposes the following test for the presence of minute quantities of opium, founded upon the property of porphyroxin of being reddened when heated, by dilute muriatic acid. The suspected substance is to be mixed with a small portion of potassa and shaken with ether. Bibulous paper is to be moistened in this solution, and dried after each immersion. Dilute muriatic acid is then applied, and the paper exposed to the vapor of boiling water. If opium be present, the paper acquires a reddish-purple tint.

*Papaverin.*—This new alkaloid, discovered by Merck in opium, has the formula  $C_{40}H_{21}NO_8$ . It forms crystals insoluble in water, and more soluble in hot than in cold alcohol, and ether. Its salts are crystallizable. It is prepared by adding soda to a decoction of opium, treating the precipitate with alcohol, and evaporating the strained tincture to dryness. The residue is treated with dilute acid, the liquid filtered, and ammonia added. The resinous precipitate is then to be dissolved in dilute hydrochloric acid, and acetate of potassa added. The resinous precipitate thus thrown down, after having been washed with water, is then to be acted on with boiling ether, which, on cooling, drops the papaverin in crystals. (Liebig's Annalen, 1850.)

*Strychnin.*—Molyn (Journ. de Chim. Méd. 3) proposes the following method for making pure strychnin. 8 pounds of *nux vomica* are made into paste, with an equal weight of water, and left to repose, for 3 weeks, in a temperature of  $68^{\circ}$ – $78^{\circ}$ . The fermented mass is then pressed and exhausted by three several boilings with water, and the expressed liquids united and evaporated to 12 quarts. 9 oz. lime are next added, and after a repose of 6–8 hours, the mass is strained and pressed, and the resulting liquid treated with sulphuric acid to remove lime, filtered, and evaporated to 2 qts. and subjected to a second treatment as before, with 1 oz. lime. The precipitates, after the entire expulsion of all liquid by pressure, are to be dried,



powdered, and digested with alcohol of .935, which removes brucin and coloring matter, and then displaced with spirit of .838. This tincture, relieved of four-fifths of its alcohol by distillation, will drop strychnin in granules, which may be rendered perfectly pure by washing in alcohol of .935 and recrystallization.

*Thein*.—Heijnsius (Scheidk. Onderzoek, and Ch. Gaz. viii.) recommends an easy method for preparing thein by sublimation. For this purpose, damaged tea is placed in an iron pot, covered with filtering-paper, and surmounted by a paper cylindric cap. Cautious application of heat insures the success of the operation.

*Oenanthin*.—A resinous principle, obtained by Gerding (Journ. f. Prac. Chem. 1848) from the plant *Oenanthe fistulosa*. Its effect upon the system is very decided and powerful, producing hoarseness and even vomiting, when taken in the dose of a half to one grain.

*Cedron*.—This remarkable substance is, according to Hooker (Lond. Pharm. Journ. x. 344), the cotyledon of the seed of the *Simaba Cedron*, a plant indigenous to Panama, New Grenada. The seed, as well as the bark and wood, are bitter and tonic. So highly is it esteemed by the natives, as an antidote for bites of venomous reptiles, and as a specific in intermittents and diseases of the stomach generally, that it commands, frequently, an enormous price. Herran (Comptes Rendus, 1850), who administered it in eight cases, attests its efficacy. He gave it in doses of 5 or 6 gr., mixed with a spoonful of brandy, and at the same time dressed the bitten part with linen saturated with some of the spirituous liquor. After repose, the patient recovered without any repetition of the dose. A similar treatment was equally successful in cases of fever, where quinin had failed.

*Githagin*.—A poisonous principle, obtained by Scharling (Central Blatt, 1850) from the seeds of the *Agrostemma Githago*, or corncockle. It is a starch-like inodorous substance, soluble in water and dilute alcohol, and insoluble in ether.



*Atropin.*—Rebourdain (Comptes Rendus, 1850) gives the following process for the ready preparation of atropin. Fresh belladonna leaves are to be bruised, the juice extracted by pressure, heated to  $176^{\circ}$ – $194^{\circ}$  F. and filtered. When the filtrate has cooled, 4 grm. caustic potassa and 30 grm. chloroform per quart are added, and the whole well shaken together. After an hour's repose, the chloroform, holding in solution the atropin, subsides as the lower stratum, and after decantation of the supernatant liquid, is to be washed repeatedly with water. The chloroform solution is then distilled over a water-bath. The residue in the retort, by digestion with dilute sulphuric acid, yields the atropin. This solution, on treatment with carbonate of potassa, drops the atropin, which may be obtained in acicular crystal by resolution in alcohol and spontaneous evaporation.

*Pyrotartaric Acid.*—According to Arppe (Liebig's Annalen, lxxv.) pyrotartaric acid may be prepared by distilling together, in a capacious green-glass retort, a mixture of equal parts of powdered crystals of tartaric acid and pumice-stone dust. For 2lb acid, the time required is 12 hours. The distillate is to be mixed with water, the supernatant empyreumatic oil separated by the aid of a funnel, and the liquor gently evaporated and set aside. The crystalline mass which forms is to be pressed between paper, and then spread upon papers saturated with alcohol in order to remove the empyreumatic and coloring matters. The product amounts to 7 per cent. of the acid employed.

*Anhydrous Prussic Acid.*—Wöhler (Central Blatt, 1850) gives the following process for preparing anhydrous prussic acid. 10 pts. prussiate of potassa, 7 pts. sulphuric acid, and 14 pts. water are mixed together in a retort and distilled over an open charcoal fire. The neck of the retort should be raised to an angle of  $45^{\circ}$  and occasionally cooled, so as to condense and drive back the aqueous vapor, and thus prevent its passing over into the drying-tube attached, containing the chloride of calcium. Between this latter tube of U shape, there should be another vessel containing a small quantity of chloride of



calcium or cyanide of potassium, and both must be surrounded with water of  $86^{\circ}$  F. By enclosing the condenser in a mixture of ice and salt, the acid is made to crystallize.

*Gallic Acid.*—This acid may be made by boiling tannin with dilute sulphuric acid, until the liquid crystallizes on cooling. Wetherill (Journ. Pharm. xii. 107) gives 1 pt. sulphuric acid (1.84) to 4 pts. water, as the proper strength of the acid; and 500 cubic centimetres of this mixture to 50 gm. dry tannin, as the best proportions. The product will be upwards of 40 gm. gallic acid.

*Succinic Acid.*—Wackenroder has found that much of the commercial acid is adulterated largely with tartaric acid, drenched with oil of amber. (Archiv. d. Pharm. l. 280.)

*Chloroform.*—Soubeiran (Comptes Rendus, 1847) proposes to prepare pure chloroform for medicinal purposes, by the following process. 10 pts. of the best chloride of lime are mixed with 60 pts. water, well stirred and transferred to a copper still of at least one-third greater capacity than the volume of liquid, adding 2 pts. alcohol of 0.85. The apparatus being luted tightly is heated by a brisk fire. As soon as the mixture reaches  $176^{\circ}$  a violent intumescence ensues, when the fire must be immediately removed, to prevent the liquid from running over into the receiver. This mishap being guarded against by careful management of the heat, the distillate commences to pass over and continues rapidly. When the action becomes slow, the fire must be restirred in order to hasten it. When the distillate ceases to taste sweet, the process is terminated. The distillate consists of two strata, one dense and yellowish, consisting of chloroform contaminated with alcohol and chlorine; the other is a mixture of water, alcohol, and chloroform, and, after a day, deposits a portion of the latter product. The chloroform is to be decanted, washed by agitation with water, the chlorine removed by a dilute solution of carbonate of soda, and then rectified over chloride of calcium in a water-bath. As the operation is more productive the quicker it is effected, the pulverized chloride of lime should be mixed with hot water.



Soubeiran determines the purity of chloroform by means of a test liquid of  $40^{\circ}$ , or spec. grav. 1.35, made by mixing equal parts of concentrated sulphuric acid and distilled water, and allowing the whole to cool. One drop of chloroform poured into this liquid will sink if it is free from alcohol.

Böttcher's process (Polytech. Notizbl. No. i.) is to distil to dryness, in an iron retort, equal parts of acetate of soda and chloride of lime. A large quantity of dilute acetone and but little chloroform passes over. The distillate is then to be mixed with chloride of lime and again distilled, and the same process repeated a third time, in order to decompose the whole of the acetone. The last distillate is to be rectified over caustic lime.

According to Soubeiran and Mialhe (Journ. de Pharm. 1849) there are two kinds of chloroform in commerce. One, the *normal* chloroform, prepared by the action of hypochlorite of lime upon alcohol; the other made from pyroxylic spirit instead of alcohol. The latter (*methylic chloroform*), though similar in appearance to the former, is less sweet, has a different odor, and produces nausea. Its spec. grav. is only 1.413, and its boiling point much lower than true chloroform. These discrepancies do not proceed from any actual difference in the two liquids, but are owing to the presence of a peculiar chlorinated oil, obtained in both instances, but readily separable from the normal chloroform. It is to the presence of this oil that the nausea and other ill effects of chloroform in certain instances are attributable, and therefore methylic chloroform is unfit for inhalation, it being impossible to remove all the empyreuma from it. To separate it from normal chloroform, the latter must be distilled, and the process stopped before the end of the operation, in order to prevent the reproduction of the mixture.

When chloroform is poured upon a doubled sheet of bibulous paper, one portion soaks through, and another, by its rapid evaporation, produces sufficient cold to congeal it into crystals.

*Alcohol in Chloroform.*—Cattel detects the presence of al-



cohol in chloroform by adding one or two crystals of chromic acid to 2 drachms of the suspected mixture. If it contains alcohol, the acid is soon reduced to green oxide. (Journ. de Chim. Méd. iv. 257.)

On the tests and purification of chloroform, by Dr. Gregory, see Chem. Gaz. viii. 189. The method was afterwards shown to be defective, rendering the chloroform liable to decomposition.

*Collodion*.—Maynard (Silliman's Journ.) was the first to propose an ethereal solution of gun-cotton as a substitute for adhesive plaster. The ordinary gun-cotton is, however, somewhat insoluble in ether. It must therefore be prepared by a special method, known as Malgaigne's (Lond. Med. Gaz. 1848), which gives a perfectly soluble product.

Mix together, in a stone pan, 40 oz. purified nitre in powder, with 60 oz. of sulphuric acid of  $66^{\circ}$ , and stir in 2 oz. of finely-carded cotton. After 3 minutes, remove the cotton with a glass rod and plunge it into a large volume of water, and renew the washing with fresh water until the removal of all acidity. Press, dry in a warm room, and pull out the wool. 8 oz. of this cotton form, with 125 pts. of rectified ether, a ready solution, which must be diluted with 8 pts. of rectified alcohol and strained through a linen cloth.

The liquid is the collodion of the shops, now much used for surgical purposes. It is applied either alone with a brush, or upon a linen cloth. Its adhesiveness is said to be increased by the addition of Venice turpentine. The parts to which it is to be applied must be free from all dampness, as water decomposes the collodion.

When containing one grain of morphin to the ounce, it is also a very efficient remedy for the toothache.

As the solvent of ethereal extract of cantharides, it is an admirable blistering-plaster. It may be spread on with a camel's hair pencil. The evaporation of the ether leaves a dry coating in a few seconds; and as soon as the principle of the cantharides begins to act upon the epidermis, the coating rises and forms a blister. If opened at the side, the film



of collodion remains unbroken, and by thus protecting the sore obviates the necessity of dressing it with ointment. It is a much more active, cleanly, and convenient vesicant than the *unguent. cantharid.* (Lond. Pharm. Journ. 1850.)

*Benzole.*—This liquid carbohydrogen, so valuable as an economical solvent of caoutchouc, gutta-percha, resins, and other difficultly soluble substances, is readily prepared by Mansfield's process (Journ. of Chem. Soc. i., and Chem. Gaz. vii.) from coal-tar.

The light coal-naphtha, obtained in the early stage of the distillation of coal-tar, is distilled in a metal retort having its head surmounted with a chamber containing cold water, so that the liquids less volatile than water may be condensed and fall back into the retort or into a separate receiver, while those more ethereal pass on in vapor to a condensing vessel kept cool with water or ice. The liquid ceases to pass as soon as the water in the chamber commences to boil, because all vapor volatile below  $212^{\circ}$  has then been driven over into the condenser. The distillate is rectified by a second distillation as above, taking care, this time, that the temperature of the water surrounding the head of the still shall not quite reach  $176^{\circ}$  F., that being the boiling point of Benzole. The distillate obtained before the temperature within the retort has risen to  $194^{\circ}$  F., is a yellowish volatile oil, which at  $4^{\circ}$  F. drops one-half of its bulk in crystals.

This liquor, by agitation with one-tenth its volume of strong nitric acid for the removal of the oxidable substances, and, subsequently, after separation from the acid, with one-fourth its volume of oil of vitriol, to separate neutral oils, basic, and coloring matters, is prepared for the last distillation. All the distillate obtained below  $194^{\circ}$  is to be reserved and washed with water, and finally with an alkaline solution. The purification is completed by congealing it at  $4^{\circ}$  F. and pressing out the solid portion, filtering, and drying by means of chloride of calcium.

The volatility of benzole imparts great value to it as the solvent of resins for forming varnishes, or artificial cuticles in



dressing wounds and burns. Those resins, as copal, &c., which do not dissolve in the liquid, yield readily to the vapor.

Air or coal-gas, surcharged with benzole, yields a flame of highly luminous power, and the author has recommended (Ch. Gaz. vii. 188) a system of illumination based upon this property.

So also, when mixed in the proportion of one volume to two of alcohol or pyroxylic spirit of .840, it forms an admirable burning fluid.

It, moreover, possesses anæsthetic properties.



## V. KALISTICS.

It embraces the ornamenting and modifying of tissues, such as yarns, cloths, horn, ivory, paper, leather, &c., and may accordingly be divided into processes performed on *textile fabrics*, yarn, cloth, and on *sheet fabrics*, paper, leather, gum-elastic; while a third division embraces the cements and varnishes employed upon those fabrics.

### 1. TEXTILE FABRICS

Includes the preparation of fibre and dyes, the processes of dyeing and calico-printing.

1. *Fibrous substances*, such as cotton, wool, silk, &c. are bleached and dyed of various colors, either in the crude state, or as yarn, or woven into cloth. When colored uniformly, throughout, they are said to be dyed; when colored topically, or according to figures and designs, they are said to be printed. The term calico-printing has been applied to topical dyeing, but the general term should be *color-printing*, since the art consists in the application of colors to textile fabrics of cotton, wool, silk, &c., as well as to wall-paper.

*Flax and Hemp Retting*.—The process of retting, as usually practised, is objectionable on many accounts; it requires much time, the putrefaction disseminates a disagreeable, and, it is believed, a miasmatic odor; and it is moreover very liable to be carried too far, to the injury of the fibre. Poole's method (Rep. Pat. Inv. 1845) consists in the use of dilute acid to dissolve the material which glues the fibres together. A bundle of flax or hemp is saturated with water and exposed to the air for 8–9 hours, then again saturated towards evening and exposed for the night. The following morning it is put into a vat containing sulphuric acid diluted with 200 pts. water for hemp



(with 400 pts. for flax), and, after a time, is removed and put on a lattice. The operation is repeated in the course of 5-6 hours, and oftener, until the retting is complete, which is indicated by black spots on the stems. It is then rinsed thoroughly in water, passed through a bath of 1 pt. potash in 10,000 pts. water, to neutralize any remaining acid, and, lastly, rinsed in clean water, and dried.

*Hemp and Linen, with New-Zealand Flax.*—New-Zealand flax diminishes the value of cordage, &c. made of hemp or flax, rendering it less durable. Vincent gives the following method of detecting the mixture. (Comptes Rendus, 1847.) Hemp fibre, dipped for a few seconds into nitric acid, is colored pale-yellow, linen not at all, and New-Zealand flax blood-red. A piece of cloth, containing both flax and New-Zealand flax, dipped into the acid, showed red striæ in the woof and none in the chain, which was all common flax.

*To detect Cotton in Linen.*—Elsner has published a critical review of the various methods proposed to distinguish cotton and flaxen fibres (Berlin. Industrie u. Handelsbl. xxiv.), the best of which we extract from his report. Stöckhardt observed that a flaxen fibre, inflamed in a vertical position, and then extinguished, appeared to be carbonized at that end in a smooth, coherent shape, while cotton, similarly treated, appeared to be spread out like a brush or tuft. Elsner observes that it especially occurs when the flame is violently blown out, and that it succeeds with dyed goods, unless dyed by chrome yellow.

The potash test consists in putting the fibre into boiling caustic potassa-lye for a couple of minutes, when the flax turns deep-yellow and the cotton is scarcely changed. The test is not reliable.

One of the best is the microscopic examination, for when flax is magnified 300 times, it appears like long, compact tubes, with a narrow channel in the centre, while cotton appears to be flattened, ribbon-like cylinders, with a wide channel, and mostly in spiral windings.

The test with oil of vitriol is reliable in an experienced



hand, but every trace of weaver's gum must have been previously removed by boiling with water. The fibres are laid on a plate of glass, and oil of vitriol dropped on it. A single lens is sufficient to observe the effect. In a short time the cotton fibre is dissolved, the flax unaltered, or only the finest fibres attacked.

The oil test is also a good one, and convenient in execution. When flaxen fibres are rubbed up with olive-oil, they appear transparent, like oiled paper, while cotton, under similar circumstances, remains white and opaque. Dyed goods exhibit the same, if previously bleached by chloride of lime.

Elsner's method consists in putting the fibres for a few minutes into a tincture of various red dyes, of which cochineal and madder give the most striking results. The tincture is made by putting 1 pt. madder, &c. into 20 pts. common alcohol for 24 hours. In the cochineal tincture, cotton is colored bright-red; flax, violet;—in madder, cotton becomes light-yellow; pure flax, yellowish-red.

It is better to employ several of these tests, the microscopic, oil, sulphuric acid, and combustion, rather than to rely upon a single test.

*Tanning Cotton and Linen.*—English and French fishermen have been long in the habit of tanning their sails, &c. in bark liquors, in order to render them more durable. Millet states that pieces of linen, treated for 72 hours with an oak-bark liquor at  $150^{\circ}$ , and stretched on frames, remained unaltered in a damp cellar for 10 years; while untanned linen in the same place and for the same time had entirely rotted. The one frame, also tanned, was perfectly preserved, and the other, untanned, had rotted. It was further shown that linen, which had begun to moulder, might be preserved from further change by being tanned. It seems to be only necessary that the articles should be kept 2 or 3 days in a warm solution of tannin. Sponge may be similarly tanned.

2. *Bleaching.*—The oldest process of employing sun and dew is still resorted to, but has been almost supplanted by the use of chlorine or chloride of lime. The new and singular



substance, ozone (singular, because but little understood), seems to possess bleaching properties, and hence we notice it.

*Ozone.*—Phosphorus kept in moist air imparts to it the property of bleaching various vegetable colors, and when kept too long in this air, their texture is weakened, as in bleaching by chlorine. Such air is termed ozonized air by Schönbein, who first investigated its properties, and called the substance itself ozone. A convenient way of making ozonized air is to cover the bottom of a capacious bottle with water, to set in it a stick of phosphorus, which must rise above the water, to close it loosely with a cork, and place it in a temperature of 60–68°. The air will be ozonized in the course of an hour, may be used, and fresh ozone obtained with the same arrangement.

Its bleaching effects are due to its large content and loose combination of oxygen, analogous to that of binoxide of hydrogen, and to that of dilute solutions of chlorine. A coloring substance is changed in its nature by oxidation, and new colorless compounds formed. Schönbein has further shown its oxidizing effect on protosalts of manganese. By writing with a solution of sulphate of manganese, and putting the dry writing for a short time into a bottle of ozonized air, the writing appears of a brown color, from the formation of peroxide of manganese. The writing will vanish in sulphurous acid by reduction to protoxide, and will reappear in ozonized air.

*Bleaching Sponge.*—After extracting lime by dilute muriatic acid, and washing with water, it is put into very dilute muriatic acid and a solution of chloride of lime added, after which it is rinsed in water and passed through an acid bath. It is then put into very dilute sulphuric acid, containing sulphite of soda, thoroughly washed, pressed out and dried. (Kressler in Journ. f. Chem. u. Pharm. lxiv.)

Bastick, examining the effect of chloride of lime upon starch, sugar, cotton, &c., found that when free lime is present, formiate of lime is produced; when absent, carbonic acid is generated. (Journ. Pharm. (3) xiv.) It appears then that



where the alkaline base is absent, the decomposition by oxidation is more violent: a fact of importance in the use of this bleaching agent.

*Bristles Bleached.*—Winkler and Fink give the following as the best method of bleaching bristles. (Monatsbl. d. Hessisch. Gewerbver. 1847.) They are first well washed in a solution of soft-soap in luke-warm water, rinsed in cold water, then laid for 2–3 days in a saturated solution of sulphurous acid in water, well washed, and dried. By merely moistening and exposing them to the air, most kinds may be bleached, and still better by moistening them with very dilute sulphuric acid, and sunning them. In the latter case, however, Winkler observed that they were slightly attacked by the acid.

3. *Mordants.*—Under *Chemics*, we have seen the preparation of the two great mordants, alum and copperas, together with several others. A few are prepared more exclusively for the dyer, and some by the dyer himself.

*Persulphate of Iron.*—A mixture of powdered copperas and some soda-salt-peter is ignited for a short time in a crucible, and, when cooled, extracted by water. The presence of the sulphate of soda, also formed by the process, does not interfere with its employment in dyeing, &c. Elsner properly remarks that this process is not as economical as the older method of heating a due mixture of oxide of iron and oil of vitriol in a cast-iron vessel. It may nevertheless be sometimes convenient to employ it. (Mechan. Mag. 1847.)

A good article on the nitrates of iron, &c., appears in the American Journal, 2d series, ix. 30, by Ordway.

*Nitrate of Copper.*—This salt may be made by mixing  $1\frac{1}{2}$  pts. powdered blue vitriol with 1 pt. soda-salt-peter, moistening it with water, and heating it in a crucible until the fluid mass begins to evolve red vapors. The solution then made will contain sulphate of soda, which does not injure its value to the dyer. (Mechan. Mag. 1847.)

*Tin-salt.*—C. Nöllner proposes (Ann. der Chem. u. Pharm. lxiii. 120) to adapt stoneware receivers to the retorts in which muriatic acid is generated, and to fill them with granulated



tin. The concentrated solution of tin thus obtained is evaporated in a tin pan, containing an excess of granulated tin; so that the pan will not be acted on, because it becomes positively, and the granulated tin negatively, electric. All copper present in the solution is precipitated as a black powder on the granulated tin.

*Salts of Tin.*—Bouquet, in his paper upon the preparation of some protosalts of tin (Journ. de Pharm. xi. 460), gives the following formula for making the sulphate of the protoxide ( $\text{SnO}, \text{SO}_3$ ). Dissolve recently precipitated protoxide of tin in warm dilute sulphuric acid. Nacreous plates of sulphate separate on cooling.

*Stannate of Soda.*—It is usually made by adding caustic soda-lye to a solution of chloride of tin. Another method, suitable for dyeing and color-printing, consists in heating 22lb caustic soda in an iron crucible to a red-heat, adding 8lb soda saltpeter and 4lb common salt, bringing it to fusion, and then adding 10lb granulated tin. The heat is continued until ignition takes place and the mass has a doughy consistence. It may be powdered and used at once, or may be purified by solution in water and crystallization. (Journ. of Arts, 1846.)

