to the extent of about 25 per cent.; it is then carefully desiccated either in iron pots or in a muffle furnace so as to expel all the moisture, sulphurous acid, and hydrocarbons, and afterwards it is carefully stored away in air-tight iron boxes ready to be used in the distillation.

3. *Phosphorus Retorts and Furnaces with description of the Distillation and Condensation.*—The distillation is carried out in small bottle-shaped retorts made of the best weathered and prepared Stourbridge fire-clay; these retorts or pipes are about 3 ft. long by 11 in. external diameter—the clay being about 1 in. thick.

The retorts are placed in a furnace something like a Belgian zinc furnace in construction, but having only two tiers of retorts, each row being placed back to back with their narrow mouths projecting an inch or so through the brickwork. There are 28 retorts in one furnace, that is to say—taking one side of the furnace and considering it for a moment—there are in the first tier seven retorts and directly above these there are another seven, making 14 retorts which, as explained, project slightly through the side of the furnace. The other side of the furnace is similarly equipped.

The mouths of the retorts are connected to the condensers by 2-in. malleable iron or copper pipes which are luted with clay joints both to the retort and to the condenser.

Hot water is used in the condensing trough, so that whenever the phosphorus is condensed it fuses and runs down by gravitation to the lower end and may then be lifted out conveniently by a ladle.

Each retort holds between 20 and 30 pounds weight of phosphorus mixture and yields up the phosphorus existing in the free uncombined phosphoric acid in about 15 hours.

Whenever the distillation is completed the 2-in. pipes are disconnected from the retorts and the residue is rapidly withdrawn and the bench of retorts again recharged, the heat being steadily maintained.

Should a retort be cracked or fused either during the distillation or at charging, any phosphorus mixture it may contain is withdrawn, the dampers are closed and the retort removed from the furnace; a new retort, heated in an adjoining kiln to the required temperature, is substituted and all proceeds as before.

The crude phosphorus thus obtained is dark mahogany-brown in colour, as may be observed in the large specimen of this substance placed before you. It contains a good deal of impurity.

4. *Refining and Packing.*—The crude phosphorus is fused under water in a lead-lined circular tank heated by lead coils for high-pressure steam or steam jacketed. As much water as can safely be decanted off the surface of the crude phosphorus is removed and about 4 per cent. of bichromate of potash (on the weight of the crude phosphorus), is added in solution. An agitator with which the vessel is provided is set in motion and is continued in motion during the refining. After stirring for half an hour with the solution of bichrome about the same weight of oil of vitriol is added; in this way chromic acid is formed which oxidises the lower oxides of phosphorus and leaves the element pure and nearly colourless.

Another method of refining, and one more suitable under certain conditions, is to redistil the crude phosphorus in an iron retort. The phosphorus distils over rapidly and at a comparatively low temperature. A combination of these two methods is in some ways desirable.

The refined phosphorus is next moulded into "wedges" or "sticks." The "wedges" are made by melting the phosphorus and transferring it into circular tin dishes, 10 in. diameter by 4 in. deep, and when filled a star-shaped mould is introduced into each, which divides the circle into 10 wedge-shaped pieces, suitable for packing into tin cases. After this cold water is introduced, which soon solidifies the phosphorus and admits of its easy removal.

DISCUSSION.

Dr. DONNIX asked how the inaccuracy of the text-book statement regarding the manufacture of phosphorus (which was so very explicit) was to be accounted for. Had the

statement no real foundation in fact, and who was the author of it? Was the process which Dr. Readman had described the one carried out by the very few phosphorus manufacturers in the country?

The CHAIRMAN asked if it was an essential feature of the process that the retorts should be as small as had been stated? He thought it would have added further to the interest of the paper if some idea of the cost had been given.

Dr. READMAN, in reply, said that it was not to the interest of manufacturers to correct mis-statements in text-books. With reference to the smallness of the retorts, in his experiments he commenced with a gas retort, but found it to be an entire failure, and he was of opinion that it was impossible to make a retort to stand the necessary heat more than 4 ft. long. As to the cost, he did not think it would be of interest to give it, but perhaps in his concluding paper he would say something in that connexion.