*Arseniate and Stannate of Soda.*—Stannate of soda is made as usual from oxide of tin and soda, or tin and nitrate of soda, and dissolved in water until it reaches  $50^\circ$  Twaddle, and about  $1\frac{1}{2}$ lb arseniate of soda (made by fusing together equal parts of arsenious acid and nitrate of soda) is added to a gallon of the hot solution, in an iron vessel over the fire. As soon as a little of the mass taken out congeals at once, the compound is completed. In like manner, phosphate of soda may be added to the stannate, in order to make phosphate and stannate of soda. (Lond. Journ. Aug. 1850.)

*Lead Mordants.*—The best mordants of lead are: 1. Basic acetate of lead, obtained by digesting litharge in a solution of sugar of lead; 2. Potassa-lime and oxide of lead, obtained by digesting litharge in a solution of caustic potassa containing lime; and, 3. A similar solution with soda instead of potassa. All these mordants give a beautiful chrome-yellow. A



gray is obtained by passing the goods thus mordanted through a solution of sulphuret of calcium; and a deep-black by the same, finishing with iron mordant and campeachy wood. (Technologiste, 1846.)

*New Mordant.*—Broquette's new method of fixing colors, or his new mordant, is a solution of casein in ammonia, with which the goods are impregnated, and then heated to expel the ammonia and leave the casein on the cloth. He has also employed casein with lime alone, or with lime and ammonia. See Chem. Gaz. viii. 384.

4. *Dye-stuffs.*—Many experiments have been recently made on well-known dye-stuffs, especially on the invaluable madder, and a few new dyes have been added to the list; but experience alone can prove their durability, beauty, and economy.

*Madder.*—The investigation of this valuable coloring-substance is attended with many difficulties, in consequence of the presence of several different coloring principles, which have some analogy in color, are different in their properties, and yet, according to some observations, one may be transformed into another. It is probable that the substances *alizerin* and *xanthin*, found some twenty-five years since, were not pure. In 1835, Runge described, in a valuable essay on madder, five coloring principles in it, *madder-purple*, *red*, *orange*, *yellow*, and *brown*, and mentioned also two acids, *rubi-acic* and *maddric*; but he viewed the substances solely as a dyer and not as a chemist, leaving the most important part undone, their more important combinations, transformations, and their composition.

Schiel also examined the colors of madder. (See essay in Ann. d. Chem. u. Pharm. Oct. 1846.) To prepare *madder-purple*, water is poured over the ground madder in a wooden vat, suffered to stand for 1 or 2 days, and drawn off. The madder is then pressed, boiled in a copper vessel with a strong solution of alum, and filtered hot. It deposits a reddish-brown substance, which is separated by filtration. Sulphuric acid is added to the red solution, which deposits the purple in 24 hours. The latter is again dissolved in alum and precipitated.



It is then boiled with muriatic acid, washed with cold water, dissolved in alcohol, and the solution evaporated, when it deposits the pigment. It is, lastly, dissolved in ether several times, and separates from it by evaporation. It is a cherry-red powder, insoluble in cold water, rather soluble in hot, very soluble in alcohol and ether; soluble in alkalies with deep-red color, and reprecipitable by acids. It fuses by heat, and sublimes with partial decomposition, condensing in the form of red needles, which dissolve in alkalies with a violet color. Its composition is expressed in the formula  $C_{28}H_{10}O_{15}$ . Both madder-purple and madder-red dissolve in cold oil of vitriol, with a brilliant red color, and are again precipitated unchanged by the addition of  $\frac{1}{3}$  its volume of water. Hence, in preparing *garancine*, the oil of vitriol should be diluted with  $\frac{1}{3}$  its volume of water, which would not dissolve the colors, while it chars the woody fibre.

*Madder-red* is contained in the precipitate which separates from a cooling decoction of madder. After repeated purification, it is a yellow powder, difficultly soluble in water, readily soluble in alcohol and ether, soluble in potassa with a violet, in ammonia with a red color, sublimes at  $437^{\circ}$ , and deposits orange-yellow needles. Both the sublimed and the unsublimed appear to have the same composition, expressed by the formula  $C_{28}H_9O_9$ . The red appears to pass into the purple by taking up 1 eq. water and 5 eq. oxygen.  $C_{28}H_9O_9 + HO + O_5 = C_{28}H_{10}O_{15}$ .

Schunck performed a series of experiments on madder root, from the aqueous extract of which he obtained alizarin, *rubiacin*,  $\alpha$  and  $\beta$  resins, a bitter principle *rubian*, *pectic* and *rubiacic* acids, and a dark-brown substance. After thorough extraction by water, and then by hydrochloric acid, which removed lime and magnesia, he obtained by extraction with potassa, alizarin, pectic acid,  $\beta$  resin, and probably rubiacic acid. Alizarin has the formula  $C_{14}H_5O_4 + 3HO$ , soluble in pure water with a yellow color, in alcohol and ether; soluble in caustic and carbonated alkalies, with a brilliant purple color; the potassa solution is precipitable by alumina, which becomes reddish-purple; by



peroxide of iron, which becomes blackish-purple. It is soluble in sulphuric acid, and reprecipitable by water unaltered; hence its permanency when madder is charred by oil of vitriol. Nitric acid, perntrate and perchloride of iron convert it into alizaric acid. Rubiacin (probably Runge's madder-orange) has the formula  $C_{31}H_9O_{10}$ , is slightly soluble in boiling water and in sulphuric acid without decomposition; in caustic potassa with a purple, and in carbonated with a blood-red color; forms a dingy-red precipitate with chloride of calcium, and an orange-colored compound with alumina, which last is soluble in potassa with a purple color. Boiling perntrate or chloride of iron changes it to *rubiacic acid*. The resins are slightly soluble in boiling water; the  $\alpha$  resin in caustic and carbonated alkalis with a purple-red color,  $\beta$  resin with a dingy-red color. Rubian is the bitter, nitrogenous principle. Schunck believes alizarin to be the active dyeing substance in madder, although he states in one place that rubiacin assists in brightening color when alkali is present. He thinks that the resins impart a yellowish, and xanthin a brown tone to the color. (Ann. Ch. Pharm. lxvi. 174.)

Higgin ascribes some effect to rubiacin and xanthin in dyeing. He believes that xanthin passes by a kind of fermentation, first into rubiacin and then into alizarin, and that the resins are products of decomposition with boiling water. (Phil. Mag. (3) xxxiii. 282.)

*Residue of Madder.*—Wydler proposes the following method of using the residue of madder, exhausted by dyeing (Schweizer Gewerbebl. 1847). The pressed residue is mixed with 40 per cent. oil of vitriol, the mixture steamed for an hour, and then washed until the wash-water tests no longer acid. It is said to yield as much color as before.

*Madder-lake.*—A fine madder-lake is thus prepared from an ordinary article, by Kressler. 1 oz. common madder-lake is powdered, treated with 2 oz. strong acetic acid (1.045), stirred frequently, set aside for 12 hours, then diluted with 6–8 pts. distilled water, and filtered. Twice as much boiling water is added to the clear filtrate, and then gradually a dilute



solution of carbonate of soda (3-4 oz.) until all is precipitated. The precipitate is filtered, washed, pressed in linen, and dried in the shade. It has a rich carmine color, and rubbed on glass with a good oil-varnish, appears as transparent as red glass. Its solution in strong acetic acid gives a beautiful and durable red ink, which does not mould and requires no gum. It may be diluted at pleasure.

For the properties of a new dye of somewhat analogous character to madder, we refer to the Lond. Journ. xxxvi. 335.

*Red Coloring-matter of Rhubarb.*—The *erythrose* of Garot (Journ. de Pharm. et de Chim. 1850) is extracted from rhubarb by acting on 1 pt. with 4 pts. of nitric acid. The residue, remaining untouched, is the coloring-matter, and varies in different rhubarbs from 8 to 20 per cent. It is orange-red, soluble in alcohol and ether, and forms with the alkalies red compounds of eminent tinctorial power. It is said to give a dye of much greater brilliancy and stability than that from cochineal.

*Cochineal.*—Warren de la Rue (Chem. Soc. Trans. 1847) thus obtains the coloring-matter. 3lb powdered cochineal are boiled for 20 minutes in 60 litres distilled water, strained, and poured off clear in  $\frac{1}{2}$  an hour. It is then precipitated by a solution of acetate of lead previously acidulated by acetic acid (6 pts. acetate, 1 pt. acid), the precipitate washed with boiling water, dried in warm air, and powdered. This yields 17 oz. crude carmine-oxide of lead. The cake is suspended in water, sulphuretted hydrogen passed through, the deep-red solution evaporated in a water-bath, and lastly dried in vacuo.

The crude carminic acid contains phosphoric acid, and to purify it, it is dissolved in boiling absolute alcohol, and digested for some hours with carminate of lead. Ether is added to the solution, which precipitates a little nitrogenous matter, and the filtrate evaporated in a retort, and finally dried in vacuo. It is the pure cochineal-red or carminic acid.

This substance is a purplish-brown pulverizable mass, transparent under the microscope, of a beautiful red color when finely divided, decomposed by chlorine, bromine, iodine,



and nitric acid, above  $277^{\circ}$ . It is soluble in all proportions in alcohol and water; difficultly so in ether, its solution giving an acid reaction. The alkaline earths throw it down of a purplish color; the acetates of lead, copper, zinc, and silver, purplish-red. Sulphate of alumina does not throw it down, but upon adding a little ammonia, a brilliant carmine-lake is precipitated. The chlorides of tin do not precipitate it, but impart a rich carmine tint to the liquid. Its formula is  $C_{28}H_{14}O_{16}$ .

*Alkanet.*—Bolley gives (Schweizer Gewerbebl. 1847) a method of preserving the tincture of alkanet, which is valuable, since alkanet is a costly dye, and its tincture produces a peculiar violet of the fastest character. The method consists simply in the addition of a very little pure muriatic acid to the tincture, a few drops being sufficient for large quantities. Its action is supposed to be its neutralizing a little ammonia, which is the cause of the tincture spoiling; but it is more probable that it combines with the substance from which the ammonia is produced by decomposition.

*Rocella Tinctoria* (*Orchil*, *Cudbear*).—Schunck's examination of this lichen is described in Ann. d. Chem. u. Pharm. lxi. 64, &c. The cut lichen is boiled in water for some time, in a spacious vessel, and the yellowish-brown liquid strained. On cooling, white flocks and crystals separate, and when filtered off, washed and dried, are gray. Dissolved in boiling alcohol, a slight-brownish residue remains, and the cooling solution deposits a white crystalline substance, Heeren's erythrin, Kane's erythrillin, and Schunck's erythric acid. It is the most important constituent of the lichen, as it produces the color for which the lichen is gathered. 1lb lichen yields about 50 grains.

It is white, tasteless, soluble in alcohol and ether; 1 pt. dissolves in 240 pts. boiling water, but the greater part separates on cooling; it is also more soluble in boiling than in cold alcohol; its solution reddens litmus; it is soluble in caustic and carbonated alkalies, in lime and barytic water, and is again precipitated by acids in a gelatinous form. Its



tincture is not precipitated by a tincture of acetate of lead, but a solution of subacetate gives a large precipitate. Its solution in ammonia, by exposure to the air, becomes purplish-red. By continued boiling in water it is converted into picroerythrin. Heated on platinum foil, it fuses and burns without residue; heated in a glass tube, it yields first an oily, then a crystalline sublimate of orcin. Erythric acid is the basis, and, according to Schunck, the only basis of all the coloring-matters of the lichens. Its composition is  $C_{34}H_{19}O_{15}$ .

Picroerythrin is a product of the decomposition of erythric acid, and is the cause of the bitter taste of an extract of lichens. A hot solution of the acid, evaporated, leaves a brown glutinous mass, which becomes solid and crystalline, has a bitter taste, and leaves white picroerythrin when extracted by cold water. Its composition is  $C_{34}H_{24}O_{20}$ ; and it is formed from the acid by its taking up the elements of 5 eq. water.

*Extraction of Color from Orchil.*—Chandois (Ch. Gaz. vii.) exhausts the lichens by repeated washings with water, and separates the coloring-matter from this liquid by means of ammonia or alkali.

*New Mode of Testing Indigo.*—Reinsch's new process (Jahrbuch für Pract. Pharm.) for testing the coloring power of indigo is said to give accurate results, with greater facility than the usual methods. It consists in the use of a standard solution, made by triturating  $1\frac{1}{2}$  gr. finely-powdered Bengal indigo, of best quality, with 4 or 5 drops of very concentrated fuming sulphuric acid, and when the mass has become uniformly brown, adding 15 gr. more of the same acid. The rubbing is to be continued until the mixture turns green, when another 15 gr. of acid is added, and the whole diluted with 150 gr. water. Two uniform cylinders having been previously graduated into 20 equal divisions, one is to receive 15 gr. of the above solution, or more if necessary, to give a light-blue liquid by filling the glass with water. The other cylinder is similarly filled, to determine whether the contents of the two are alike in shade. This being so, one is emptied, and then,



having received 15 gr. of solution of inferior indigo, prepared as above directed, water is to be poured in until it assumes the tint of the standard liquor. The difference in the quantity of water required to produce a uniformity of shade in the two liquids, denotes the ratio of the quality of the indigoes employed. For example, 20 pts. water were used for the standard solution, whereas the same quantity of the indigo under test required only 15 measures to produce the same degree of coloration: therefore the latter contains 25 per cent. ( $\frac{5}{20}$ ths) less of coloring matter than the former.

The author gives the following results of certain essays with solution of best Bengal indigo, = 20.

Bengal, No. 2, quality.....	19
“ No. 3, “ .....	7
Java, No. 1, quality.....	19 $\frac{1}{2}$
“ No. 2, “ .....	18 $\frac{1}{2}$

*Coloring-matter of Soorangee.*—This material, extensively used by the native Indians as a dye, is imported from Bombay. According to Dr. Anderson, it is the root of the *morinda citrifolia*. His examinations (Ch. Gaz. vi.) prove that it contains a red coloring principle *morindin*, extracted by alcohol, which is very similar to madder-purple both in physical and chemical properties and in composition, though differing remarkably as a dye. Its behavior to mordants is given in detail in the original paper.

*Wongshy.*—This new yellow dye, imported from Batavia, according to Stein (Journ. f. Prac. Chem. 1849), consists of the seed-vessels of a plant of the family of gentianæ; by trituration with water it gives a reddish-yellow liquid which retains its color even when largely diluted. Alcohol acquires by digestion with it a bright-red tint. It yields an orange-color to unmordanted woollen cloth; cottons require to be mordanted. The color resists the action of soap, but is yellowed by alkalis and reddened by acids, and fades by exposure to light. The details of the author's experiments are given in the original paper.



See a full essay on this material in the Lond. Journ. xxxvi. 265-273.

5. *Dyeing*.—Some goods will receive a color directly from a solution and retain it, but in most cases it is necessary to impregnate the goods first with a mordant or color-base, and then to pass them through the dye, which adheres to the color-base. We present a few suggestions which have been recently made in reference to dyeing.

In place of the cream of tartar used in woollen fabrics, a patentee (Lond. Journ. xxxvi. 385) proposes mixtures of salts and acids, enumerating 8 acids, 4 alkaline chlorides, 3 alkaline sulphates, besides alkaline acetates, nitrates, oxalate, borate, and sulphate of zinc. Out of these twenty salts and their scores of compounds, one may possibly succeed.

*Recovery of Soap from Scouring*.—Where large quantities of soap are used, as in scouring wool, cotton, &c., it may be recovered by adding muriate of lime to the wash-water (which is a solution of soap), and precipitating the salt of lime with the fat acids. The salt, being collected, is easily decomposed by sulphuric or muriatic acid, and the fat acids obtained to be again used in the making of soap. This is the subject of an English patent. See Rep. Pat. Inv. July, 1850.

*Orchil, Cudbear*.—Lightfoot proposes (Lond. Journ. Sept. 1850) preparing vegetable textile fabrics by the Turkey-red preparation (pearlash, olive-oil, and water) by 10-12 paddings, then padding in acetate of alumina or aluminate of potassa, and dyeing in orchil or cudbear. He also proposes impregnating the goods with salts of magnesia, lead, zinc, copper, tin, &c., and fixing the base by alkali before printing with orchil or cudbear. The proposition to use cobalt or nickel salts is absurd on account of their cost.

*Indigo*.—According to Chevreul (Comptes Rendus, 1846) indigo is more permanently fixed on woollen goods, dyed in the hot vat, by steaming them, or by a boiling bath of alum and argal, or tin-salt and argal, or by a bran-bath, or, lastly, by a solution of potassa or soda.

*Red Prussiate of Potash*.—Dr. Meitzendorff published an



essay in the *Verhandl. z. Beförd. d. Gewerbl. in Preussen*, 1846, on the process of shading with blue on woollen-yarn.

*Chromate of Lead, as a Gold-yellow for Cotton.*—The gold-yellow color with a silky lustre, on cotton-yarn, is prepared by mordanting in a solution of subacetate of lead, and then passing it through bichromate of potassa, acidulated with nitric acid; after thoroughly rinsing in water, it is dipped for a few minutes into an alcoholic tincture of saffron, and dried in the shade without previous washing. (*Innerösterr. Industr. und Gewerbebl.* 1847.)

*Chrome Dyes.*—Kurrer (*Ch. Gaz.* viii. 461, and *Lond. Journ.* Aug. 1850) has made some valuable contributions to the chemistry of colors, in an essay on chrome dyes. As these latter resist the action of light, acids, and alkalies, they may be considered fast colors. The new methods of preparing the different shades, with the requisite proportions of materials to be employed, are given in the original paper, which may be profitably consulted.

*Sea-green.*—Prepared by dissolving hydrated peroxide of chrome in dilute hydrochloric acid, carefully neutralizing excess of acid with caustic potassa, and evaporating solution to 46° B. The chrome oxide is precipitated from solution of bichromate of potassa by arsenious acid.

For cylinder-printing, either starch or gum tragacanth may be used for thickening; but the gum is preferable, because it gives colors of greater depth and richer tone.

The prints are brightened, after being stretched over night in a cool place, by passing them through caustic potash-lye of 2° B., airing, pressing, washing, drying, and, finally, by immersion in a bath of acetate of copper, rinsing, and drying.

*Olive.*—The addition of catechu-brown to the chloride of chrome, in varying proportions, produces the different shades of olive.

*Pearl-gray.*—This tint is obtained by a mixture of sulphate of chrome and chrome alum. The prints are finished by immersion in milk of lime, rinsing in hot and cold water, and drying.



*Black Dye for Felt Hats.*—The composition of this dye, for which a prize was awarded, is as follows. 1. The felt hat-bodies are first cleaned, and galled by passing them through the following solution, and washing: fustic, copperas, argal, each 8lb, are boiled together in water for half an hour. 2. The dye-bath consists of 55lb campeachy wood, 1½lb gum, 3lb galls, which are boiled together in water for 3 hours. To produce the black color, 5lb refined verdigris, 2lb each of blue vitriol, sugar, and quicklime, are added to the bath. (Bulletin de la Société d'Encouragement, August, 1846.)

6. *Color-printing.*—The expansion of chemical science and of calico-printing are simultaneous, and must necessarily be so, for this beautiful art includes in it a larger share of the principles and practice of chemistry than any other, or perhaps than all other arts. Little of the experience of the calico-printer is published, except by the issue of his beautifully finished goods, and the cost of that experience is a sufficient apology for his silence.

*Steam-blue for Printed Goods.*—According to Petersen (Polytech. Centralbl. 1847, 14) a topical blue for cotton, silk, wool, &c. is obtained by printing a thickened mixture of prussiate of potash with tartaric or sulphuric acid, and steaming. The ferrocyanhydric acid, thus set free, penetrates the fibre, depositing cyanide of iron, somewhat colored, which first assumes a fine color by oxidation in a bath of chromate of potash or chlorine, a blue protopercyanide being formed.

The lively tone of French blue is due to the use of tin-salt together with the others, or to ferrocyanide of tin, which is obtained by adding tin-salt to prussiate of potash.

*Prussian-blue for Calicoes.*—A solution of pertartrate and persulphate of iron is treated with ammonia in excess, and then with yellow prussiate of potash. Cotton is not immediately colored when dipped into this solution, but by subsequent exposure to the air, it assumes a violet-blue, which passes into a beautiful deep-blue when passed through a bath of tin-salt. (Dingl. Journ. xcix. 399.)

*White Discharge on Indigo.*—This is usually effected by



bichromate of potassa and an acid, but is objectionable because the white ground requires cleaning. Mercer (Phil. Mag.) proposes to effect it by red prussiate of potash and caustic alkali; for when the former is printed on, and the cloth is then passed through dilute caustic-lye, a brilliant white is discharged.

*Ammonia-oxide of Copper.*—Runge draws attention to the resolution of sulphate of copper in ammonia (Polytech. Notizbl. 1847), and shows its utility for color-printing, when mixed with decoctions of plants. Thus, catechu gives almost the same brown as chromate of potassa, by fusing 1 pt. catechu in 4 pts. water, adding 12 pts. of the liquid ammonia-oxide of copper, and printing with the liquid, thickened with tragacanth. It shows a singular action on the yellow color which separates from a cold infusion of French berries. This color, when treated with the ammoniacal copper, becomes reddish-brown in the course of 6–8 hours, and if then treated with alcohol, the brown copper-salt is left, and a red color dissolved, which yields compounds with alumina of a beautiful red, like those from madder.

*Pyrophosphate of Copper and Potassa.*—Persoz proposes this double salt for calico-printing, as it is decomposed by zinc or iron with less facility than any other salt of copper, and as difficulties attend the use of other salts of copper. (Ann. de Chim. et de Phys. and Journ. f. Prac. Chem. xli. 361.)

7. *Coloring Fluids.*—We may conveniently embrace under this head various fluid inks, which are liquid dyes; as well printing-inks, which are pasty dyes, printed on from a type or pattern.

*Black Ink from Logwood.*—Boil 125 pts. rasped logwood with so much water that it will yield 1000 pts. of the decoction, and when cold, stir in 1 pt. yellow chromate of potassa. It is a beautiful blue-black, and gives no precipitate. But if too much chromate be used, or the decoction be too concentrated, a dark precipitate takes place. (Runge's Grundriss d. Chem. ii. 207, 1847.) Being free from acid, it will not corrode steel-pens, but it does not write as freely as our most fluid inks, made from nut-galls and copperas.



Another ink is made by adding a very small quantity of blue vitriol to a solution of logwood-extract. This is apt to precipitate.

*Soluble Prussian-blue (a Blue and Black Indelible Ink).—*Dissolve in a solution of iodide of potassium as much more iodine as it contains, and pour this solution into one of yellow prussiate of potash, containing as much of the solid prussiate as the whole amount of iodine. Soluble Prussian-blue precipitates and iodide of potassium remains in solution. After filtering, the precipitate is dissolved in water, and forms a blue ink, containing no free acid, and therefore adapted to steel-pens. If the soluble blue be added to common black ink (from galls), the result is a black ink which cannot be removed from paper without destroying it.

*Indelible Ink.*—To remove spots of indelible ink, T. and H. Smith propose moistening the spots for a few moments with moist chloride of lime, which forms chloride of silver, and then dissolving the latter by caustic ammonia. It may be sometimes necessary to repeat the operation. (Chem. Gaz. Sept. 1847.) Cyanide of potassium may also be employed.

*Printing-ink.*—Pratt's patent consists in the use of rosin-oil, instead of linseed oil, with rosin, yellow soap, &c., in the manufacture of printing-ink.

## 2. SHEET FABRICS AND SOLID TISSUES.

Among these are paper, leather, horn, caoutchouc, &c., of which caoutchouc and guttapercha, being new, and presenting remarkable properties, have been most rapidly advanced of all others, during the past few years.

*Paper.*—Amos and Clark claim improvements in the manufacture of paper, whereby, 1. The bluing material is more uniformly distributed so as to equalize the tint on both sides of the paper; 2. The pulp is more expeditiously sifted; 3. The paper is better dried on the cylinders; 4. The paper is glazed by means of a traversing horizontal table with two or more pairs of rollers. (Lond. Journ. xxxvii. Aug.)



*Bleaching Paper.*—After bleaching the pulp by chloride of lime, small quantities of this salt or chlorine remain in the paper, tending to injure its quality. It is entirely removed by sulphite of soda, which is converted by chlorine and water into muriate and sulphate of soda. Sulphite of lime, or, better still, a stale solution of sulphide of calcium, would probably answer the purpose as well.—*J. C. B.*

*Water-proof Paper.*—J. Bossy prepares such paper by treating half-stuff alternately with soapsuds and a solution of sulphate of alumina, which results in producing an aluminous soap in the pulp. The sheets, after drying, are sized with glue, rosin-soap, &c. (Rep. Pat. Inv. Aug. 1846.)

*Tracing Paper.*—A paper dipped into a thick solution of gum arabic and pressed between two dry sheets, renders the three transparent. When dry, it is every way superior for tracing purposes, as it can be written or painted upon. Like the oiled paper, to which it is every way superior, it impresses the traced lines upon linen or paper. (Chemist, 1850.)

*Tanning.*—The ancient process of tanning requiring a long period of time to produce leather, numerous processes have been latterly set forth, and many of them tried on a working scale, for the purpose of shortening this lapse of time. Although the end has been attained in a variety of ways, yet the quality of the leather has proved so inferior, that the slower process is still preferred for the finer qualities. The deterioration has been nearly, but not however quite, in direct proportion to the reduction of time in tanning, so that we may hope that methods will be devised for shortening the time without losing in quality. It is true that we are not thoroughly acquainted with the exact nature and progress of the change which a hide undergoes in its transformation, but we believe, on sufficient grounds, that it consists in the simultaneous metamorphosis of the hide into a gelatinous material and its combination with tannin. In some kinds of tanning, alumina, or an aluminous salt, seems to act the part of tannin. It has been found that an elevated temperature hastens the transformation; that strong liquors, or the injection of liquors by



force, hasten the combination of tannin. The same ends appear to be also attained by the free use of lime, whereby the hide is swelled and its pores opened. The precise action of acid is not well ascertained, except that the process is shortened. These are the main principles by which a shortened process of tanning has been accomplished. Where lime has been freely used, acid liquors generally follow, and the hide is so puffed and porous, that tanning becomes expeditious; but the hide has been torn and rent asunder, and the organized structure must be necessarily impaired, and the strength and firmness of the leather consequently diminished. It will be observed that in the older processes the change was so slow that the organized structure of the skin was not impaired; that but little matter was removed from the hide, while a quantity was added to it. In accelerating the change, a portion of the matter is removed by solution while undergoing transformation, before it can unite with, and become fixed by, the tannin. Hence the greater looseness and levity of leather prepared by the more modern and rapid processes. It may perhaps be stated as an ascertained fact, that leaving the side in the vats during two years instead of one, the increase of weight and quality thereby, compensates for the loss of time, by paying a fair interest on the capital invested.—*J. C. B.*

A patentee, in *Lond. Journ.* xxxvi. 310, proposes a combination of the white leather (alum and salt) process, with the tanning process by means of catechu. Another (*Lond. Journ.* xxxvi. 319) suggests the use of sulphuret of calcium instead of lime for unhairing.

Since liming tends to lengthen tanning, by preventing the more rapid union of tannin with gelatin, Turnbull treats the hides after liming with a concentrated solution of sugar, so that the access of air is prevented during the action of the bark-liquors on the hides, and the formation of gallic acid thereby prevented. In this manner, the same amount of leather is obtained in 14 days from 100lb oak-bark, as has been heretofore obtained in 18 months from 800lb bark.

*Tannin.*—Kampfmeyer states, as a result of his compa-



rative experiments with oak-bark, alder-bark, catechu, dividivi, that sole-leather tanned with dividivi is, in dry weather, about as good as the oak-tanned, but that in wet weather it is inferior. It may, nevertheless, be used in conjunction with oak-bark. (Verh. d. Gewerbfl. f. Preussen, 1847.)

Elsner states that in Wallachia, Moldavia, and Transylvania, the root of the tormentil or septfoil is largely and successfully employed in tanning, and that its value is shown by chemical analysis, which gives 17 to 34 per cent. tannin in it.

The best method of determining, practically, the amount of tannin in a substance is that proposed by Pelouze, which is to hang a strip of hide (freshly deprived of hair and ready for the tan-vat) in a tannic solution, and keep it there until it ceases to increase in weight. This increase is tannic acid, the gallic being left in the solution.

*Horse-hair, Dyed.*—Previous to dyeing, it is cleaned by laying it for 24 hours in soapsuds heated to 130°, turning it repeatedly. For brown, it is laid for 12 hours in a decoction of logwood in lime-water cooled down to 120°, washed and dried. If the brown hair be dipped into water containing a little crystallized tin-salt, it assumes a violet-blue shade. To give a blue color, the hair is first mordanted in a hot solution of 2 pts. alum and 1 pt. argal, wrung out, then passed through water containing a little sulphate of indigo, washed, and dried. For red, it is laid for a  $\frac{1}{2}$  hour in water containing tin-salt, wrung out, laid for 24 hours in a bath prepared by boiling redwood with alum, washed, and dried at a gentle heat. (Deninger in Monatsbl. d. Gewerbever. f. d. Grossh. Hessen, 1847.)

*Hair Varnish.*—Williams (Monit. Indust. 1848) gives the following recipe for a varnish for converting fibrous materials into "artificial hair." It is made by dissolving 10–40 pts. hog bristles in 100 pts. linseed-oil varnish. The cloth is to be immersed in the liquid and then dried at a moderate temperature.

*Horn, Dyed.*—To give it the appearance of tortoise-shell, a paste of 2 pts. lime, 1 pt. litharge, and a little soda-lye is brushed on, and, after drying, brushed off again. It is the



same as the Indian hair-dye, and acts by forming sulphuret of lead with the sulphur of horn, producing dark spots, that contrast with the lighter color of the horn.

*Ivory hardened.*—It is said that ivory which has become friable by age, will recover its original hardness by being boiled, for some time, in a solution of gelatin.

*Ivory rendered Soft and Translucent.*—This process of Geisler, communicated by Dr. Elsner, is as follows. Small pieces of ivory are laid in strong phosphoric acid (spec. grav. 1.13) until they become transparent, then rinsed in water and dried in pure linen. When dry, it is translucent, and hard, but softens as often as it is dipped in warm water or milk. The time of immersion in the acid differs with different pieces of ivory. If certain parts are to retain their original character, they are covered with a varnish before immersion. The acid probably acts by forming an acid phosphate of lime out of the basic phosphate which constitutes  $\frac{3}{4}$  of ivory.

*Etching on Ivory.*—The ivory is to be covered with wax and the designs traced with a style, and then eaten in by a strong solution of nitrate of silver made by dissolving 6 grm. silver in 30 grm. nitric acid and 150 grm. water. Exposure to light, after the removal of the wax by hot distilled water, will blacken the color of the traces. By substituting gold, platinum, or copper nitrates, other colors may be obtained.

*Ivory Etched in Colors.*—The ivory is coated like a copper plate, with an etching ground, a design graved through the ground, and then etched by a solution of 120 gr. pure silver dissolved in a fl. oz. nitric acid and diluted with 1 qt. water. In the course of  $\frac{1}{2}$  to 1 hour, according to the depth of shade required, the liquid is poured off, the ivory washed, and dried by paper, then exposed for an hour to sunlight, and the ground removed by turpentine. The color is brown or black. Other colors are obtained by nitrate of copper, chloride of gold, or of platinum.

*Caoutchouc.*—The great expansion which the application of caoutchouc to various fabrics has received within a few years past, is largely, if not mainly, due to the persevering



industry and ingenuity of Charles Goodyear, of New Haven, Connecticut. During a series of years of patient investigation, he performed numberless experiments with a single object in view, viz. such a modification of caoutchouc, as would obviate all objections to its use, all defects in its properties, without impairing, and if possible, by increasing, its valuable qualities. Repeated failure did not discourage him, but seemed to nerve him the stronger in his toilsome pursuit, until at length success crowned his efforts. After he had been engaged some years in these investigations, and had already met with a degree of success which would have satisfied most persons, in the year 1841 he placed specimens of his manufactured *rubber* in the hands of one of the writers of this report, for the purpose of testing its properties under chemical agency, in comparison with the native caoutchouc. This writer has known him personally, and been acquainted with his successive improvements from that period to the present time. His first improvement, which constituted the basis of others, consisted in the discovery by himself, that sulphur, under the influence of a higher temperature than usual, imparted the wished-for properties to caoutchouc, and that when conjoined with oxide of lead, these properties were still further improved. He called the compound Metallic Rubber. All processes for *vulcanizing* caoutchouc employed in England and on the continent of Europe resulted from this important discovery of Goodyear. A fuller account of the process he pursued, was published some five years since in the *Encyclopædia of Chemistry*, to which reference is here made. Many other important improvements have been made under Goodyear's direction, both of a chemical and mechanical nature, some of which will doubtless be brought into successful employment, as soon as he conceives them to be sufficiently perfected. The present advanced state of the manufacture of elastic goods leads us to look onward to the time, when the manifold applications of caoutchouc, as a substitute for leather, with or without elasticity,—for various kinds of cloth, whether the coarse cloth of a tent exposed to the weather, or the more delicate fabric



upon which an engraving is printed,—its application to purposes for which no other substance can as well be employed, will all point it out as one of the valuable gifts of the vegetable kingdom to mankind. No important improvement in the method of vulcanizing, or rather sulphurizing, has lately taken place, for the use of bisulphuret of carbon, sulphuret or hypsulphite of lead, sulphuret of antimony, &c., are not improvements, but rather indifferent variations of Goodyear's processes.

Burk's process, patented in England, is to mix by grinding or rolling, 15 pts. golden sulphuret of antimony with 100 pts. India rubber, to make up cloth, &c. with this mixture, and then submit it in a boiler under pressure to the temperature of  $260^{\circ}$  to  $280^{\circ}$ . It is at least more costly than Goodyear's process, and its superiority is doubtful.

For Hancock's proposed improvements in caoutchouc, &c. see Lond. Journ. 96-104, 1849.

*Kamptulicon*.—Lieut. G. Walton, of the British Navy, has proposed a mixture of sawdust and caoutchouc, under the name of kamptulicon, as a lining for the interior of iron war-vessels. The inventor claims that, from its elasticity, it will immediately collapse when penetrated by a ball, and thus prevent the entrance of water. It also deadens concussion, and by its buoyancy will keep a vessel afloat though it should be riddled with shot, and moreover will prevent loss of life caused by splinters.

*Guttapercha*.—This remarkable product, similar in its origin and composition to caoutchouc, differs wholly from it in its external characters, being very solid and unyielding at common temperatures, having something of the character of horn, but being quite plastic at  $212^{\circ}$ , at which temperature it can be pressed and moulded into any required form, from the simple form of a tumbler or plate, to the richest carving of a picture-frame and the minute lines of a medal. E. N. Kent has observed that it dissolves in the oils of turpentine, rosin, tar, guttapercha itself, in terebinthine and its muriate, but that neither by precipitation nor by evaporation can the solvent be wholly removed from it again. When dissolved in bisulphuret of



carbon or chloroform, it may be precipitated unaltered by alcohol. Its solution in 16 pts. of the solvent is with difficulty rendered clear by filtration. See also Vogel's experiments, in *Chem. Gaz.* vi. 237.

The uses of guttapercha are evidently extending from the beautiful picture-frames, and other articles in bold relief, to more important and widely extended subjects. Its inordinate degree of toughness, with slight elasticity, imperviousness to water, slight alterability by ordinary chemical agents, and the ease with which it may be moulded by heat into any required form, and caused to adhere to itself or to other objects, constitute an assemblage of valuable properties which gives it an almost equal position with the most useful materials which man possesses. A comparison of caoutchouc and guttapercha exhibits the wonders of nature in an eminent degree. Both derived in a similar manner from the concrete juices of trees growing together in the same region, both having the same composition, both eminently resisting chemical action in a similar manner, and each dissolving or softening in similar solvents; yet one is exceedingly elastic, and extensible in every direction, yielding to the slightest force but returning to its primary form, the other resists extension powerfully, but possesses a slight elasticity at right angles to its extended surface; one, when heated only to its softening point, becomes very adhesive and gummy, and returns very slowly, in months or years, to its original elastic character, the other, when gently heated, becomes pliant and yielding like wax, and retains with unyielding obstinacy, when cold, the impressions it received while warm. We have already witnessed a vast number of applications of caoutchouc, devised by the ingenuity and perseverance of Mackintosh, Goodyear, and others; but we have yet to discover the manifold applications of which the properties of guttapercha convince us this material is susceptible, and we may be assured that neither of them will exhibit their full sphere of utility for a lengthened period of time. Its analogy with caoutchouc will doubtless hasten the development of its usefulness, but the same analogy will also



retard it in some points, by leading it too closely in the track of that substance, whereas its peculiarities should in some respects open a new path in its applications and mode of application.

The properties of guttapercha led early to the proposition to apply it to ships and other apparatus requiring to be water-proof, and Forster suggests an improvement for coating plank (Lond. Journ. xxxvi. 31), for sheathing vessels, &c.

For an account of guttapercha and its applications, see Proc. Brit. Assoc. and London Athenæum, 1849; also Amer. Journ. (2) vii. 276.

### 3. ADHESIVES.

Textile and sheet fabrics, and solid tissues, are either ornamented or united by varnishes and cements. These have either a resinous basis, or are composed of gums or glue. The solvents for resins are alcohol, or the oils, whether fat, essential, or empyreumatic; water is the vehicle for conveying gum and glue. Resins and balsams are first introduced.

*Copaiva Balsam.*—Posselt (Liebig's Annalen, lxi.) has examined a copaiva balsam, from South America, which is quite distinct from the ordinary kind. It has the same odor, but is lighter colored and more fluid. Spec. grav. 0.94. Becomes turbid on the addition of potassa solution or of aqua ammonia, but separates in time without having become soapy. In alcohol it is partially soluble, forming a milky liquid. By distillation with water, it yields 82 per cent. of *paracopaiva oil* ( $C_{10}H_8$ ), the residuum being a resin, part of which is soluble and the rest insoluble in alcohol.

*Rosin, or Common Resin.*—Louyet (Comptes Rendus, xxiv.) has obtained, by the destructive distillation of the resin of the *pinus maritima*, two products, one of which he proposes as a substitute for oil of turpentine. One is a fat oil, and the other a very fluid essential oil. The latter, by rectification over lime to separate acetic acid, water, &c., becomes suitable for purposes both of illumination and painting. E. N. Kent,



of New York, whose researches upon this subject have been extensive, proposes an economical mode of bleaching this essence, which he has patented.

*Dammara Resin*.—Dulk (Pharm. Cent. Blatt, 1847), who examined this resin, found that it fuses at  $165^{\circ}$  F. and leaves 3.9 per cent. of ash. It is nearly insoluble in alcohol, potassa, and ammonia, but is taken up entirely by strong sulphuric acid and the fatty oils. Its proximate constituents are *dammaryl*  $C_{46}H_{38}$ , forming 13.5 per cent., soluble in ether; *alpha-resin*  $C_{46}H_{39}O_4$ , 24.5 per cent., soluble in dilute alcohol and not separating on cooling; *beta-resin*, 10.5 per cent., soluble in hot dilute alcohol and depositing on cooling; *gamma-resin*, or *dammarylic acid*  $C_{46}H_{38}O_3$ , 44 per cent., dissolved by absolute alcohol; and *epsilon-resin*  $2(C_{46}H_{38}) + HO = 7.5$  per cent.

*Gold Lacquer*.—3 oz. seed-lac, 1 oz. yellow amber, 1 oz. gamboge, 40 gr. red-wood, 18 gr. saffron, 30 gr. dragon's blood, 3 oz. pounded glass, 20 oz. alcohol. The powdered substances are dissolved in the alcohol on a sand-bath. The articles should receive two or three coatings, and be dried by a gentle warmth. (Mannheim. Gewerbvereinsbl. 1847, 14.) A collection of recipes for gold lacquer will be found in the Polytech. Centralblatt, and the Polytech. Notizblatt for 1846.

*Copal Varnish*.—See an essay on the different kinds of copal and their behavior to solvents, in Lond. Journ. xxxvi. 194.

*Brilliant Lacquer for Leather*.—Over 4 oz. shellac and  $\frac{1}{2}$  oz. lampblack in a stoneware vessel, pour  $1\frac{1}{4}$  lb alcohol (of 80 per cent.), and cover it with a moist bladder. After standing in the cold 24 hours, during which it is often shaken, the bladder is punctured by a needle, the jar put in hot water, frequently shaken, and  $\frac{1}{2}$  oz. Venice turpentine added. The lacquer is shaken when used. (Polytech. Notizbl. 1846, 48.) It is recommended as a good varnish for boots, not affecting the leather; but repeated applications would tend to crack the leather, from the want of sufficient flexibility in the coating.



*Brilliant Lacquer for Paper and Papier-maché.*—3 oz. powdered sandarac are digested on a sand-bath in 12 oz. alcohol, 2 oz. elemi-resin added, previously fused in an earthen pot, and the whole digested until dissolved. This lacquer is brilliant, and rather durable. A good lacquer for colors is 3 oz. sandarac, 2 oz. mastic, 2 oz. pounded glass,  $1\frac{1}{2}$  oz. Venice turpentine, and 1lb alcohol. After solution, the varnish is filtered through felt. It may be colored red by anotto, dragon's blood, or red-wood, yellow by gamboge or turmeric, and green by buckthorn berries. (Polytech. Notizbl.)

*Oil Varnish.*—Liebig's method of preparing a good varnish is as follows. 1lb acetate of lead, 1lb litharge, and 5 pints water are digested together until the reddish color of the litharge has become white, from the formation of  $\frac{1}{8}$  acetate of lead, and filtered. 20lb linseed oil, containing 1lb litharge, is added to the filtrate, exposed to the sun, and frequently shaken, until the varnish has become wine-yellow and clear, when it is filtered through cotton. It dries rapidly. An analogous method for poppy-seed oil prescribes 4 oz. oil, 2 oz. litharge, and 2 pints water, and directs that the liquid should be poured off, 8 oz. of the oil poured on the white basic acetate remaining, and exposed to the sun until it has become colorless.

*Varnish for Patent Leather.*—The process followed in France for glazing leather is to work into the skin, with appropriate tools, three or four successive coatings of drying varnish made by boiling linseed oil with white lead and litharge, in the proportion of one pound of each of the latter to one gallon of the former, and adding a portion of chalk or ochre. Each coating must be thoroughly dried before the application of the next. Ivory-black is then substituted for the chalk or ochre, the varnish slightly thinned with spirits of turpentine, and five additional applications made in the same manner as before, except that it is put on thin and without being worked in. The leather is rubbed down with pumice-stone powder and then varnished and placed in a room at 90°, out of the way of dust.



The last varnish is prepared by boiling  $\frac{1}{2}$  lb of asphalt with 10 lb of the drying oil used in the first step of the process, and then stirring in 5 lb copal varnish and 10 lb turpentine. It must have a month's age before it is fit for use.—*Patent Journal*.

*Elastic Varnish*.—2 pts. rosin, or dammar-resin, and 1 pt. caoutchouc are fused together, and stirred until cold. To add to the elasticity, linseed oil is added. Another varnish for leather is made by putting pieces of caoutchouc in naphtha until softened into a jelly, adding it to an equal weight of heated linseed oil, and stirred for some time together, while over the fire.

*Cement for Luting Joints of Steam Apparatus*.—Serbat prepared a mastic instead of the red-lead cement used for this purpose, by thoroughly incorporating sulphate of lead, black oxide of manganese, and linseed oil. See Lond. Journ. 1849, 61.

For the preparation of a lubricating grease from rosin oil, see the Report on Serbat's process, in Lond. Journ. 1849, 58. The quantity made by Serbat in 1847 was 305,000 lb, which may give some idea of its value.

*Cement (glue)*.—Herberger recommends the following as an excellent cement to join metal with glass or porcelain. To 2 oz. glue, dissolved in water and boiled down to a thick solution, are added 1 oz. oil varnish, or  $\frac{3}{4}$  oz. Venice turpentine, and the whole heated to ebullition to incorporate them thoroughly. The articles cemented should remain 48–60 hours before use.

A good *cement for glass, porcelain, and pottery*, which is not to be exposed to water, is to mix equal parts dry quicklime and gum arabic, in fine powder, and to moisten the whole with water or white of egg, to make a thick paste. (*Elsner*.) Quicklime and white of egg alone make an excellent cement of this kind; but the diamond cement, a dilute alcoholic solution of fish glue and resin, is far superior, although more costly, and will withstand a considerable exposure to moisture.

*Emery and sand-paper*, being made with glue, which is liable



to become moist and injure the efficiency of the paper, a water-proof adhesive surface is desirable, to which the grinding powder may be attached; and for this purpose it has been proposed to use a solution of copal in hot linseed oil, together with Venice turpentine, Venetian red, a little litharge, and caoutchouc. (Lond. Journ. xxxvi.)



## VI. OLEICS.

ALTHOUGH some fatty bodies are very different from others in their chemical nature, and all of them differ from the essential oils, yet being often used in the same branch of manufacture indiscriminately, they may be embraced together as a class.

### 1. OILS AND FATS.

By far the larger proportion of oils and fats agree in being composed of a fat acid united to a base called glycerin. The three principal acids are stearic, margaric and oleic; when stearate or margarate of glycerin predominate (the compound being called stearin or margarin), the fat is more solid, as tallow, suet, &c.; when oleate of glycerin (called also olein) is in sufficient quantity, the fat is fluid or oily, as olive oil. The chemical connection between margaric acid, which is a solid crystalline fat, and vinegar or acetic acid, and the connection between acetic acid and common alcohol, are pointed out in an essay by one of us, published in the Journ. Fr. Inst. 1848. Now since formic, acetic, and valeric acids can be shown to be derived from wood-spirit, common alcohol, and fousel-oil, which are their respective alcohols, we may infer that the higher fat acids have also their alcohols. The investigations of Brodie in wax seem to point out such alcohols and their acids. The general formula for this fat acid series, the most extended series yet developed in organic chemistry, is  $C_nH_nO_4$ ,  $n$  being an even number (see below). No well-defined connection has yet been established between other fat acids not belonging to this group.

*Cocoanut Oil*.—According to Georgey (Ann. der Chem. und Pharm. lxvi.) the butter of cocoa contains the following acids :



Caproic .....	$C_{12}H_{24}O_4$
Caprylic .....	$C_{18}H_{36}O_4$
Capric .....	$C_{20}H_{40}O_4$
Pichuric (lauric, laurostearic) .....	$C_{24}H_{48}O_4$
Myristic (probably).....	$C_{28}H_{56}O_4$
Palmitic .....	$C_{32}H_{64}O_4$

The *cocinic* acid of St. Evre is a mixture of capric and pichuric acids.

*Stearic Acid*.—Gerhardt and Laurent have endeavored to prove (Comptes Rendus, 1849) that the formula for stearic acid is  $C_{34}O_{34}O_4$ ; that margaric acid is an isomeric modification of it, and should be called metastearic acid.

*Oil of the Beaked Whale*.—The train-oil of the *balæna rostrata* has recently been examined by Scharling (Journ. f. Prac. Chem. xliii.), who gives it the formula  $C_{62}H_{60}O_4$ . It consists principally of a liquid fat, free from glycerin, a minute portion of spermaceti and traces of other fats. Its spec. grav. is .8807 at 52°. It burns with a bright flame, and its illuminating power is in the ratio of 1.57 : 1 of common whale oil. It also burns slower and emits less smoke than the latter oil.

*Bleaching of Oil by Chromic Acid*.—Mr. C. Watt, Sr. (Newton's Journ. 1848, and Ch. Gaz. vi.), uses the following method for bleaching dark oils or tallow. To every  $\frac{1}{2}$  ton of oil take 10lb bichromate of potassa. Powder the salt, dissolve it in 4 pts. hot water, stir, and carefully add 15lb sulphuric acid, and continue the stirring until complete solution. This mixture is then thoroughly incorporated with the melted fat, previously separated from foreign matters by repose and decantation. The containing vessels should be of wood, and the temperature about 130° F. When, after much agitation, the liquid fat assumes a light-green color, the bleaching is completed, and 4 buckets of boiling water are then to be added, the whole stirred for five minutes and then left to repose for several hours, when it will be white and ready for use.

Mr. Watts, Jr., proposes to recover the chromic acid *ad infinitum*, and thus render the process very economical, in



manner as follows. Transfer the green chrome liquor, after the separation of the fat, to a tub, dilute it with water, and then add thick milk of lime until the sulphuric acid is nearly saturated; leave to repose, decant the liquor from the sulphate of lime, and carefully add to it another portion of cream of lime until the precipitation of all the green oxide, and the supernatant liquor is clear and colorless. Drain off this liquor, add fresh water, and, after settling, again decant. Repeat this washing, then transfer the precipitate to a red-hot iron slab, and keep it constantly stirred until it changes to a yellow powder. The chromate of lime, thus formed, if decomposed by sulphuric acid in slight excess, yields chromic acid as well suited for bleaching purposes as that from bichromate of potassa.

*Oil-filter.*—A good filter is said to be made of fine sand, charcoal, and gypsum; the sand to retain substances suspended in it, charcoal to decolorize it, and plaster to remove water. (*Journ. de Chim. Med.* 1846.)

*Raw Linseed Oil Decolorized.*—A solution of 2lb copperas in  $2\frac{1}{2}$ lb water is poured into a flask containing 2lb linseed oil, and exposed to the sun for several weeks, during which it is frequently shaken. The oil is said to be rendered limpid and colorless, and may be drawn off by a siphon or stoppered funnel.

*Lubricating Oil.*—Many substitutes have been proposed for the more costly oil for lubricating machinery, but hitherto with only partial success. Munkittrick's patent (*Lond. Journ.* xxxvi. 98) consists mainly in the addition of caoutchouc to common grease, the former being softened by spirit of turpentine; but he also uses other ingredients. For example: 10 galls. water being heated, 1lb glue and 10lb carbonate of soda are stirred in, 10 galls. oil or grease are next added, whereby a quasi soap is formed, and lastly, 4lb caoutchouc, softened by turpentine, are incorporated.

Boudet (*Journ. de Pharm.*, and *Lond. Pharm. Journ.* 1850), gives the following as the process by which the French *liard*, or lubricating fluid, is made. Add 1 pt. finely minced caout-



chouc to 50 pts. rape-oil, and heat until the mixture is complete. A very unctuous oil is thus formed, which remains fluid at freezing temperature, and does not clog the machines, but facilitates the motion of their parts.

*Fat Oils, to distinguish them.*—Heydenreich proposes (Journ. de Connais. Utiles, 1849) to distinguish these oils from each other by their odor when warmed, their color by contact with oil of vitriol, and their specific gravities. By the first process, the oil is heated in a porcelain capsule over a spirit-lamp, when the peculiar volatile odor of fish, linseed, and other oils may be detected, especially if compared in the same way with the unadulterated oils. For the acid test, 10–15 drops of the oil are dropped upon a piece of glass, underlaid by white paper, and a drop of oil of vitriol is brought in contact with it by a glass rod. If it be rape-oil, a greenish-blue circle is formed around and at a short distance from the drop, while light yellowish-brown striæ form towards the centre. The same takes place with oil of black mustard, but 25–30 drops of the oil are required. With whale oil, the color is reddish, after 12–15 minutes violet on the edge, and in 2 hours violet throughout. Olive oil gives a pale-yellow passing into greenish-yellow. Linseed oil is at first dark reddish-brown and then black.

2. *Chandlery.*—The more solid fat, stearin, is separated from the more fluid olein by pressure, to make stearin-candles, or, the fats being decomposed, the more solid stearic acid is separated from buttery or fluid acids, to make stearic acid lights. Under this head we may embrace spermaceti and wax. There is but little novelty offered on any of these points.

*Stearin, &c.*—To separate the solid from the more fluid fat in palm oil, lard, &c., the fats are granulated and pressed cold in bags by a powerful hydraulic press, the olein which flows out being used for soap. The contents of the bags being again granulated, and pressed between warm plates of iron, the balance of the olein with some margarin and stearin is removed. To remove color from the stearin thus obtained, it



is fused with a very little nitric acid. To remove still further all the olein, Morfit proposed mixing it with a little oil of terpentine, and then pressing.

See Morfit's "Chemistry Applied to the Manufacture of Soap and Candles." According to Heintz (Ber. d. Berl. Acad.) stearin from mutton-suet becomes transparent at  $124-126^{\circ}$ , but does not fuse before  $144^{\circ}$ .

*Candles of Fats and Rosin.*—A process is described in the Rep. Pat. Inv. Oct. 1850, for mixing some 20–30 per cent. of rosin with fatty bodies in the melted state, by adding sulphuric acid gradually, heating it from 12 to 18 hours so as to evolve sulphurous acid, and then submitting the dark-brown crystalline solid to distillation by heated steam. The solid and oily portions are then separated by pressure.

*Wax, Test of Purity.*—To test for the presence of stearic acid, Geith pours over 2 drachms wax 1 oz. lime-water diluted with 1 oz. water. If the acid be present, the liquid loses its alkalinity and remains clear. Buchner proposes fusibility and specific gravity, as an approximate test of the presence of stearic acid or tallow. Tallow fuses at  $108^{\circ}$ , yellow wax at  $142^{\circ}$ . (Buchner's Rep. xlv.)

*Waxes.*—Our knowledge of the composition and alliances of the waxes has been much enlarged by Brodie's investigations of common beeswax and Chinese wax. He found common wax to consist of *cerotic acid* (formerly *cerin*), soluble in hot alcohol, of the composition  $C_{54}H_{54}O_4$ , therefore of the fat acid series  $C_nH_nO_4$ ; and of *palmitate of meliss-ether* (formerly *myricin*). By saponifying myricin he obtained palmitic acid and melissin, which last has the formula  $C_{60}H_{62}O_2$  ( $=C_nH_{n+2}O_2$ ), or that of an alcohol. By the action of lime and potassa on melissin he obtained the corresponding acid, melissic acid  $C_{60}H_{60}O_4$ . Upon examining Chinese wax, he found it to consist chiefly of cerotate of cerote-ether,  $=C_{54}H_{55}O, C_{54}H_{53}O_3$ , for by saponification he obtained cerotic acid  $C_{54}H_{54}O_4$ , and cerotin (the alcohol)  $C_{54}H_{56}O_2$  ( $C_nH_{n+2}O_2$ ). (Phil. Mag. Sept. 1848, Amer. Journ. (2) vii. 427.)



## 2. SAPONIFICATION.

Soap-boiling consists in boiling a fat with alkali and water, whereby the fat acid unites with the alkali to form a soap, and glycerin is set free. The soft soaps usually contain the glycerin, but it is removed from the hard soaps, and remains in the saline solution. Soaps retain variable quantities of water, even to 30 per cent. and more, when they appear to be dry. Rosin is usually added to make the common yellow soaps, but it can hardly be called an adulteration, as it possesses some detergent properties.

*Irish Moss and Salt in Soap.*—(Lond. Journ. 1849, 37.) To a strong solution of Irish moss (1lb to 6 galls. water), made by a short ebullition and maceration for several hours, and run through sieves, a quantity of common salt is added, 1lb to each 4 galls., and stirred until dissolved. One ton of this mixture is combined with 5 tons of soap. The utility of this compound is not clear.

*Oily Acids.*—When wool is cleaned by alkali in water, a portion of fat is removed, and in order to get the oily acids again from the water, Shearman treats the water with sulphuric or muriatic acid, heats the fat acid, separated from the liquid, to  $212^{\circ}$  in a leaden vessel, saturates the free acid with chalk, adds hot water, stirs, and lets it settle for several days, when the fat can be drawn off clear. It may be reconverted into soap by alkali.

*Perfumery* is allied to soap-boiling, which in fact forms part of this art, since one of its most extended applications is to perfume soap. The perfumes are essential oils, sometimes solid; usually derived from the distillation of odorous plants or parts of plants. Many of them are simple compounds of carbon and hydrogen; others contain also oxygen, and a few sulphur. It is probable that we shall be enabled to make some of them artificially on a large scale; for through the interesting experiments of Wöhler and Liebig, it was shown how oil of bitter almonds was formed; through those of



Procter and Cahours, that oil of winter-green could be made artificially, and below is an account of Deville's having procured oil of lemons from spirit of turpentine.

*Essential Oils.*—Van Hess has given the following table of the yield of essential oils, with their specific gravities. The oils heavier than water were distilled by surrounding the still with high-pressure steam; those lighter than water by blowing steam through the vegetable matters.

			Sp. grav.
Oleum anisi.....	20lb.....	yielded 5½ oz.	0.977
Ol. anisi stellati..	20lb .....	" 8 "	0.976
Ol. calam. arom..	Old oil .....	" "	0.984
"	55lb calamus, of a previous year....	" 12 "	0.956
"	85lb new calamus .....	" 10 "	0.950
Ol. carui.....	12½lb of last year's seeds.....	" 8 "	0.923
"	25lb fresh seeds from the Eifel.....	" 17 "	0.913
"	½ cwt. Saxony seeds .....	" 6 "	0.926
Ol. caryophyll....	10lb Amboina cloves, at 6 distillations	" 31 "	1.040
"	8lb Bourbon cloves.....	" 21 "	1.035
"	25lb Dutch cloves, at 8 distillations..	" 74 "	1.033
"	¼ cwt. clove-stems.....	" 16 "	1.049
Ol. cass. cinnam..	½ cwt. bruised cinnamon.....	" 2¾ "	1.035
Ol. cass. flor.....	12½lb.....	" 3½ "	1.023
Ol. foenic. ....	10lb .....	" 5 "	0.968
Ol. junip. bacc...	44lb dried ripe berries.....	" 2¼ "	0.870
"	96lb fresh " " .....	" 7½ "	0.862
"	53lb unripe " " .....	" 3 "	0.864
Ol. lavendul.....	½ cwt. dried flowers.....	" 2 "	0.892

*Artificial Oil of Lemon.*—Deville (Comptes Rendus, 1849) has shown that the camphor produced by the action of chlorohydric acid upon oil of turpentine, when treated with potassium, yields an essential oil identical in odor, boiling point, density, and composition, with oil of lemon.

*Oil of Rue.*—Wagner (Journ. für Prac. Chem. xlv.) has proven by experiments that the oil of rue (*ruta graveolens*) is evolved from cod-liver oil when the latter is acted upon by sulphuric acid, and the resulting purplish mass saturated with alkali or alkaline earth. Wagner does not consider it a product of decomposition, but adopts the theory of Gerhardt in considering it the aldehyde of capric acid  $C_{20}H_{40}O_2$ , and exist-



ing as such naturally in the oil. He draws the inference, therefore, that the  $\text{SO}_3$  combines with the aldehyde, or rather with the oxide of caprinylic  $\text{C}_{30}\text{H}_{48}\text{O}$ , and that this compound, upon the addition of a base, is decomposed, and aldehyde separates.

*Castoreum Canadense*.—F. Wöhler has by recent examinations (Liebig's Annalen, lxxvii.) confirmed the supposition that the odor of *castor* is due to the presence of carbolic acid. He also found that it contains salicin and benzoic acid. Carbolic acid is obtained among the products of coal-tar.

*Adulteration of Attar of Rose*.—Guibourt (Journ. de Pharm. 1849), after showing the unreliableness of the physical characters, as a test of purity, because of the readiness with which they may be imitated, proposes three tests for distinguishing the true attar. The usual adulterants are oils of rosewood and geranium. They may be detected as follows:

*By Iodine*.—The suspected attar is placed in watch-glasses, under a bell, along with a capsule containing iodine. The vapors of iodine, after some hours, condense, and form a brown areola upon the oil, if adulterated, but do not change its color, if pure. On exposure to air, the iodine volatilizes, but the color, in either case, remains unaltered.

*By Nitrous Acid*.—This serves only to detect the oil of geranium, to which it imparts an apple-green color; as it tinges the attar and oil of rosewood alike dark-yellow.

*By Sulphuric Acid*.—This reagent turns all three of the oils brown, but the attar retains the purity of its odor, while that of the oil of rosewood is rendered more perceptible; the geranium oil, at the same time, acquiring a strong and unpleasant smell.

*Sandal Wood*.—According to Meier, there are six different substances in sandal-wood. (Ch. Gaz. vii. and Archiv. der Pharm. lv. and lvi.)

1. *Santalic acid*, extracted by alcohol, in microscopic prisms of a beautiful red tint, soluble in alcohol and insoluble in water, and forming deep-violet salts with the alkalies.

2. *Santalic oxide*, also extracted by alcohol; a brownish



mass, soluble in alcohol of .863, but insoluble in water and cold ether.

3. *Santalide*, extracted by water; a dark-red mass, soluble in ether and alcohol of .863, but, when pure, insoluble in water.

4. *Santaloide*, extracted by water; a yellowish amorphous mass, soluble in cold water and alcohol of .863, but insoluble in ether.

5. *Santaloidide*, extracted by water; a dark-brown resinous mass, insoluble in water and ether, and only slightly so in cold alcohol.

6. *Santalidide*, extracted by water; an amorphous brown mass, soluble in water, sparingly so in boiling alcohol of .912, and insoluble in ether and cold absolute alcohol.

### 3. ILLUMINATION.

The fatty bodies and resins of the preceding and present classes, together with bituminous coals, are the sources of artificial light. The fats are generally used as oils, spermaceti oil, whale oil, to be burned in lamps; or the more fluid portions of fat, as lard oil, are removed by pressure, and the hard stearin remaining is formed into candles; or a stearic fat is decomposed by alkali and acid, so that stearic acid is obtained to be made into candles. Spermaceti and wax are also burned in the form of candles. Their preparation falls under a preceding division, while under the present we might consider their comparative merits as sources of light; as there is, however, little of novelty to offer in this respect, we confine ourselves to improvements in the gas manufacture, and to what are termed burning-fluids.

1. *Illuminating gas* is obtained by throwing bituminous coal, grease, or rosin, upon a red-hot surface, whereby it is resolved into new compounds by an internal combustion; into permanent gases; vapors, which condense into aqueous solutions and tar; and coke, which remains. The coke is used as fuel; the tar is either distilled to obtain ethereal oils and



pitch, or burned to make lampblack; the aqueous solutions contain ammonia, and are sometimes used to procure it; the gas is a mixture of carbohydrogens, carbonic oxide and acid, &c. The gas is freed by cooling and by lime from sulphuretted hydrogen, carbonic acid, suspended tarry matter, cyanogen, &c. Since the proportion of carbohydrogen determines the illuminating power of gas, and some coals yield too much carbonic oxide, &c., it has been proposed to pass the gas through volatile, liquid, and solid carbohydrogens, of which it will take up a small quantity and increase its luminosity: this is termed naphthalizing. Quite recently, hydrogen has been used, in a naphthalized condition, but we may doubt its success.

*Coal Gas.*—On the comparative value of the different kinds of coal used for illumination, and on methods for ascertaining the value of the gases, see an article by Dr. Fyfe, in *Edin. Phil. Journ.* xlv. and in *Amer. Journ.* 2d ser. vii. 77–86, 157–167.

*Rosin Gas.*—A variation of the manufacture of gas from rosin is patented by Robertson (*Lond. Journ.* 1849, 37), in which the rosin, mixed with sawdust and alkali (lime, &c.), is charged into iron cases, which are put into a gas-retort and heated as usual. The products of distillation are passed into a second retort filled with lumps of coke, brick, &c., and heated to cherry redness. To make gas alone, these products pass through a third and fourth retort, filled with brick, coke, &c., and are then washed and purified by lime. To obtain partly gas and partly oily matters, the vapors issuing from the first retort, containing coke, &c., are passed through a tank containing water, where oily matter deposits, and then through the washer and purifier. The oily products are made into a grease for machinery by mixing it with lime and finely granulated zinc. Or, the oily product may be first distilled with water, yielding a spirit, which, after several distillations with a little lime, becomes colorless and thin, and is used for illumination or for a varnish.

On water and rosin gas, see an article by Prof. Fyfe, in the *Journ. Fr. Inst.* (3) xx. 271, 319.



*Purification of Gas.*—All the sulphuretted hydrogen may be removed from coal-gas by the washers and lime purifier, but a perfect decomposition may also be effected (according to Croll, Lond. Journ. 1849) by passing the gas through a solution of sulphurous acid, whereby water is formed and sulphur deposited. The excess of sulphurous acid is removed by washers and the dry lime purifier.

Lanning's process (Ch. Gaz. viii.), which has been successfully carried out at the Chartered Company's works, is said to remove from illuminating gas every trace of ammoniacal and sulphuretted impurity. The principal agent employed is the carbonic acid of the gas, assisted by a mixture of oxide of iron and chloride of calcium. The latter is made by precipitating solution of chloride of iron with lime or chalk, and adding sawdust to the mass to render it permeable. The precipitated iron becomes peroxidized by the atmosphere during the progress of preparation. In its transit through this mixture, the gas loses its impurities in the following manner. The chloride of calcium contained in it acts by its hygroscopic property as an absorbent or solvent, and thus promotes the contact of the foul matters with the disinfecting material. The peroxide of iron takes the sulphur of the hydrosulphuret of ammonia and becomes sesquisulphuret, at the same time surrendering its oxygen to the eliminated hydrogen to form water. The ammonia set free immediately unites with the carbonic acid as carbonate, and this latter salt exchanges bases with the muriate of lime as fast as it is produced. A portion of it, however, forms sulphate with the spontaneously generated sulphuric acid.

The mixture may be repeatedly regenerated by exposure to air, and thus made serviceable for new operations. When it becomes surcharged with ammoniacal salt, the latter must be removed by washing with water. In the original mixture, the lime-salt was a chloride, whereas after usage it becomes sulphate; thus, the sesquisulphuret of iron in contact with air changes into sulphate by the absorption of oxygen, and this sulphate, reacting upon the carbonate of lime thrown down



from the muriate by the carbonate of ammonia, becomes sub-carbonate, and ultimately sesqui or peroxide of iron.

According to the inventor, the sulphuret of carbon is also removed during the operation, and the illuminating power of the gas thus augmented about 8 per cent., with but slight expense for material and a great economy as to wear and tear of apparatus.

*Gas-lime.*—Graham's examination of gas-lime exposed to the air for a few hours after use, was composed of—

Hyposulphite of lime.....	12.30
Sulphite           “ .....	14.57
Sulphate         “ .....	2.80
Carbonate       “ .....	14.48
Caustic lime .....	17.72
Free sulphur.....	5.14
Sand .....	0.71
Water.....	32.28
	<hr/>
	100.00

In this state it is well adapted to the preparation of hyposulphite of soda, for which purpose it is extracted with water, the solution decomposed by carbonate of soda, and evaporated to crystallization. The hyposulphite of soda thus obtained may be used for the daguerreotype, and might possibly be used instead of common salt to extract silver from its ores. By proper calcination, gas-lime may be converted into a mixture of nearly equal parts of sulphate and carbonate of lime, in which state it may be employed in agriculture and other arts. (Rep. Pat. Inv. 1845.) Elsner draws attention to its value for removing hair from hides.

*Naphthalizing Gas.*—Among the many patents for naphthalizing gas, is one in Lond. Journ. xxxvii. Aug., in which the heat of the burning jet is communicated by metal to a vessel containing a hydrocarbon. The gas, in passing through this vessel, takes with it a portion of the hydrocarbon, passes into a sphere over the jet, where it is heated, and then passes out at the jet. It is supposed to yield a whiter light. There



are other inventions for the same purpose, and doubtless some will be made of great practical value; but it would be much more desirable that gas, capable of yielding the fullest intensity of light, should be made at the gas-works. The consumer should be saved the trouble of making his own light. Whether there be any advantage in heating gas previous to its combustion in the naphthalizing process or not, we offer a suggestion by way of improvement. The vessel to be heated over the jet might be concave underneath, provided with a tube passing off from the highest point of the concavity into the open air, or chimney, so that it would carry off the products of combustion. The heated vessel might be a double cylinder or a cylindrically wound spiral tube.

*Hydrogen for Illumination.*—Various processes have been devised or adopted for obtaining light by means of hydrogen: and this gas is obtained for the purpose by one of three methods, in each of which cases water is decomposed, by incandescent iron or coal, or magnetic force. 1. Vertical iron pipes are filled with scrap-iron, and heated externally to a high temperature; steam is introduced, forming oxide of iron and liberating hydrogen, which passes into a gas-holder. In order to reduce the oxide of iron to the metallic state, to be again subjected to the action of steam, carbonic oxide gas is passed through the heated pipes, and becomes carbonic acid, which escapes. The carbonic oxide is obtained by passing the waste gases of the fire through a fire or ignited carbon. Instead of carbonic oxide, carburetted hydrogens may be employed, such as tar, &c.

2. Another method for obtaining hydrogen, mixed with carbonic oxide and other gases, is to pass steam through ordinary gas-retorts charged with carbonaceous matters, brought to a state of high ignition, whereby these gases are generated together with carbonic acid. A purifier serves to remove the carbonic acid from the combustible gases.

3. By means of a magnetic battery, hydrogen and oxygen are separately liberated from decomposed water.

In order to utilize the hydrogen, &c., obtained by any of



these methods, the flame as it issues from a jet may be directed upon a wick of fine platinum wire, whose incandescence will produce the desired illuminating effect. Another method is to naphthalize the hydrogen, i. e. to pass it through a liquid or over a solid hydrocarbon (such as naphtha or naphthalin), or to mix it with the vapor of a hydrocarbon, in all which cases its illuminating property depends on the same causes as in all ordinary cases of combustion for light, viz. the inflammation of hydrogen and the precipitation and momentary incandescence of carbon in the flame.

2. *Burning-fluids.*—These are generally solutions of camphire (purified spirit of turpentine) in alcohol, and are burned in lamps constructed for the purpose. Their danger has been pointed out from year to year by one of the writers, in public lectures delivered in the Franklin Institute, in Philadelphia; yet such is the neatness of these illuminating liquids, their convenience and brilliancy, that they continue to be used until a serious accident awakens the public to a sense of their danger. But the disaster serves only to deter those from their use who were more immediately affected by it. There is no doubt that burning-fluids may be safely used by those who understand the conditions of their explosiveness, or who exercise care in their use; but since their tendency to explosion cannot be prevented, and since knowledge and care will not generally attend their use by the public, they should be abandoned.

Let us not however abandon the idea of finding a liquid which shall possess the requisite qualities of cleanliness, cheapness, illumination, and freedom from danger. Sperm-oil possesses the last two qualities; burning fluids the first three; lard-oil is cheap and free from danger, but is not cleanly, is too liable to congeal in winter, and is apt to clog the wick. Naphtha is very little, if at all, liable to explosion, but it contains an excess of carbon, and it is too apt to smoke when burned in an ordinary lamp. Since sperm-oil has a high illuminating power and is free from danger, we may yet hope to discover a liquid which shall possess these properties to-



gether with cleanliness and cheapness combined. May not such a liquid be found among the products from the distillation of coal, to be used either by itself or in conjunction with other substances?

3. *Apparatus for Illumination*.—We have nothing novel to present in relation to lamps and jets, except a remark upon reflectors.

Reflectors are found to increase the ordinary effect of a light in proportion to the perfection of their reflecting surface and their approach to a parabolic form; but, being constructed of metal, they are expensive. Kempton (Lond. Journ. 1849, 330) proposes making earthenware reflectors of a good form, and then lustring their reflecting surface in the usual manner. Clay-ware is undoubtedly an excellent material for giving a good form to a reflector, as it is readily and cheaply made, and retains its shape tolerably well during burning. But the new method of precipitating silver from solution, with a brilliant surface, might advantageously be substituted for the method usually adopted for lustring pottery with silver.



## VII. SITEPSICS.

THE present class embraces arts which are exclusively confined to the preparation of food, or which prepare substances largely used in the preparation and preservation of food, both solid and liquid, and likewise used in the arts generally.

### 1. PREPARATION OF FARINA AND SUGAR.

Flour, starch, and sugars, are employed both as food and in the arts.

1. *Starch* is extracted from roots, as the potato, arrow-root, or from grain, wheat, rice, corn, by washing over and collecting the finely suspended sediment. There are different kinds of starch, but even the same kind, as that obtained from the above-named substances is supposed to be, differs in its properties so far that it is desirable to distinguish one from the other. The form of the grain under a powerful microscope is one mean of distinguishing them, and probably the best.

*Starch, Wheat and Potato.*—Redwood has given the following method of distinguishing them. If wheat-starch be ground well in a mortar with water, then filtered, and the filtrate tested with tincture of iodine, it strikes a yellow or reddish, but not a blue color, whereas potato-starch, similarly treated, strikes a blue color.

Instead of soda-ash liquor to steep grain in, it is proposed to use quicklime and salt. (Lond. Journ. xxxvi. 391.)

*Amidulin.*—Schulze applies this name to a substance of the same elementary composition with starch, and forming the transition substance preceding all the transformations of starch into dextrin. It is perhaps identical in composition with Jacquelin's amylum granules; is soluble in hot and insoluble in cold water, and reacts with iodine like starch. (Journ. für Prac. Chem. xliv. and Ch. Gaz. vi.)



*Bleaching Gums.*—Picciotto describes a process for decolorizing Arabian gums (Lond. Journ. 1849), by dissolving them in a strong solution of sulphurous acid, distilling off part of the acid, and precipitating the balance by carbonate of baryta, and, after filtering, evaporating to dryness. Or, the gums may be decolorized and cleansed by adding hydrated alumina to their solution, filtering and evaporating. If the gums are to be used for medicinal or alimentary purposes, the use of baryta is highly objectionable, and indeed for most purposes the decolorization is a matter of minor importance.

2. *Sugar.*—When starch is acted upon by sulphuric acid or diastase in water, it is converted into a sugar, called starch-sugar, which seems to be identical with grape-sugar. Cane-sugar treated with acids is resolved into the same kind; but we have not as yet succeeded in producing cane-sugar from grape or starch-sugar. There is room for extended observation in the changes suffered by the sugars, both in relation to science and to practice.

*Tests for Sugars.*—G. Reich thus distinguishes between different kinds of sugar. (Gewerbvereinsbl. d. Provinz Preussen, 1846.) If a hot concentrated solution of bichromate of potassa be added to molasses (cane-sugar molasses), in a test-tube, and heated to boiling by a spirit lamp, an energetic action takes place between them after removing the flame, until the liquid has assumed a beautiful green color from oxide of chrome, which is rendered more distinct by dilution with water. Starch-molasses produces no change whatever, under similar circumstances. Even when common molasses is mixed with  $\frac{1}{8}$ — $\frac{1}{3}$  starch-molasses, no change is produced, or if it be, it does not exhibit the fine green color of pure cane-molasses. A solution of the bichromate is not acted on by syrup (a solution) of cane-sugar, and hence molasses-sugar shows itself distinct in kind from the two others.

A solution of nitrate of cobalt is, according to Reich, a good mean of distinguishing cane and grape sugars. A strong solution of cane-sugar, treated with fused potassa, heated to



ebullition, diluted with water, and then treated with a few drops of nitrate of cobalt solution, yields a bluish-violet precipitate, which after some time has a greenish color. A concentrated solution of starch-sugar, similarly treated, yields a dirty, light-brown precipitate; or, if dilute, remains clear. A very small quantity of starch-sugar contained in cane-sugar prevents the violet precipitate by nitrate of cobalt.

Chevallier tests the presence of starch-sugar in cane-sugar by warming the solution with caustic potassa, whereby a greater or less quantity of the former produces a red or yellow coloring. According to Cotterau, all the caustic alkalies, including ammonia, produce this effect,—even their carbonates, but not their bicarbonates,—and hence he proposes starch-sugar as a test for the presence of neutral.

Maumenè (L'Institut, No. 846, and Silliman's Journ. 1850) proposes bichloride of tin as a reagent for detecting the presence of sugar in urine; the test-cloth is made of white *merino*, saturated with diluted tin solution, drained and dried in a water-bath. This cloth, when spotted with urine and held over a heated coal, turns black in the moistened places if sugar is present; whereas the stain of ordinary urine is not darkened. The reaction is due to the dehydration of the sugar, highly carbonated caramel being formed.

The author suggests the possibility of forming a useful brown pigment by the above reaction.

*Quantitative Test for Cane-sugar.*—Peligot's method depends upon the definite constitution of sugar-lime, its greater solubility in water than lime alone, and the unalterability of this solution by heat. Soubeiran had found that sugar-lime consisted of 3 eq. lime to 2 eq. sugar, *i. e.* 84 pts. lime to 342 pts. sugar, or 1 : 4. 10 grm. sugar are dissolved in 75 cub. centimetres water, ground up with 10 grm. slacked lime, filtered, and again filtered through the lime. 10 cub. cent. of the filtrate, diluted with 2–3 decilitres water, and tintured with a little litmus, are carefully neutralized by a measured volume of dilute sulphuric acid (21 grm. oil of vitriol in 1 litre water), and the quantity of acid used noted. It gives the



quantity of lime neutralized, and from the above proportion the quantity of sugar present.

If cane-sugar is to be examined for starch or grape-sugar, one test is made as above, and another test in which the liquid is heated to  $212^{\circ}$ , and then, when cool, tested with the acid. The lime solution with cane-sugar becomes cloudy by heat, but clarifies on cooling, while, if grape-sugar were present, it becomes brownish-yellow, and requires much less acid for neutralization. Indeed, a decilitre of starch-sugar solution requires 4 cub. cent. of the test-acid, or just as much as lime-water itself. Cane juice may be similarly tested after concentration to  $6-8^{\circ}$  Beaumé. (Le Technologiste, 1846.)

One of the best means of determining the quantity of cane-sugar present in a solution is an instrument for showing circular polarization in liquids, a full description of which will be found in a Report to Congress by Prof. R. S. McCulloh, made several years since.

*Honey.*—Soubeiran's (Comptes Rendus, 1849) examination of honey proves that it consists of—1. Glucose, or granular sugar; 2. A right-rotating sugar, alterable by acid; 3. A left-rotating sugar. In the original paper, the author has given some distinctive characteristics of each, and promises the results of further investigations as soon as completed.

*Purification of Honey.*—André's method of purifying honey is simple, and is said to be efficient. Three sheets of white bibulous paper are doubled up and put into 25lb honey, diluted with half its weight of water, and the whole boiled over a gentle fire, until the paper is dissevered into a pulp. After cooling, the liquid is filtered through a woollen cap or cone, and evaporated gently to the consistence of honey.

*Refining Sugar.*—Much has been lately said, and some patents issued (Lond. Journ. Sept. 1850) for clarifying and defecating saccharine solutions by the use of salts of lead, and ingenious processes have necessarily followed for removing from the solutions every trace of lead. But we must express an unqualified disapproval of all poisonous materials in the preparation of substances used as articles of diet. The ma-



nufacturer might at first test his liquors and sugars with all possible care, to insure the removal of every trace of lead, but can he be sure that the same nicety will be observed when he transfers this operation to workmen? If a chemist were employed, might not his tests sometimes deceive him? Now, it may be shown that a very minute dose of lead, frequently repeated, will produce deleterious effects on the system; and yet such traces are apt to elude the vigilance of even an experienced chemist, when he is called upon to repeat his tests day after day. In the patent referred to (Lond. Journ. Sept. 1850), the collection of sulphite of lead as a pigment is too trivial to notice further.

Acetate of alumina may be safely used in defecating saccharine solutions (see Oxland's patent, Lond. Journ. Sept. 1850), but whether efficient or not, is to be tried. It is probable that it will answer a good purpose in part, from the acknowledged effect of aluminous solutions. In the above patent, the remainder of alumina is thrown down by a solution of tannin. The two substances are stated to be used either before or after neutralization by lime in the case of cane juice or beet-root juice. The acetate of alumina is easily made by precipitating sulphate of alumina by alkali, washing thoroughly and dissolving the moist precipitate in vinegar. It is stated that, on trial, 4lb of alumina were sufficient for one ton of sugar.

Another patented process (Rep. Pat. Inv. July, 1850) for clarifying cane juice and sugar solutions, is the use of sulphate of alumina with chalk and silex. The process seems to be not well digested, and there is a liability of leaving some soluble sulphate in solution, which tends to injure sugar upon evaporation.

*Extraction of Sugar.*—Melsen's novel process (Gard. Chron. 1849) for extracting sugar from cane juice, consists in the use of sulphurous acid combined with lime, forming a bisalt. Its presence arrests the action of the air, and thus prevents the development of any ferment. In accomplishing so much, it obviates all the difficulties heretofore experienced, in the



manufacture of sugar, by the too rapid decomposition of the crude juice, in warm climates.

It is to be poured in cold solution upon the cane, as it passes through the mill, so as to insure its intimate mixture with the expressed juice. Here it exerts its antiseptic property, and also, by its great affinity for oxygen, intercepts the action of that gas upon the constituent of the juice. Its influence does not, however, stop here, for when the mixture is heated to  $212^{\circ}$ , the caseum, albumen, and analogous nitrogenous matters separate as a coagulum, and the liquid becomes materially blanched. Thus it acts also as a defecating and bleaching agent. It likewise prevents the formation of any new coloring matter by the action of air upon the pulp, insures a more perfect crystallization without the necessity of haste, decreases the amount of molasses, and yields nearly double the quantity of sugar obtained by the old methods.

The sulphurous acid, in exerting this beneficial influence, absorbs oxygen and becomes sulphuric acid, and as this latter would transform the cane into grape-sugar, the lime base is necessary to neutralize and convert it into insoluble sulphate of lime as fast as it is formed.

The sulphurous taste adhering to the sugar may be removed by crushing and exposing it to the air. A more effectual way is to refine it until its weight is decreased one-tenth. A very white and pure sugar is thus obtained.

It may be observed, in regard to the reason given for having a *salt* of sulphurous acid, that, if the acid were oxidized, we would have, it is true, the insoluble sulphate of lime, but also free sulphuric acid. According to Lüdersdorff this free acid is not injurious.

The English patent for Melsen's process appears in the Lond. Journ. xxxvi. 229. The accompanying propositions and claims, for the use of baryta or oxide of lead, are objectionable, for the reasons stated below.

Lüdersdorff's method, especially applicable to beet-sugar, is based upon the fact, determined by experiment, that juice contains two kinds of extraneous matters, of opposite chemical



relations. The use of both an acid and an alkali are therefore required for effectual defecation.

The freshly-rasped pulp is to be mixed with  $\frac{1}{2000}$  of its weight of sulphuric acid. All oxidation (?) is thus prevented and the quantity of juice increased, while the pulp retains its whiteness. Three per cent. of plastic clay is added to the juice to remove its cloudiness, and at the end of twelve hours separated by filtration. The filtrate, which runs through perfectly limpid, is entirely proof against viscous fermentation, but still contains foreign matters, which are to be removed by the usual process of heating with milk of lime. The juice, thus defecated, yields by evaporation and crystallization, a very fair sugar without the use of boneblack.

Phosphoric would be preferable to sulphuric acid, were it less costly. The use of the latter is attended with several serious disadvantages; one of which is the difficulty in removing the sulphate of lime formed, and another in preventing injury to the juice at the temperature  $167^{\circ}$  F. required for its rapid filtration. Both of these might probably be obviated by the substitution of phosphoric acid. See details in Lond. Journ. xxxvi. 403.

*Sugar-filters.*—For filtering saccharine and other liquids, a patent appears in the Lond. Journ. xxxvi. 107, in which a cycle of filters is used, the bottom of each being connected by a pipe with the top of the next. The first liquor is run into that one longest in use, and passes successively through the others. One is always out of use, and being prepared with a fresh charge of boneblack.

A filter of cotton for sugar solutions is described in Lond. Journ. 1849. About  $2\frac{1}{2}$  lb of raw cotton are drenched with hot water and allowed to remain in water for 12 hours. A little chalk and starch, with a boiling heat and skimming, are used to remove a portion of the impurities. The drenched cotton is then put on the slat-bottom of a cylinder or conical filter and a little water poured through, which is run off by a cock under the false bottom. The sugar solution is next poured on the filter, and, after passing through, is immediately



boiled down to crystallization. The sugar adhering to the cotton is washed out and added to the blow-up; the impurities remain in the cotton.

A late improvement in refining sugar is the employment of centrifugal force for driving out the syrup from the crystalline grains of sugar. For this purpose, the syrup, with the grains formed in it, is led into a drum fixed on a vertical shaft, with its circumference formed by wire-gauze. The drum being made to revolve with rapidity, 2000 times per minute, the liquid mass is driven by centrifugal force to the circumference, where the grains are detained by the gauze and the liquid oozes through on the outside. It is a constantly acting force, and it would seem as if the same effect might be produced by a broad and shallow filter, the lower part of which should be partially exhausted by an engine.

## 2. FERMENTATION.

Practically, we have only to consider the manufacture of alcohol and vinegar, but the consideration of fermented liquors generally may be introduced. Vinegar is now chiefly made from alcoholic liquids by simple oxidation, and the process is a beautiful gift from chemical science to the arts. As there is nothing new in relation to the vinegar process, we offer a few observations in regard to the nature of fermentation, to alcohol and wines. We notice a large work on Fermentation, issued in Germany, entitled "Gährungschemie in 3 Bänden, 1845, und 4ter (Supplement) Band, 1847," by Prof. C. Balling.

*Fermentation.*—According to Helmholtz's experiments, substances capable of undergoing fermentive changes in common air, do not suffer them if the air have been previously ignited; from which he drew and confirmed a formerly advanced opinion that fermentations arise from the exhalations of matter in the act of fermentation, whose germs or seed are conveyed to fresh matter capable of these changes, and impart to it their own character; and that these germs being destroyed by heat, such air will not produce fermentation.



Mitscherlich's experiments lead to a similar conclusion. (Berzelius Jahresb. 1846.) The fermentable substances were put into flasks with water, and boiled to destroy the vitality of seed. One flask was left open, and the other closed with filtering paper, pasted tightly around the edges. The open flask soon showed signs of fermentation in the formation of mould; while the other did not exhibit any such change in the course of months, the paper apparently filtering off the germs from the air which entered the vessel.

Döppning and Struve, repeating Helmholtz's experiments, drew the conclusion that all nitrogenous substances undergo decomposition, even in air previously ignited, and that it is chiefly prevented or diminished by a boiling temperature. They also observed that paper, straw, and other porous bodies may be fermented without the presence of a ferment, but that the resulting product is butyric acid and not alcohol. The same fermentation occurs when solutions of sugar are brought in contact with powdered charcoal or sulphur, but in the latter case, a little tartrate of ammonia should be added. (Bullet. de St. Petersburg, 1847.)

*Action of Ferment on Sugar.*—Dubrunfault's examination of the changes suffered by cane-sugar, in the fermenting process, previous to the formation of alcohol and carbonic acid, led him to the following conclusions. The altered cane-sugar (or its analogous grape-sugar or fruit-syrup) is not a simple variety of sugar; only a certain quantity of it becomes glucose by crystallization, the residue polarizing to the left with the same power that the separated grape-sugar polarizes to the right. In the vinous fermentation of the altered sugar, that which disappears in the first part of the process is optically neutral, while the sugar which disappears last polarizes strongly to the left. No one sugar is exclusively decomposed before another in fermenting mixed sugars. The sugar produced from starch, by the action of malt, is not identical with grape-sugar; for the former is less soluble in alcohol, less liable to change by ebullition, or the alkalies, and its polarizing power is three times that of the latter. The optical deflecting



powers of such quantities of grape-sugar solution, kept for a long time, of freshly dissolved grape-sugar, of starch malt-sugar, and of dextrine, as will all give the same quantity of alcohol, are in the ratio of 1 : 2 : 3 : 4. (Journ. Prac. Chem. xlii. 418.)

*Alcohol and Water.*—Townes gives the following results of his experiments to determine the specific gravity of mixtures of alcohol and water. Column A shows the percentage of alcohol by weight in the mixture, and B the spec. grav. at 60°.

A	B	A	B	A	B	A	B
5	0.9914	30	0.9578	55	0.9069	80	0.8483
10	0.9841	35	0.9490	60	0.8956	85	0.8357
15	0.9778	40	0.9396	65	0.8840	90	0.8228
20	0.9716	45	0.9292	70	0.8721	95	0.8089
25	0.9652	50	0.9184	75	0.8603	100	0.7938

*Alcoholometers.*—Two instruments have been invented for determining the proportions of alcohol in liquids containing substances in solution which increase the spec. grav. of the liquids, in which case the indications of a hydrometer are not to be relied on. The principle of their use depends upon the lower boiling point of a mixture in proportion to the quantity of alcohol it contains. They are termed *Ebullioscopes*. The instrument employed by Brossard-Vidal is a large thermometer; the mercury in the tube carrying a float, from which a cord passes over a pulley and is counterpoised by a light weight. An index is attached to the roller, which points to degrees on a graduated scale, according as the pulley revolves, *i. e.* as the level of mercury alters, when the liquid boils.

Conaty's instrument is a common thermometer, with a scale attached, which directly indicates the proportion of alcohol contained in a liquid into which it is immersed during ebullition. The movable scale may be also adjusted for barometric variation, so that further corrections are avoided. Both instruments have been reported to the Paris Academy as capable of indicating 1 or 2 per cent. of alcohol in a liquid, but that of Conaty is thought to be the most convenient. (*Comptes Rendus*, xxvii.)



Ure has constructed an instrument of the same kind, similar in principle to that of Conaty. (Phar. J. Trans. vii. 166.)

*Dilatometer.*—Silbermann (Comptes Rendus, 1848) has invented an instrument for determining the relative quantity of each liquid in mixtures of water and alcohol. It is called a dilatometer, and derives its principle from the fact, that the dilatation of alcohol is three and a half times greater than that of water, at temperature from  $77^{\circ}$  to  $122^{\circ}$  F. For example, if the bulb of a thermometer-tube be over-filled with alcohol and heated to  $122^{\circ}$ , it will be seen that the liquid rises in the tube three and a half times higher than would the same quantity of water under like circumstances. So, also, any mixture of the two would give a mean point of dilatation, approximating that of the alcohol or water, according as either may preponderate. Thus, by making the water point  $0^{\circ}$ , and noting severally and consecutively the degree of dilatation of a series of 100 mixtures, commencing with water 99 and alcohol 1, and ending with alcohol 100, water none, a centesimal alcoholometric scale may be graduated so as to show at a glance the proportion of either in any mixture of the two liquids.

Other scales may be adopted upon the same principle, to determine the ratios of any other two liquids differing in their degree of dilatation.

The dilatometer is particularly applicable for testing wines. The particulars as to its construction and use are given in the original paper.

*Distilled Liquors and Fousel-oil.*—To free them readily from fousel-oil, Peters recommends a hogshead with a false bottom to be half filled with well-ignited charcoal, the top of this to be strewn over with 10lb boneblack, and 5lb black oxide of manganese, and the whole to be filled up with charcoal. The hogshead is to be filled with brandy, whisky, &c., which is to remain in it for 3 days, and then drawn off. That which first runs off cloudy is to be redistilled, but this operation will not be again required. The vessel thus prepared will last 12–15 months.



*Butyric Ether.*—This ether is used for imitating rum, on account of its agreeable apple-odor. To obtain it dissolved in alcohol, Wöhler recommends (Pogg. Ann. xlix. 360) saponifying butter with strong potassa-lye, dissolving this soap in the least amount of alcohol, by the aid of heat, adding to it a mixture of alcohol and sulphuric acid until it has a strong acid reaction, and distilling it as long as the distillate possesses the apple-odor.

*Sulphuric Acid in Wines.*—Lassaigne (Ann. de Ch. et de Phys. xxi. 119) proposes a very simple and delicate test of the presence of sulphuric acid in wines. When a piece of white-glazed paper, containing starch, is touched with pure wine and dried at a gentle heat, no spot is produced; but if sulphuric acid be present, even to the extent of  $\frac{1}{10000}$ , the spotted portion reddens and becomes brittle between the fingers before the white paper becomes at all colored. Pure wine leaves, by spontaneous evaporation, a violet-blue spot, but if containing 2–3 thousandths of sulphuric acid, a rose-red spot.

*Effect of Oak-casks upon Wines.*—Famè (Journ. de Pharm. et de Chim. xiii. and Millon and Reiset's Annuaire, 1849) gives the following conclusions, based upon the results of a series of analyses.

1. That the oak woods used by the coopers for making wine and liquor casks are the same in composition; though the proportions of the ingredients vary with the place of growth of the tree.

2. That the soluble principles of oak-wood have an appreciable action upon liquors, and particularly upon wines.

3. That this action is more evident upon white than upon red wines; more so upon light and delicate than upon colored and coarse wines.

4. That American oak contains less soluble matter than other kinds.

5. That casks made of American, Dantzic, or Stettin oak, have, in general, the least action upon spirituous liquors. The two latter even, sometimes, improve the quality of the wines.

6. That alkalies increase the color and solubility of the ex-



tractive matter of the wood; and the mineral acids, on the contrary, weaken them.

*Sweetening of Sour Wines.*—Liebig (Ann. der Chem. und Pharm. lxxv.) proposes to remove the acidity of sour Rhine wines, by means of a concentrated solution of tartrate of potassa, which precipitates the acid as insoluble bitartrate. The proper proportion of the salt varies with the wines, their age and quality, and must be determined by the intelligence of the operator. This mode is far preferable to neutralization by lime or potassa, as it leaves no salt in the wine to impair its flavor.

*Malt Liquors.*—On the amount of inorganic constituents in ale and porter, see Phil. Mag. xxxiii. 341, and Amer. Journ. (2) vii. 102.

### 3. CULINARY ARTS.

1. *Beverages.*—Doubtless the most important of these is water, which we have considered in regard to manufactures under Chemics, and now present it in its character of a beverage. Soft water, taken on shipboard, frequently undergoes several distinct fermentations, after which it appears to be no longer liable to alteration; but the character of these changes has not been studied. Probably all sweet waters, and perhaps all waters on the globe, contain more or less organic matter, generally a minute quantity, dissolved in them, and the putrefactive processes observed in a ship's supply of water is doubtless due to this cause; for if caused by other organic matter, the cessation of putrefaction would not be observed, as the same cause would continually present itself. How to remedy the defect is an important question.

Perinet has found that binocide of manganese will preserve the sweetness of water for years. 60 gallons of water, containing 3lb of the powdered binocide, remained perfectly sweet and clear for seven years in a wooden vessel. (Journ. de Chim. Medic. April, 1846, 301.)

*Purification of Sea-water.*—According to Cardan, sea-water



is entirely deprived of its nauseous taste by infiltration through powdered charcoal. A siphon-shaped vessel is recommended—the coal to occupy the long arm. (Lond. Athenæum, 1850.)

*Action of Water upon Lead.*—Horsford (Proc'dgs. Amer. Acad. Arts and Sciences) classifies drinking-waters, as follows:

1. Open waters, as ponds, lakes, and rivers, having their sources in rainfalls and surface drainage.

2. Waters concealed from sunlight, as wells, and certain springs, formed by infiltration through earthy and rocky strata.

The latter, except in winter, are colder and contain a greater amount of gases than the former. They also hold, in solution, more inorganic matter, especially nitrates and chlorides, but have less organic matter than open waters.

The results of his experiments authorized the following conclusions. That neither dry air, or water freed of air, have any oxidizing influence upon lead; that metal being acted upon proportional to the amount of free oxygen in solution. That the nitrates are partially reduced by lead, and that both they and the chlorides facilitate the solution of the plumbic coating formed in service pipes. That the presence of animalculæ or vegetable matters does not impart corrosive properties to water; for these substances being most abundant in summer, the oxygen arising from their decomposition (?) is expelled by the natural heat of the water. Moreover, the escape of gas and air is promoted by the presence of insoluble organic matter, whilst that portion of the latter which may be in solution consumes the dissolved oxygen and reduces the nitrates. Organic matter, therefore, rather impairs the solvent action of water upon lead.

Lead does not reduce iron oxide, nor is it corroded by alkaline chlorides, in the absence of air. Pure water, as a general rule, possesses a greater solvent power than when salts are in solution. All natural waters produce more or less corrosion in the interior of lead conduits, but the coating at first formed is entirely insoluble; contact with water and carbonic acid, however, soon increases its state of oxidation, and it then becomes soluble in 7 to 10,000 parts of pure



water. When sulphuric acid, oxide of iron, or organic matters are present, this oxide unites and forms with them a highly protective covering.

*Paraguay Tea.*—A decoction of the leaves of *Ilex Paraguayensis* is used in South America as a beverage, in place of tea and coffee, and hence its vulgar name of "Paraguay tea." According to Stenhouse and Rochleder (Ann. der Chem. und Pharm. lxvi.) its crystalline principle is identical with caffeine, and its acid gives the same reactions as caffeo-tannic acid.

*Chicory Coffee.*—This article, originally manufactured in Holland, a century since, was first made in France in 1801, by Orban and Giraud. Since then, it has become an important object of commerce; the exports from 1827 to 1836 having reached 458,971 kilogrammes. The home consumption alone amounts to 12,000,000 pounds. It is used alone, or mixed with coffee, to which it imparts a bitter taste, and at the same time, it is said, modifying its stimulant action. It is frequently adulterated with coffee-grounds, brick-dust, earthy matters, roasted acorns, corn, haricots, and peas. Of these fraudulent mixtures, those containing starch may be detected by means of iodine-water. The coffee-grounds are recognised by throwing a pinch of the suspected chicory, previously dried, over a water-bath, upon the surface of water; the chicory absorbs water and sinks, the coffee-grounds float.

The mode of preparing chicory coffee is, to collect the plant in the spring, and to strip and wash the roots. These roots are then divided into longitudinal strips, which are in turn still further reduced in size by being cut transversely, and dried in a heated chamber. The drying is facilitated by frequent stirring, and the root thus prepared takes the name of *cossetes*. After roasting in cylinders, 2 per cent. of butter is added and the machine rotated several times, in order to give lustre and the appearance of coffee to the chicory. Grinding between cylinders, sieving, and coloring with *rouge brun de Prusse*, complete the operation.

On chicory coffee, by Chevallier, see Amer. Journ. 2d ser. viii. 441, and Chem. Gaz. 1849.



*Alcoholic Drinks.*—Bouchardat and Sandras (Ann. de Chim. et de Phys. 1847, and Ch. Gaz. vi. 121), with a view of determining the manner in which alcohol is absorbed by and the changes which it undergoes in the system, performed a series of experiments, the results of which go to prove that it is absorbed by the veins, and not by the lacteals; and, excepting a minute portion escaping by the lungs, it is entirely oxidized into carbonic acid and water, either directly or by passing through the intermediate stage of acetic acid.

2. *Preparation of Food.*—On this subject, much cannot be yet offered by the chemist; but, with his wonted spirit, Liebig has led the way in this branch of the chemical arts.

*Index of Nutrition.*—Dr. A. Vœlker's essay, presented to the British Association at their late meeting (1850), showed that the quantity of nitrogen, considered as an index of the nutritive value of food, had been incorrectly estimated, in consequence of a portion of it existing in the form of ammonia.

*Detection of Corn-meal in Wheat-flour.*—La Grange (Journ. de Chem. Med. iv. 339) takes of the suspected matter 2 grm. sifts and places it in a test-tube, and then stirs in 4 grm. nitric acid. After this it is diluted with 60 grm. water, and then a solution of 2 grm. carbonate of potassa in 8 grm. water is added. After the escape of carbonic acid, if there is no corn present, the subsiding flocculæ will be yellow; otherwise they will be intermixed with orange-colored particles. This test serves for the detection of as little as 4 per cent. of indian-meal.

*Horse-chesnut.*—Flandin (Comptes Rendus, xxvii.) proposes to remove the acrid resin and bitter taste of the horse-chesnut, by kneading the powdered kernel with  $\frac{1}{10}$  to  $\frac{1}{100}$  of its weight of soda, and then washing out with water.

*Cooking of Meat.*—Liebig's researches (Ann. Ch. Pharm. lxii. 257) upon the juices of flesh have furnished valuable results, which are full of general interest, because of their practical application. All the nutritious portions of flesh may be extracted by finely mincing and exhausting it with cold water. The liquid, thus obtained, contains creatin, some cre-



atinin, albumen, coloring matter, inosinates, lactates, alkaline phosphates and chlorides, with other salts. It is to be heated over a water-bath in order to coagulate the albumen, which carries with it the coloring matter. The liquor is then strained, and if the constituents are to be separated, treated with caustic baryta to precipitate free phosphoric acid, which would, otherwise, cause the deposit of a brown sediment during the subsequent evaporation. If the liquor is intended for soup, instead of being strained, it may, after maceration in the cold, be gently boiled with the meat for a few minutes, and strained. The clear liquor then only requires seasoning to become palatable broth, embodying all the nutriment of the flesh. The residual meat is sinewy and without taste or nourishment. Gelatine forms but a very small portion of the dissolved matters; and Liebig confirms Proust's view that soup does not derive any taste or nourishing power from it. The flavor is due to the soluble constituents of the meat, which exist in it ready formed, and are not generated during the process of boiling. By a gradual and carefully managed evaporation in shallow pans, the liquor, prepared as above, may be converted into a brown "extract of flesh," retaining the savory odor of roast-beef. It may be called portable soup, for it can be preserved any length of time, and gives, with 30 pts. water and proper seasoning, a most palatable and nutritious broth.

From these facts, it follows that the proper way of boiling meat, so as to insure the retention of its flavor and nutriment, is to plunge it directly into boiling water, and after a few minutes to reduce the temperature of the liquid to  $158^{\circ}$  by the addition of cold water. The outer portion of the meat is thus hardened, and a gentle simmer, so as to heat the interior to  $158^{\circ}$ , will coagulate the albumen, enveloping the fibres and also the coloring matter of the blood, without hardening the flesh. The nutriment and flavor of the meat are thus preserved unimpaired.

According to Liebig, the brine running from meat packed with dry salts, consists mainly of the juice, and that, therefore, the process of salting lessens its nutritious power.



*Testing Butter for Casein.*—Add ether to the butter, contained in a flask, and shake them together for some time. The butter is dissolved and the casein remains. (Archiv. der Pharm. lvi.)

3. *Preservation of Food.*—This subject has also been but superficially investigated by the chemist. Some of the substances used for preserving food are ice, sugar, alcohol, and vinegar; but more attention should be given to the preservation of food, by procuring it in a dry state, where chemical action cannot take place. We offer the preservation of milk as an example.

*Ice.*—As this article is now regarded as almost indispensable to health in summer, and as it is unquestionably one of the greatest luxuries, it would be desirable to manufacture it in the season when it is wanted, especially in latitudes and localities where it is not obtained in sufficient quantity in winter and cannot be procured at a moderate cost by importation. Several of the freezing mixtures, formerly used as subjects of pleasing experiment by the chemist, begin to attract attention, as means of economic manufacture of ice in summer. See an article on the subject, in Amer. Journ. 2d ser. vii. 280.

*Preservation of Milk.*—Louis (Ch. Gaz. vii. 48) renders milk portable without impairing its original sweetness, by mixing it with clarified sugar, 4 oz. to the gallon, evaporating it in shallow pans by steam, and removing it at the solidifying point, and pressing it into cakes.

Another method recommended is to curdle the sweetened milk by rennet, and then to separate the solid from the liquid portion, by means of a sieve. The whey is evaporated to dryness and the residue mixed, by the aid of heat and a little bicarbonate of soda (1 pt. to 20 pts. of residue), with the curd previously washed and pressed. When the amalgamation is perfect, sufficient tragacanth is added to promote the solidification of the mass.

*Milk and Cream.*—Bethel has obtained a patent (Newton's Journal, 1849) for preserving milk or cream, by first scalding it, and then surcharging it with carbonic acid by means of



a force-pump, and afterwards drawing it off into strong metal barrels. By the aid of a valve-cock attached to a pipe leading to the bottom, the exit of the liquid, as may be wanted, can be managed; the internal pressure of the gas being sufficient to force out the milk. The milk may be placed in the barrels first and the gas forced in afterwards.

*Products of the Decomposition of Casein.*—Iljenko (Liebig's Annalen, lxiii.) has reported the following results of the action of water upon casein. He obtained pure casein by washing fresh cheese with water, dissolving it in soda-lye, skimming off the fat which rose to the surface after repose, precipitating casein from the clear liquid by sulphuric acid, and washing with alcohol and ether.

Eight pounds of this casein were mixed with distilled water and exposed to the air at summer heat. After a week, ammoniacal and sulphuretted odors were evolved and continued during the whole process, the liquid remaining alkaline from the commencement to the end of the reaction. The liquid was replaced every four days by fresh water. After ten weeks, the united liquors, after having been tested separately and found to behave alike, were filtered. The casein had decreased in weight considerably during this time.

The volatile products of the distillation of this filtrate were volatile oil, butyric, and valerianic acids. The ammonia generated during the putrefactive fermentation, dissolved a portion of the casein. The liquor also contained *aposepedin*, or oxide of caseum.



## VIII. BIOTECHNICS.

SINCE plants are modified in appearance and special products by the use of manures, and the products of animals are influenced by food and other conditions, the study of these modifying circumstances is an art of the highest importance. To ascertain them to a limited extent, empirical experiment will be of much assistance; but to determine them more fully, proximate analysis of organized bodies and organic mixtures demands a more thorough elaboration. Quantitative proximate analysis is still in its beginning. After this, or simultaneous with its development, must be a study of the successive changes experienced by special substances in plants and animals during growth, both in normal and abnormal conditions, under usual circumstances or when subjected to particular chemical influences. We have an ingenious investigation of this kind to report by Fremy.

1. *Physiology.—Ripening of Fruit.*—Fremy's investigation of the ripening of fruits has opened a new and interesting field. He calls *pectose* a substance associated with cellulose in unripe fruits, in carrots, turnips, &c.; it is insoluble in water, alcohol, and ether. It is converted into *pectin* by heat and dilute acids, or by the ripening of fruits, in which case malic and citric acids produce the effect. When pectin is boiled for some time in water, it is converted into *parapectin*, of the same composition as pectin, but precipitable by sugar of lead. Parapectin boiled with dilute acids is rapidly changed to *metapectin*, of the same composition as pectin, but decidedly acid, and precipitable by chloride of barium. Fremy has found a ferment in fruits, and carrots, &c., which he terms *pectas*, the soluble modification of which is obtained from carrots. Pectas, or cold dilute alkaline solutions, transforms pectin into *pectosic acid*. The longer action of pectas, or alkalies, or ebullition



converts pectin into *pectic acid*, which is insoluble in cold water. Continued ebullition of pectic acid in water converts it into soluble *parapectic acid*, and this is easily changed by dilute acids into *metapectic acid*. The last acid is also formed by the action of strong acids on pectin, or of an excess of alkali on pectin, pectosic or pectic acid. The following table shows the composition of these bodies and their respective compounds with oxide of lead.

			Lead-salt.
Pectose.....	—	.....	—
Pectin.....	$8\text{HO}, \text{C}_{64}\text{H}_{40}\text{O}_{56}$	.....	—
Parapectin .....	$8\text{HO}, \text{C}_{64}\text{H}_{40}\text{O}_{56}$	.....	$7\text{HO}, \text{PbO}, \text{C}_{64}\text{H}_{40}\text{O}_{56}$
Metapectin.....	$8\text{HO}, \text{C}_{64}\text{H}_{40}\text{O}_{56}$	.....	$6\text{HO}, 2\text{PbO}, \text{C}_{64}\text{H}_{40}\text{O}_{56}$
Pectosic acid....	$3\text{HO}, \text{C}_{32}\text{H}_{20}\text{O}_{28}$	.....	$\text{HO}, 2\text{PbO}, \text{C}_{32}\text{H}_{20}\text{O}_{28}$
Pectic acid.....	$2\text{HO}, \text{C}_{32}\text{H}_{20}\text{O}_{28}$	.....	$2\text{PbO}, \text{C}_{32}\text{H}_{20}\text{O}_{28}$
Parapectic acid	$2\text{HO}, \text{C}_{24}\text{H}_{15}\text{O}_{21}$	.....	$2\text{PbO}, \text{C}_{24}\text{H}_{15}\text{O}_{21}$
Metapectic acid	$2\text{HO}, \text{C}_8\text{H}_5\text{O}_7$	.....	$2\text{PbO}, \text{C}_8\text{H}_5\text{O}_7$

The above series commences with neutral pectin, and passes through a series of bodies successively more acid, to a strong acid, the metapectic. They either differ from each other by the elements of water, or are isomeric.

The changes of the pectin series by water, acids and alkalis are similar to those which take place in the ripening of fruits. Unripe fruits contain pectose, which is, during ripening, gradually converted into pectin and parapectin, by the action of acids present (malic, &c.); and these are changed by pectas into metapectic acid, which unites with potassa or lime. The metapectic acid probably causes the conversion of starch into sugar. Boiling unripe fruits induces a similar formation of pectin, which by the action of pectas is transformed into gelatinous pectosic and pectic acids, forming a jelly. (Ann. d. Ch. u. Pharm. lxvii.)

2. *The Atmosphere.*—The presence of carbonic acid in the air has long been known. Its influence on vegetation has been brought out more prominently by Liebig. Many experiments seem to determine the presence of ammonia in the air,



and its influence on the growth of plants is maintained by Liebig. Future analysis may determine the presence and influence of other matters, which at present elude our analytic methods, or whose presence is only suspected.

Marchand found, as the mean of 150 experiments, that 10,000 volumes of air contain 3.1 of carbonic acid. Kemp found that 24,840 cubic inches of air yielded 1.8 milligrammes of ammonia. Græger and Horsford have also found ammonia.

The discrepancies in the experiments of Græger, which gave 0.323 grm. ammonia = 0.938 carbonate, and those of Dr. Kemp, determining 3.68 caustic = 10.37 carbonate of ammonia in 1,000,000 grm. of the atmosphere, induced Fresenius to make some essays with a view to the correct decision of the matter. His apparatus consisted of two gasometers, of nearly 2 galls. capacity each, with a collecting apparatus of two flasks, containing 1 pt. muriatic acid of 1.12 and 20 pts. water. The passage of the air was continued, day and night without intermission, for six weeks. The results obtained were .089 ammonia = .283 carbonate during the day, and .169 ammonia = .474 carbonate during the night, in every 1,000,000 grm.

3. *Mineral Manures*.—That mineral matters in the soil exert an important influence on plants is generally admitted, but which substances are most influential and how far they are beneficial have not been determined. On this head, we call attention to the investigations of G. Magnus, of Berlin.

Magnus made a series of careful experiments, during 1849, on the growth of plants (barley having been selected), from which he drew the following conclusions :

1. When mineral matters are not present, the barley attains only the height of 5 inches, and then dies.

2. When a small quantity of mineral matter (different salts) is present, perfect development takes place.

3. If somewhat more mineral matter is present, the plant either grows in a stunted form or is not developed at all.

4. In feldspar alone, barley attains complete development and produces seeds.



5. The progress of growth varies according as the feldspar is used in the state of coarse or fine powder.

6. Manure exerts its fertilizing action also at a distance. It then acts, not only by conveying certain mineral matters to the soil, but its organic constituents also contribute, and that essentially, to the promotion of vegetation.

For a more detailed account of Magnus's experiments, see Chem. Gaz. viii. 261.

*Common Salt.*—The injurious effects of common salt on vegetation were clearly shown in a case reported to the British Association. See Amer. Journ. 2d ser. vii. 299.

W. B. Randall (Ch. Gaz. vi.) has proved by experiment that water, containing as much as seven grains of chloride of sodium to the pint, is highly destructive to the weaker forms of vegetation.

On the other hand, Dubreuil, Fauchet, and Girardin experimented practically on the effects of common salt on wheat, and found that in the ratio of 6–8½lb per acre, the straw and grain were both heavier; when more salt was employed, the straw was more influenced than the grain.

Persoz found that hortensias flourished far more in an ordinary soil manured, than the same not manured; the manure being 6lb boneblack, 3lb nitric acid, and 1lb phosphate of potassa. A vine manured with 1lb silicate of potassa, 3lb phosphate of potassa and lime, and an equal weight of dried blood and goose-dung, produced a shoot of more than 11 yds. in a year, while another, not manured, gave a shoot of only 4¾ yds.; the former produced on nine shoots 25 bunches of grapes, the latter none.

Polstorff (Ann. Ch. Pharm. lxii. 192) drew the following conclusions from experiments with salts upon barley grown in lead-lined boxes, and in the field: 1. That barley reaches its full development in a soil containing only the constituents of its ashes; 2. That the amount of nitrogen in grain is therefore not dependent on the soil; 3. That mineral manures are capable of producing entirely different results, according to the



form in which their constituents are employed. Excrements gave much more than their ash, when each were employed separately. In the field, he found that ammonia-phosphate of magnesia did not affect the development of the grain, that it injured the formation of the straw, and that mineral manures without ammonia retarded vegetation.

*Disintegration of Rocks.*—Soils being formed by the disintegration of rocks, the study of this point is of some importance in vegetable physiology.

Ebelmen (*Comptes Rendus*, xxvi. and *Ch. Gaz.* vi.) gives, as conclusions from a series of analyses, 1. That silicates, which contain no alumina, lose, on disintegration, silica, lime, and magnesia: sometimes the iron disappears with the bases, and at others, remains in the residue as peroxide. 2. Silicates containing alumina and an alkali, and even other bases also, become richer in alumina on disintegration; and this alumina retains the silicic acid and assimilates water, while the other bases, with a portion of the silicic acid, disappear. In this case, the residue approaches in composition to a hydrated silicate of alumina.

W. B. and R. E. Rogers have given the results of a series of experiments (*Amer. Journ.* 1848) upon the solvent power of pure and carbonated water upon mineral compounds, by which they prove in two ways, 1st, by an extemporaneous method with the tache, and, 2dly, by prolonged digestion at the ordinary temperature, "the solvent and decomposing power of pure and carbonated water upon all the important mineral aggregates, as well without as with alkaline ingredients."

*Phosphate of Lime in Basaltic Rocks.*—Deck (*Chem. Gaz.* vi.) has, by recent analyses of some basalts, proved the presence of phosphate of lime in igneous rock, and thereby confirmed those of Mr. Forbes, in contradiction of those by Prof. Kersten.

*Artificial Mineral Manures.*—Liebig gives the following proportions of salts, as the basis for manures. 1.  $2\frac{1}{2}$  pts. carbonate of lime and 1 pt. potash (or 1 pt. of a mixture of



potash and soda). The potash usually contains 60 per cent. carbonate, 10 per cent. sulphate, 10 muriate, and some silicate of potassa. 2. Equal parts of phosphate of lime, potash, and soda. The above mixtures are each fused separately in a reverberatory. According to the peculiar wants of the soil, the proportions given may be varied, and also different substances added, such as plaster, bones, silicated alkali, ammonia, phosphate of magnesia. According to Stenhouse, the calcareous phosphate may be obtained from urine, as well as from guano and bones, by adding milk of lime, drawing off the liquid from the deposit, and drying the latter. 100lb urine yield nearly  $\frac{1}{2}$ lb of the precipitate, which when dry contains  $\frac{2}{3}$  phosphoric acid,  $\frac{2}{3}$  lime, &c., and  $\frac{1}{4}$  nitrogenous organic matter.

*Analysis of Bone-earth.*—Heintz's analyses of bones (Berlin. Berichte, 1849) give the following results.

	Human.		Sheep.		Ox.
Lime .....	37.89	37.51 ...	40.00 ...	37.46	
Magnesia .....	0.57	0.56 ...	0.74 ...	0.97	
Phosphoric acid.....	28.27	28.00 ...	29.64 ...	27.89	
Carbonic " .....	2.80	2.81 ...	3.08 ...	3.10	
Water, fluorine, and organic matter .....	30.47	31.12 ...	26.54 ...	30.58	

*Phosphates of Lime.*—Rœsky's experiments (Comptes Rendus, xxvi. and Ch. Gaz. vi.) show that the artificial or bone phosphate of lime has the composition  $3\text{CaO}, \text{PO}_5$ ; that the biphosphate of lime is decomposed by alcohol into a phosphate and free acid; but the former is not a neutral salt but a new phosphate  $3\text{CaO}, 2\text{PO}_5, 4\text{HO}$ .

*Solubility of Phosphates.*—According to Liebig, 1 litre of water saturated with carbonic acid, dissolves 0.6626 grm. of bone-earth, of which 0.500 grm. is deposited by boiling. (Ann. der Chem. und Pharm. lxi.) According to Lassaigne, water with its own volume of carbonic acid, dissolves in the course of 12 hours, at the temperature of  $50^\circ$ , 0.00075 of artificial basic phosphate of lime, 0.000166 from fresh bones, and 0.0003 from bones that had been buried for 20 years. He



states that 40 cub. centimeters water, containing  $\frac{1}{12}$  their weight of common salt, dissolve 0.0127 grm. basic phosphate of lime; and that salammoniac increases the solubility still further. (Journ. Ch. Med. iii. and iv., Comptes Rendus, and Lond. Journ. 1849.) Crum has observed that 100 pts. of various acids (diluted in the proportion of 1 equiv. acid to 1000 eq. water), dissolve from  $\frac{3}{4}$  to  $1\frac{1}{2}$  pts. of basic phosphate of lime. The acids were sulphuric, tartaric, acetic, lactic, malic, hydrochloric, and nitric; the first dissolving the most, the last, the least. (Ann. der Ch. und Pharm.)

*Acid Phosphate of Lime.*—It is some years since this salt was proposed as a manure, and repeated trials since that time have fully demonstrated its efficiency. The simplest method of preparing it is as follows. Bones are thrown into heaps, where they soften by fermentation. They are then covered with half their weight of water in wood or stone vats, and half their weight of oil of vitriol added. The whole passes into a pasty state in the course of 8 or 10 days, when it is mixed with earth, charcoal, or sawdust, to render it pulverulent. If it be required to apply the salt in a fluid state to land, the paste is diluted with 100–200 times its bulk of water.

*Ammonia Phosphate of Magnesia.*—Boussingault and Smith propose making this salt from urine, by treating the latter with a solution of sulphate or muriate of magnesia. The ammonia phosphate will separate in the course of a month. They state that 6300 pts. urine gave 46 pts. of the salt, equal to  $\frac{3}{4}$  of one per cent. It might readily be made in towns and manufacturing establishments; and while the proposed treatment will diminish the disagreeable odor of putrefying urine, it will offer an invaluable manure to the agriculturist.

*Phosphatometry.*—Moride and Bobierre have proposed (Technologiste, 1849) an expeditious method for determining the proportion of phosphates in manures. 1 grm. boneblack or dust, dried at  $212^{\circ}$ , is to be incinerated and reweighed, so as to estimate the carbon and organic matter by loss. The soluble saline matters are separated from the ash by leeching



with water, and their amount ascertained by the decrease of weight. The residue, insoluble in water, is then carefully digested in nitric acid, saturated dropwise with aqua ammonia, and when a cloudiness appears, treated with acetic acid to redissolve the suspended phosphate of lime.

A normal liquor is now prepared by dissolving 3.107 grm. of pure acetate of lead in 50 cub. centimeters of water, that amount of salt having been found by experiment to be equivalent to 1 grm. phosphate of lime. The liquor must be slightly acidulated with acetic acid, and then poured into a tall glass cylinder graduated into 100 equal parts, so that each degree may represent 1 centigramme of phosphate.

The acetic solution of phosphate, prepared as above, is mixed with this liquid until it assumes a yellowish tint, when two-thirds of its volume of alcohol must be added to mitigate the solvent power of the free acid upon the lead phosphate, and the pouring of the test-liquor continued, very carefully, until a drop of the mixture gives the greenish-yellow lead reaction with iodide of potassium. The number of divisions of the normal liquid required to bring it to this point denotes the number of centigrammes of phosphate of lime contained in the solution.

4. *Organic Manures*.—The fæces of animals alone, or mixed with other organic matter which they cause to putrefy, have been used as manures time out of mind, and their value universally attested. The great influence of their ashes or mineral constituents has been investigated latterly, and has almost led to a disregard of their organic contents, unless in the form of a compound yielding up ammonia to the air. Too much haste has been shown in these conclusions. We report a few examinations of excrements, which are of value independently of theory.

*Human Fæces*.—Fleitmann, who carefully examined the human fæces (Silliman's Journ. 1849), found their inorganic contents, as follows:



	<i>Fæces of one Day.</i>	<i>Urine of one Day.</i>
NaCl.....	0.0167	8.9243
NaO .....	0.0185	—
KCl .....	—	0.7511
KO .....	0.5455	2.4823
CaO .....	0.5566	0.2245
MgO .....	0.2781	0.2415
Fe <sub>2</sub> O <sub>3</sub> .....	0.0544	0.0048
PO <sub>5</sub> .....	0.8072	1.7598
SO <sub>3</sub> .....	0.0293	0.3864
SiO <sub>3</sub> .....	0.0375	0.0691
	2.3438	14.8438

*Composition of Excrements.*—The first four analyses are by J. R. Rogers (Ann. Ch. Pharm. lxx. 85), the fifth is by Vohl.

CONSTITUENTS.	Pig.	Cow.	Sheep.	Horse.	Dog.
100 of flesh excrement yielded water.	77.13	82.45	56.47	77.25	....
“ dried “ at 212° yielded ash.	37.17	15.23	13.49	13.36	....
“ ash gave matters soluble in water .....	9.65	5.84	17.29	3.16	....
“ ash gave matters soluble in hydrochloric acid.....	18.70	32.21	....	22.59	....
“ ash gave matters soluble in nitric acid.....	....	....	34.54	....	....
“ ash gave insoluble residue.....	71.65	61.95	48.17	74.25	....
Composition of the Ash.					
Potassa.....	3.60	2.91	8.32	11.30	0.30
Soda .....	3.44	0.98	3.28	1.98	0.44
Lime .....	2.03	5.71	18.15	4.63	33.05
Magnesia .....	2.24	11.47	5.45	3.84	0.09
Oxides of manganese .....	....	....	traces.	2.13	....
Chloride of sodium.....	0.89	0.23	0.14	0.03	....
Phosphate of iron .....	10.55	8.93	3.98	2.73	....
Phosphoric acid .....	0.41	4.76	7.52	8.93	34.46
Sulphuric “ .....	0.90	1.77	2.69	1.83	....
Carbonic “ .....	0.60	....	traces.	....	7.46
Chlorine “ .....	....	....	....	....	0.04
Silica .....	13.19	62.54	50.11	62.40	{ traces. ....
Sand .....	61.37				
Iron .....	....	....	....	....	0.01
Organic matter .....	....	....	....	....	14.15

Kuhlmann has concluded from his experiments that, while salts exert an influence in promoting the growth of plants, nitrogenous matter is the most efficacious.



*Deodorizing Putrid Matter.*—Among the various substances proposed to disinfect excrements, and at the same time to fix and retain their valuable constituents, some, as sulphuric and muriatic acids, expel sulphuretted hydrogen, and are therefore objectionable; others, as the metallic salts, may themselves be injurious to plants (see Magnus's experiments). Boussingault proposed chloride of magnesium, which would form the difficultly soluble ammonia-phosphate of magnesia. Calloud proposes the mother-waters of salines, containing salts of lime and magnesia, together with charcoal. While the former would form phosphates of slow solubility, the coal absorbs the noxious gases, and by its porosity also oxidizes sulphuret of ammonium into sulphate of ammonia.

To deodorize human excrements, the best material is probably the pyrolignite of iron, the free acid of which has been previously neutralized by a base (ashes, lime, &c.).

To prevent the escape of disagreeable and perhaps noxious gases from decomposing animal matter, and to convert it into good manure, E. Brown recommends (Lond. Journ. Arts, 1847) pouring into a privy a dilute solution of sulphate, muriate, or pyrolignite of iron, or muriate of manganese (from the manufacture of bleaching-salt), stirring up, then covering it with a good absorbent (75 pts. wood-ash, and 25 pts. sawdust, bone-powder, &c.), and closing the building for 10 minutes. Thus freed from odor, it may be transported to a poudrette building, where it is mixed with 15–20 per cent. of a drying powder, dried, and packed.

Blood may be rendered inodorous and incapable of putrefaction by adding to it a solution of chloride of iron or of manganese, which unites with and coagulates the albuminous matter, and then drying it alone, or mixing with absorbents and drying it.

5. *Ashes of Plants.*—It is hoped, and with good reason, that an accurate determination of the ashes of plants and of parts of plants, will assist in determining what special mineral substances are needed by those plants, or their parts, for their more perfect development. Hence these analyses have been



multiplied in no ordinary degree within the few last years. For the fullest view of them, we refer to the Annual Report for 1849, by Liebig, Kopp and others, and give here only an example of such analyses.

*Ashes of Pine-wood.*—Sacc's analysis (Ann. de Chim. et de Phys. xxv.) gives the following result :

Silica.....	10.8667
Sulphuric acid.....	1.2844
Phosphoric acid.....	3.5569
Chlorine.....	0.1229
Peroxide of iron.....	2.6018
Protoxide of manganese.....	2.6498
Magnesia .....	3.9873
Lime .....	58.6475
Potassa .....	2.3076
Soda.....	13.9751

*Ashes of Coffee.*—T. J. Herapath, who analyzed the ashes of the berries of the *coffea Arabica*, with a view to the determination of the best manure for promoting the growth of the plant, obtained the following per centage composition. (Ch. Gaz. vi.)

Phosphoric acid.....	19.801
Sulphuric “ .....	0.244
Potassa.....	16.512
Soda .....	6.787
Chloride of sodium.....	0.645
Lime.....	2.329
Magnesia .....	5.942
Sulphate of lime.....	1.751
Phosphate of lime.....	45.551
Silicic acid.....	0.438
	<hr/>
	100.000

The author calculates, from this analysis, that every ton of berries removes from the soil the following proportions of mineral substances :



	lbs.	oz.
Phosphoric acid.....	27 ...	14½
Sulphuric " .....	0 ...	13½
Potassa .....	11 ...	4
Soda.....	4 ...	10
Chloride of sodium.....	0 ...	7
Lime .....	18 ...	14
Magnesia.....	4 ...	1
Silicic acid.....	0 ...	5
	—	—
	68	5

6. *Agricultural Products*.—That chemistry might prove a great benefit to agriculture, no one doubts; but that it has not yet done so, is true. The changes undergone by milk and cream in their metamorphosis into cheese and butter have not been minutely and accurately studied; and by way of illustrating the bearing of chemistry on these points, we offer an alkalimetric method of determining the richness of milk, and Reiset's examination of the yield of butter under different circumstances of milking.

*Lactometry*.—Poggiale (*Comptes Rendus*, 1849) proposes to estimate the richness of milk by determining the volume of sugar of milk contained in it; the proportion of that ingredient having been found by experiment to be uniformly near 52.7 in 1000 pts. of pure milk. His process is based upon the reduction of copper-salt by sugar of milk. He employs a test-liquid, made by mixing a solution of 10 grm. crystallized sulphate of copper, with one of 10 grm. crystallized bitartrate of potassa, and dissolving the precipitate in an aqueous solution of 30 grm. caustic potassa, diluting with water to the quantity of 200 grm., and filtering. 20 cubic centimeters of this clear blue liquid correspond with two decigrammes of whey, of which latter pure milk contains 923 pts. in the thousand. In 1000 pts. of whey, there are therefore 57 pts. of sugar. The fat and casein having been coagulated by mixing the milk, say 50 grm. with a few drops of acetic acid, and heating to 120°, are then to be separated



by filtration. The filtrate or whey is poured into a cylinder graduated into divisions of a fifth of a cubic centimeter, and thence added, dropwise, to 20 cub. centimeters of the test-liquid, until the disappearance of its blue color. The number of divisions of whey required to effect this are then to be noted, and the weight of sugar in the 1000 pts. calculated by the rule of three. The liquor must be contained in a glass flask and boiled before and after each addition of whey.

*Yield of Butter.*—Reiset instituted a series of experiments to determine the truth of a statement by Peligot, that, during milking, the last portions of milk were richer in solid constituents than the first. He employed two cows, which grazed through the day and were stalled without food through the night. The following tables contain the results. The residues were obtained by evaporating 20 grm. of the milk to dryness at 212°.

White Cow, No. 1.						
DATE.	Time of Milking.	Time since the previous milking.	Residue in 100 pts. of the first Milk.	Residue in 100 pts. of the last Milk.	Mean.	Weight of Milk obtained.
1843.	h. min.	h. min.				
16 Oct.	6 A. M.	12	9.33	16.04	12.68	4940
27 "	7 "	12	9.90	15.85	12.87	4840
31 "	7 "	12	9.90	17.82	13.86	4200
29 "	6 30 P. M.	11 30	10.41	21.30	15.85	4570
31 "	6 30 "	11 30	9.62	19.07	14.34	4100
28 "	6 30 "	6	13.30	16.30	14.80	2000
26 "	6 30 "	6	12.80	16.06	14.43	2540
25 "	12 M.	5	11.49	17.70	14.60	2600
27 "	12 "	5	12.00	21.20	16.60	2695
1 Nov.	12 "	5	13.60	18.50	16.05	2355
30 Oct.	4 P. M.	4	17.19	16.93	17.06	1320
1 Nov.	4 "	4	15.28	14.73	15.00	1240
30 Oct.	6 30 "	6 30	14.60	13.33	13.86	425
1 Nov.	6 30 "	6 30	12.84	13.08	12.86	530
1844.						
20 Sept.	2 15 "	1 15	13.65	13.89	13.77	650
"	3 30 "	1 15	11.65	11.89	11.77	60
"	5 "	1 30	10.96	—	—	20
"	6 30 "	1 30	10.88	13.33	12.10	normal.
1843.						
Red Cow, No. 2.						
3 Nov.	7 A. M.	12 30	11.01	17.63	14.32	4465
2 "	6 30 P. M.	6 30	13.15	17.29	15.22	2210
3 "	12 M.	5	14.37	18.93	16.65	2120
"	6 30 P. M.	5	13.20	17.50	15.35	2040
"	1 30 "	1 30	18.34	16.33	17.33	80
1844.						
20 Sept.	12 M.	5	10.96	Residue of the middle.	Residue of last milk.	
27 "	"	5	12.13	13.14.....	19.20.....	White Cow.
				13.72.....	20.00.....	Red Cow.



The white cow gave, on an average, in 24 hours, 12,500 grm. milk; the red cow, 10,250 grm. Both cows were usually milked at 6 A. M., 12 M., and 6 P. M. It appears from the above, that the fat on the milk behaves in the udder as in any quiet vessel, for the last portions are generally richer than the first. But this only occurs when it remains more than 4 hours; for if it be drawn off every 2 hours, it is uniform. The milk obtained from cows which are kept on the grass, is decidedly richer than that obtained from such as are stalled at night without feed.

The differences observed above in the milk seem only to affect the fat; for that portion of the residue insoluble in ether, as well as the nitrogen and ashes of this portion, are almost constant, as shown by the following table. The numbers in the first column will be found in the preceding table, the first of each pair being the residue from the first portions milked, the second from the last, with their respective quantities soluble in ether (fat, &c.), and insoluble (casein, &c.).

Residue in 100 pts. Milk.	Soluble in Ether.	Insoluble in Ether.	Nitrogen in 100 pts. of that insoluble in Ether.	Salts in 100 pts. of the same Residue.
{ 9.90	1.80	8.10	...	...
{ 15.86	6.60	9.25	...	...
{ 9.90	0.80	9.10	...	...
{ 17.82	9.60	8.22	...	...
{ 10.41	1.07	9.34	6.36	0.71
{ 21.30	13.20	8.10	6.28	0.80
{ 12.00	3.30	8.70	5.88	0.75
{ 21.20	13.10	8.10	6.09	0.84
{ 13.60	5.23	8.37	...	...
{ 18.50	10.70	7.80	...	...
{ 17.19	9.70	7.49	...	...
{ 16.93	8.60	8.33	6.69	1.11
{ 11.01	2.20	8.81	5.32	...
{ 17.63	9.70	7.93	6.26	0.74
{ 13.20	4.40	8.80	6.42	0.63
{ 17.50	9.10	8.40	5.70	0.70
{ 13.15	4.30	8.85	5.96	...
{ 17.29	8.80	8.49	...	...
{ 14.60	7.20	7.40	...	...
{ 13.33	7.10	6.23	...	...
{ 15.28	4.90	10.38	...	...
{ 14.73	5.10	9.63	...	...
{ 12.84	4.90	7.94	...	...
{ 13.08	4.30	8.78	...	...
{ 9.62	1.22	8.40	6.34	0.75
{ 19.07	11.20	7.87	6.11	0.74
{ 14.37	5.90	8.47	5.92	0.77
{ 18.93	10.50	8.43	6.00	0.77



It appears from the foregoing that it would be better for the farmer to reserve the last portions of milk for making butter, in order to obtain a larger yield from the same weight of milk; unless, indeed, all the milk obtained is employed for this purpose. The following experiments show this conclusively.

1. From the 21st to 28th Aug. 1843, 106,056 grm. of milk gave 4850 grm. butter, or 4.57 per cent. of the milk.
2. From the 6th to the 10th Sept., 62,415 grm. milk gave 2870 grm. butter, or  $4\frac{1}{2}$  per cent.
3. Milk collected from 27th Sept. to 3d Oct..... 79,025 grm.  
 Last portions of the milking, worked for  
     butter ..... 18,765 "  
     Amount of butter obtained..... 1,245 "  
     Or 6.63 per cent. of the milk employed.
4. Milk obtained from 4th to 7th Oct..... 42,835 "  
     Last portions of the milkings..... 8,565 "  
     Butter obtained..... 721 "  
     Or 7.53 per cent. of the milk used.
5. Milk obtained from 8th to 15th Oct. (inclusive) 85,850 "  
     Last portions of the milkings..... 12,495 "  
     Butter obtained..... 1,050 "  
     Or 8.4 per cent. of the milk used.

(Ann. de Chim. et de Phys. (3) xxv. 82-85. Abstr. in Ch. u. Ph. Centralbl. 1850.)



The first of these is the...  
The second is the...  
The third is the...  
The fourth is the...  
The fifth is the...  
The sixth is the...  
The seventh is the...  
The eighth is the...  
The ninth is the...  
The tenth is the...  
The eleventh is the...  
The twelfth is the...  
The thirteenth is the...  
The fourteenth is the...  
The fifteenth is the...  
The sixteenth is the...  
The seventeenth is the...  
The eighteenth is the...  
The nineteenth is the...  
The twentieth is the...  
The twenty-first is the...  
The twenty-second is the...  
The twenty-third is the...  
The twenty-fourth is the...  
The twenty-fifth is the...  
The twenty-sixth is the...  
The twenty-seventh is the...  
The twenty-eighth is the...  
The twenty-ninth is the...  
The thirtieth is the...  
The thirty-first is the...  
The thirty-second is the...  
The thirty-third is the...  
The thirty-fourth is the...  
The thirty-fifth is the...  
The thirty-sixth is the...  
The thirty-seventh is the...  
The thirty-eighth is the...  
The thirty-ninth is the...  
The fortieth is the...  
The forty-first is the...  
The forty-second is the...  
The forty-third is the...  
The forty-fourth is the...  
The forty-fifth is the...  
The forty-sixth is the...  
The forty-seventh is the...  
The forty-eighth is the...  
The forty-ninth is the...  
The fiftieth is the...  
The fifty-first is the...  
The fifty-second is the...  
The fifty-third is the...  
The fifty-fourth is the...  
The fifty-fifth is the...  
The fifty-sixth is the...  
The fifty-seventh is the...  
The fifty-eighth is the...  
The fifty-ninth is the...  
The sixtieth is the...  
The sixty-first is the...  
The sixty-second is the...  
The sixty-third is the...  
The sixty-fourth is the...  
The sixty-fifth is the...  
The sixty-sixth is the...  
The sixty-seventh is the...  
The sixty-eighth is the...  
The sixty-ninth is the...  
The seventieth is the...  
The seventy-first is the...  
The seventy-second is the...  
The seventy-third is the...  
The seventy-fourth is the...  
The seventy-fifth is the...  
The seventy-sixth is the...  
The seventy-seventh is the...  
The seventy-eighth is the...  
The seventy-ninth is the...  
The eightieth is the...  
The eighty-first is the...  
The eighty-second is the...  
The eighty-third is the...  
The eighty-fourth is the...  
The eighty-fifth is the...  
The eighty-sixth is the...  
The eighty-seventh is the...  
The eighty-eighth is the...  
The eighty-ninth is the...  
The ninetieth is the...  
The ninety-first is the...  
The ninety-second is the...  
The ninety-third is the...  
The ninety-fourth is the...  
The ninety-fifth is the...  
The ninety-sixth is the...  
The ninety-seventh is the...  
The ninety-eighth is the...  
The ninety-ninth is the...  
The hundredth is the...



# INDEX.

	PAGE
ADANSONIA DIGITATA, bark of.....	118
Adhesives .....	152-156
Alcoholic drink, its digestibility.....	187
Alcohol and water, spec. grav. of.....	181
Alcoholometry .....	181-182
Alizarin.....	134
Alkanet .....	137
Alloys .....	62-68
——, German silver.....	63
——, bronzes.....	64
——, speculum metal.....	64
——, malleable brass .....	64
—— for bearings.....	65
—— dentists .....	66
——, iron and zinc.....	67
Alum .....	102
Amalgam for dentists.....	66
Amalgamated zinc.....	71
Amidulin.....	172
Antimony, freed from arsenic.....	53
——, oxide of .....	106
——, pure.....	116
——, sulphuret of, and sodium.....	116
Arts, definition of the.....	9
—— chemical force and agents in the .....	10
—— tabular view of the.....	16
Artificial brilliants and gems.....	28
—— marble and stone.....	37
Arseniate and stannate of soda.....	131
Arsenic, its diffusion.....	45, 51
Asphalt pavement, &c.....	37
Ashes of plants.....	200
—— pine wood.....	201
—— coffee .....	201
Atmosphere, carbonic acid and ammonia in the.....	192
Atropin.....	121
Aventurine glass.....	26
BAR IRON, content of carbon in.....	42
—— from cast-iron.....	43
Benzole .....	125



	PAGE
Biotechnics .....	191-205
Bismuth .....	53
Blast furnace, portable .....	20
— gases .....	40
— deposit in .....	41
Black dye, for felt .....	142
Bleaching .....	129
—, oxidation by .....	130
— sponge .....	130
— bristles .....	131
Blue, steam .....	142
—, Prussian, for calico .....	142
Borate of copper, a pigment .....	104
Bohemian glass, composition of .....	26
Brass, malleable .....	64
— with iron .....	67
Bristles, bleached .....	131
Bronzes, analysis of .....	64
Bronzing and brassing .....	82
Burning fluids .....	170
Butyric ether .....	183
Butter, tested for casein .....	189
—, yield of .....	203-205
 CALORICS .....	 11-25
Calistics .....	13
Candles of fat and rosin .....	161
Caoutchouc .....	148
Carbon, reduced in the wet way .....	70
Carbonic oxide, preparation of .....	39
Carmine .....	136
Casein in butter .....	189
—, decomposition of .....	190
Castoreum Canadense .....	164
Cast-iron, carbon in .....	42
— changed to bar .....	43
— steel .....	44
Castings, malleable .....	43
— cleaned .....	68
Cedron .....	120
Cement for pottery and glass .....	33
— steam joints .....	38
Chandlery .....	160
Charcoal for gunpowder .....	23
Cheese, decomposition of .....	190
Chemics .....	12, 91
Chemicals and pharmaceuticals .....	112-126
Chickory coffee .....	186



	PAGE
Chlorine, preparation and determination of.....	114
Chloride of lime.....	100
——— iodine .....	114
Chlorate of potassa.....	101
Chloroform .....	122
Chrome, oxide of.....	112
Chromates, manufacture of .....	111
———, double salts.....	112
Chromic acid, preparation of.....	116
Chromate of lead (dye).....	141
Chrome dyes .....	141
Cinnabar.....	51
Cinchonin.....	117
Clay wares, pottery, &c.....	29-33
Coal .....	18-20
—— gas.....	166-167
Cobalt and nickel.....	62
Cochineal .....	136
Cocoanut oil.....	157
Coffee, chickory.....	186
Coke, its hardness.....	28
Colored glass.....	26
Color printing .....	142-143
Collodion.....	124
Combustion prevented and extinguished.....	24
Copaiva balsam.....	152
Copal varnish.....	153
Copper, diffusion of.....	45
——, alkalimetric test for.....	46
——, ores, new mode of reduction .....	47
——, phosphorus in.....	48
——, action of salt water on.....	49
—— on iron.....	48
—— precipitated .....	80
——, sulphuret of, precipitated.....	80
——, borate of, a pigment.....	104
——, blue sulphuret of.....	104
——, nitrate of.....	131
—— pyrophosphate of, for color printing.....	143
Coppering iron, glass, &c.....	80
Copperas purified and preserved.....	103
Cotton and linen, distinguished from each other.....	128
——, tanned .....	129
Corn meal in wheat flour.....	187
Crayon daguerreotype.....	88
Cream and milk preserved.....	189
Cudbear .....	137
Cyanide of potassium, solution of metals in .....	70



	PAGE
DAGUERRETYPE.....	87
Dammara resin.....	153
Decomposition of solutions by charcoal.....	92, 94
Diamond carbon.....	28
Dilatometer .....	182
Deodorizing excrements.....	200
Distilled liquor.....	182
EBULLIOSCOPE .....	181
Emery .....	28
——— paper.....	155
Enamel for porcelain.....	33
Enamelled iron.....	68
Erythrose .....	136
Essential oils.....	163
Etching and engraving.....	84
Ether, butyric.....	183
Excrements, composition of.....	198-199
——— deodorized.....	200
FÆCES .....	198
Fermentation.....	179-184
Ferment, action on sugar.....	180
Filtration through charcoal.....	92-94
——— cotton.....	178
Fire extinguisher.....	25
——— clay .....	30
Flax and hemp.....	126
Flux for porcelain colors.....	31
Fousel oil, removed.....	182
Fruit, ripening of.....	191
Fuel.....	17-20
——— and furnaces.....	11-21
Furnaces, kinds of.....	17
GALLIC ACID.....	122
Galvanoplastics .....	70-83
Galvanic gilding and silvering.....	76, 77
——— coppering.....	81
Garancin.....	134
Gas for illumination .....	165
——, purified.....	167
——, naphthalized.....	168
—— lime .....	168
Gems, artificial .....	28
German silver, analysis of.....	63
Gilding on iron and steel.....	73
——— watch wheels.....	74



	PAGE
Githagin .....	120
Glass, optical, Bohemian.....	26
—, aventurine .....	26
—, ruby, hæmatinone.....	27
— brilliants.....	28
—, platinized.....	79
—, coppered .....	80
— cement .....	155
Glue cement.....	155
Gold, California, analysis of.....	58
—, extracted from ores.....	59
—, increased production in 1850.....	59
—, parting .....	53
— by sulphuric acid .....	56
—, toughened .....	60
— alloys.....	66-68
— plating.....	71-78
—, oxide of.....	71
— and silver, recovered from cyanide solutions.....	78
— lacquer .....	153
Green dye from chrome.....	141
Gums, bleached.....	173
Gun cotton, its danger.....	22
—, composition of.....	23
Gunpowder, new composition.....	22
Guttapercha.....	150
Gypsum.....	36
HAIR VARNISH.....	147
Hæmatinone .....	27
Hemp and flax.....	127
Honey, analysis and purification of.....	175
Horse-hair, dyed.....	147
— chestnut, as food.....	187
Horn, dyed.....	147
Hydrated silicic acid.....	28
Hydraulic cement.....	34-36
Hydriodic acid.....	115
Hydroplastics .....	33-38
Hydrometallurgy.....	69-90
Hydrogen for illumination.....	169
Hyposulphite of soda.....	86
Ice, artificially made .....	189
Illumination .....	165-171
Indigo, tested .....	138
— dye.....	140
—, white discharge on.....	142



	PAGE
Inks, indelible and printing.....	143, 144
Iodine, extraction of.....	114
——, photographic use of .....	86
——, chloride of.....	114
Iodohydric acid.....	115
Iodide of potassium on lead .....	115
Iron ores and metal.....	40
——, vanadium and arsenic in.....	41
——, alkalimetric test of.....	41
—— reduced in retorts.....	43
——, cast, steel, and bar.....	42-45
——, and bar, soldered.....	69
—— protected from rust.....	42
——, coppered.....	48
——, enamelled .....	68
——, persulphate of.....	131
Ivory, hardened, softened, etched, &c.....	148
KAMPTULICON .....	150
LACTOMETRY.....	202
Lacquers.....	153, 154
Lead, quantity produced in Great Britain.....	49
——, alkalimetric test for.....	49
——, reduction in the wet way .....	83
—— pipe, influence of water on.....	185
—— pigments .....	108
—— mordants .....	132
Leading copper and iron.....	83
Leather varnish.....	154
Lemons, oil of.....	128
Light, action on starch and iodide of lead.....	86
Linen distinguished from cotton .....	128
—— and cotton, tanned.....	129
Linseed oil decolorized.....	159
Lubricating oil.....	159
MADDER.....	133-136
Malt liquors, ashes of.....	184
Manganese vitriol.....	104
Manures, mineral, influence on plants.....	193
——, organic .....	198
Meat, cooking.....	187
Mercury ore.....	51
——, purification of.....	51
—— distilled by steam.....	52
——, black sulphuret of.....	118
Metallurgy .....	12, 39-90



	PAGE
Milk preserved.....	189
Mordants.....	131
——, new .....	133
NICKEL AND COBALT.....	62
—— alloys.....	63
Niello work.....	84
Nitre.....	102
Nitric acid, anhydrous.....	102
Nitrates.....	115
Nutrition, index of.....	187
OENANTHIN .....	120
Oil, cocoanut.....	158
——, whale, bleached.....	158
—— filter.....	159
——, lubricating.....	159
——, fat, tested .....	160
—— varnish.....	154
Oily acids, recovered.....	162
Oils, essential.....	163
Oleics.....	14, 157-171
Olive dye, from chrome.....	141
Opium, test for.....	119
Orchil.....	137-140
Oxygen, pure.....	24
Ozone .....	130
PALLADIUM, extraction of.....	62
Papaverin .....	119
Paper, improved process of making.....	144
——, bleached, water-proof, &c.....	145
Paraguay tea .....	186
Parting by sulphuric acid.....	56
—— nitric acid .....	57
Pectin, pectic acid, &c.....	191
Perfumery.....	162
Pharmaceutics and chemicals.....	113-126
Phosphatometry .....	197
Phosphate of lime in basaltic rocks .....	195
——, composition of.....	196
——, solubility of.....	196
——, acid salt.....	197
—— magnesia and ammonia.....	197
Photography.....	85-90
—— on glass.....	89
Photographic paper.....	87
Photogenic glasses.....	89



	PAGE
Plastics .....	12, 26-38
Plaster boiled by steam .....	36
——, hardened .....	37, 38
Platinizing glass, &c. ....	79
Platinoid metals .....	61
Platinum sand, solution of .....	61
—— alloys .....	66
Plating by dipping .....	72
Porcelain, structure and composition of .....	30
——, colors for .....	32, 33
—— cement .....	155
Portable blast furnace .....	20
Pottery .....	29-33
Potash, new source of .....	101
—— tested for soda .....	101
Preservation of food .....	189
Printing ink .....	144
Prussiate of potash, yellow and red .....	109, 110
——, red .....	140
Prussian blue, for calico .....	142
Prussic acid, anhydrous .....	121
Pungernite .....	18
Pyrotechny .....	22-25
Pyrometallurgy .....	40-69
Pyrotartaric acid .....	121
QUARTATION .....	57
Quinin and quinoidin .....	117
RED PRUSSIATE OF POTASH .....	140
Reflectors .....	171
Resin, Dammara .....	152
Reverberatory furnace .....	20
Rhubarb, red dye from .....	136
Rocks, disintegration of, to form soils .....	195
Rosin, or common resin .....	152
—— gas .....	166
Roses, oil of .....	164
Ruby glass .....	27
Rubiacin and rubiacic acid .....	134
Rue, oil of .....	163
SALT, common .....	97
——, as manure .....	193
Saltpeter .....	102
Sand paper .....	155
Sandal wood .....	164
Saponification .....	162-165



	PAGE
Sea-water purified for drinking.....	184
Semivitrification.....	29-33
Sheet fabrics, &c.....	144-152
Shot .....	49
Silver, extraction from ores.....	54
——, chloride of, solubility.....	55
——, ———, reduction.....	55, 57
——, cleaned .....	58
Silvering .....	72-78
—— glass, for ornament.....	28
—— mirrors.....	74
Sitapsics .....	14, 172-190
Slags of furnaces for cement .....	36
Soap .....	162
——, recovered.....	140
Soda ash, manufacture of.....	98
——, bicarbonate of, tested .....	100
Soils, from disintegration of rocks.....	195
Soldering salt .....	69
—— cast and bar iron.....	69
Sooranjee .....	139
Solution and filtration.....	92
Speculum metal.....	64
Sponge, bleached.....	130
Starch .....	172
Stannate of soda.....	132
Stearic acid.....	158
Stearin .....	160
Steam blue.....	142
—— cement .....	155
Steel, content of carbon.....	42
—— from cast-iron.....	44
—— bar-iron.....	45
Stone, artificial.....	37
Strychnin .....	119
Succinic acid.....	122
Sugar, tests for.....	173
——, refined .....	175
—— filter.....	178, 179
——, fermented .....	180
Sulphur and sulphuric acid.....	94
Sulphuric acid and water, densities of.....	96
——, new process for .....	97
Sulphurous acid, crystallized.....	97
Sulphantimoniate of sodium.....	116
TANNING.....	145
Tannin .....	146



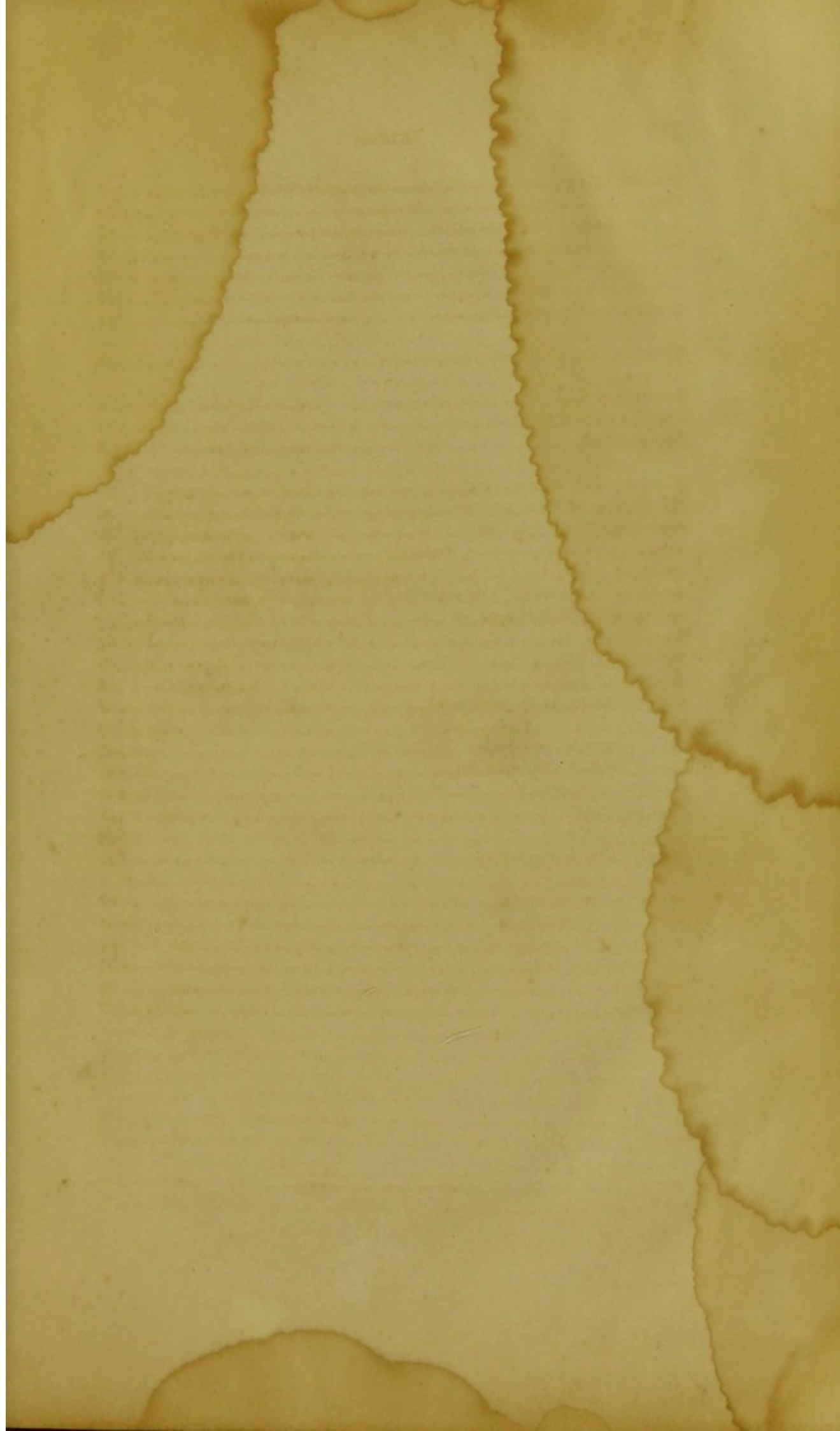
	PAGE
Tea, Paraguay.....	186
Thein.....	120
Tin, analysis of metallic.....	50
— plate .....	51
—, alloys of.....	64
—, compounds of.....	181-182
Tungsten and copper alloy.....	65
ULTRAMARINE, artificial.....	113
VARNISHES .....	153-155
Ventilation and warming.....	21
Vitrification.....	26-29
WARMING AND VENTILATION.....	21
Waste gases of blast furnaces.....	40
Water, for manufacturing.....	91
—, tested.....	91
—, as a beverage.....	184
—, from sea-water.....	184
—, action on lead pipe.....	185
Wax.....	161
Welding powder.....	69
Whale oil.....	158
Wheat flour tested for corn meal.....	187
White lead.....	108
Wine, sulphuric acid in.....	183
—, effect of oak casks on.....	183
—, sour, sweetened.....	184
Wongshy .....	139
YELLOW DYE, from chrome.....	141
ZINC-ORES in the United States.....	51
— and copper alloys.....	63-64
— and iron .....	67
—, amalgamated.....	71
Zincking .....	83
Zinc-white .....	105-107

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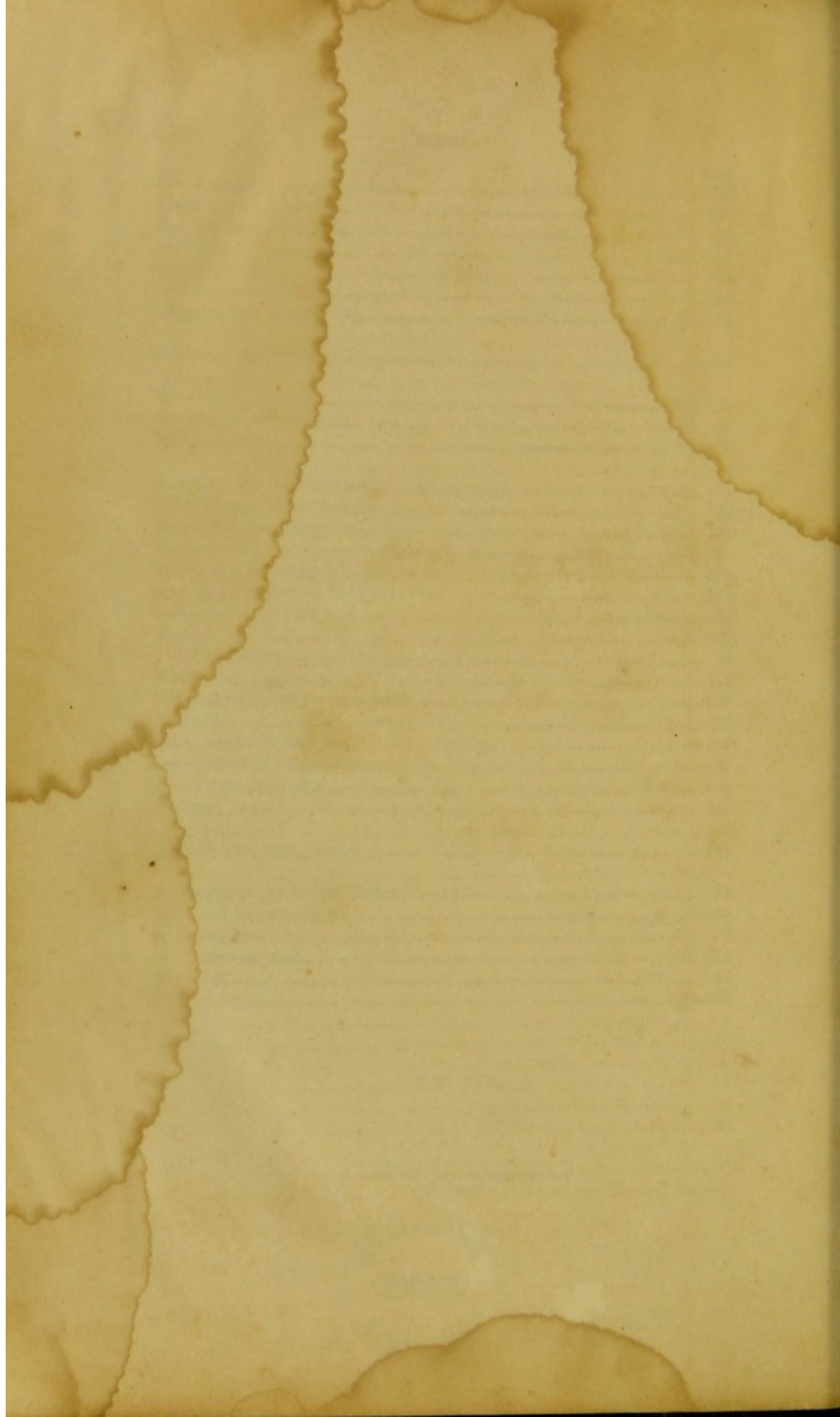
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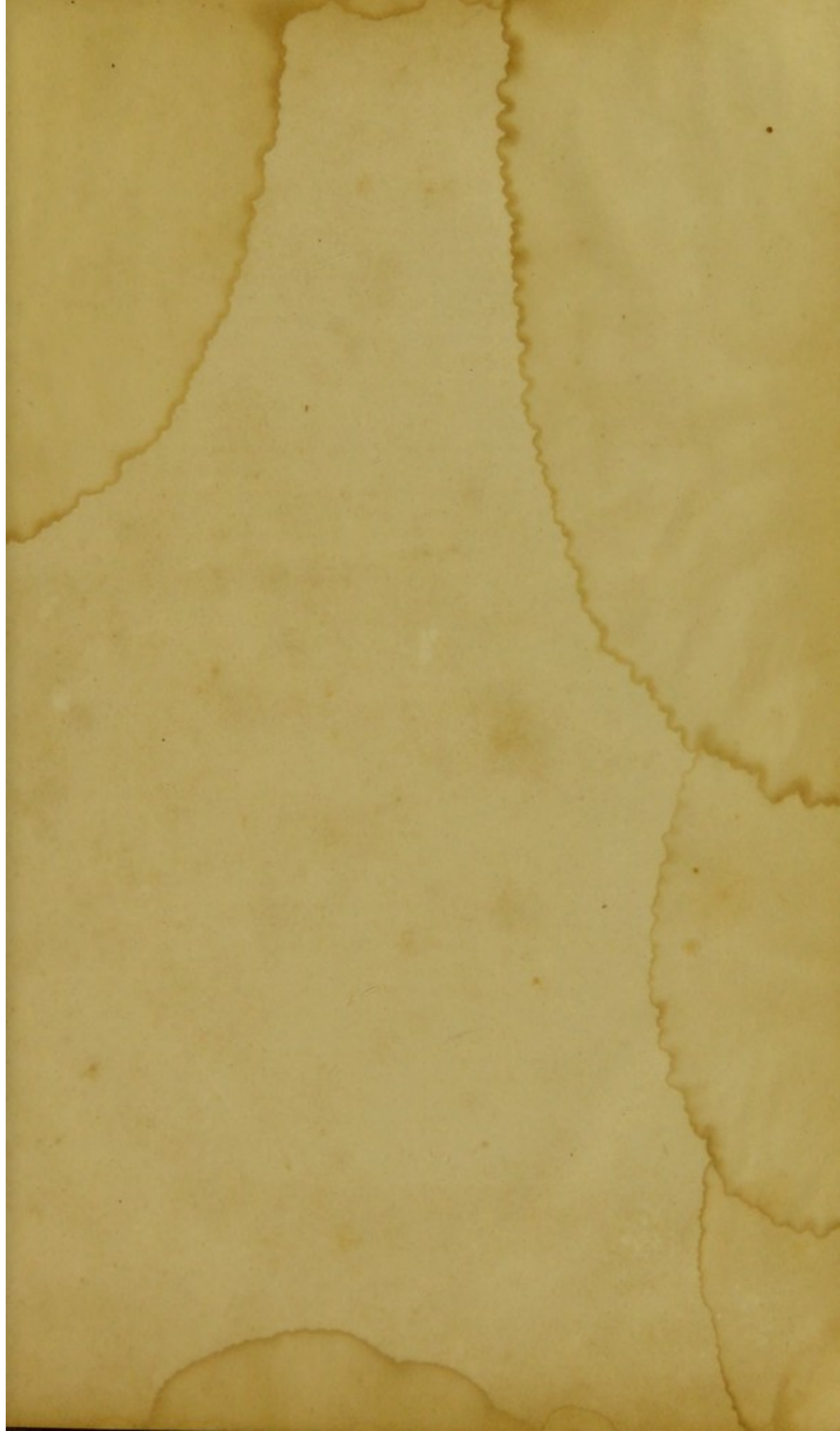














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