MOISTURE IN PAPER PULP.

By G. H. GEMMELL, F.C.S., F.I.C.

Straw and wood pulp as imported into this country from Germany and Norway—in bales of from 2 to 4 cwt. each—contains a high percentage of water, varying from 40 to 60 per cent., but the price of the material is usually based on the amount of air-dried substance present. The amount of moisture, however, in an air-dried pulp varies within considerable limits, according as the fibre is derived from wood or straw, and also according as it is prepared by mechanical means only, or by the soda, bisulphite, or other chemical process. It is also known that variations of temperature and humidity of the atmosphere causes a considerable change in this figure. In the paper trade there is no fixed standard adopted, some pulp manufacturers selling their material on the basis that it contains 12 per cent. of moisture when air-dry, others only 10 per cent., while many paper-makers affirm that 8 to 9 per cent. should be the utmost limit allowable; nor is there a uniform method adopted for calculating the weight of air-dried substance from the absolutely dry pulp, hence discrepancies and disputes often arise between buyer and seller. The paper-maker who tests his own pulp usually adds 10 or 12 per cent., as the case may be, to the percentage of absolutely dry pulp found, and this method of calculation is apparently acquiesced in by some of the manufacturers of pulp, but it is obviously incorrect. A sample of pulp containing, say, 60 per cent. of moisture and 40 per cent. of absolutely dry pulp, would by this method be said to contain 44 per cent. of air-dry material, but the correct method of stating is that if 90 of absolutely dry pulp becomes 100 air-dried, what will 40 absolutely dry become, this gives 44·44 per cent. as the correct figure. I have made a few experiments with a view of ascertaining what should be the average amount of moisture allowed for in an air-dried pulp, and though incomplete, think the results may be of interest to members of this Society. A sample of straw pulp containing 60 per cent. of water was allowed to remain exposed to the atmosphere, at the ordinary temperature of the laboratory, for 14 days, being turned over daily to expose fresh surfaces. A weighed quantity was then dried in a water oven, till constant in weight. 421 grms. of this air-dried pulp became 377 grms. of absolutely dry pulp, or a loss of 44 grms., which is equivalent to 11·67 per cent. of moisture, calculated from the dry pulp. Another sample of this same pulp, first made absolutely dry, was also exposed during the same 14 days, and was again re-dried. 1,102 grms. of the air-dried pulp became 1,017 grms. of absolutely dry, a loss of 85 grms., equivalent to 8·35 per cent. of moisture

Here we find that two samples of the same pulp, one wet and the other dry, do not become equal in the percentage of moisture after 14 days' exposure, but differ by 3.32 per cent., though at the end of the first seven days there was no perceptible difference to the touch in the wetness of the samples.

A similar trial was made with a sample of wood pulp containing 55 per cent. of moisture, and side by side with some of the same pulp previously made absolutely dry. At the end of five days there was no perceptible difference in the wetness of each sample, but they were kept exposed for five days more and a portion of each was then dried. The previously wet pulp by that time contained 13.6 per cent. of water, the previously dry pulp 10.6 per cent., a difference of 3 per cent. The remaining portions of these samples were exposed for a further seven days and then dried; the wet pulp then contained 12.2 per cent. moisture, and the dry pulp 10.4 per cent., a difference of 1.8 per cent. The moisture in the previously dry pulp thus remained practically constant while that of the wet sample more nearly approached that of the dried sample, and it was apparently only a question of being exposed for a sufficient length of time for the percentage of water to be equal in each. The weather during these trials was generally damp and wet, hence the results are probably above rather than below the average, and therefore 10 per cent. of moisture does not appear to be an unreasonable allowance to make for air dried pulp. In connection with this matter it may be of interest to note that the "Scotsman" and "Dispatch" newspapers contained when air dried 9.4 and 9.1 per cent. of moisture respectively, and two different makes of note paper 7.7 and 7.4 per cent. To obtain an average sample of the pulp for analysis is of course of the utmost importance, but owing to the nature of the material and the method of packing in bales is one of no little difficulty. 100 tons of pulp represent 1,000 bales, and to open 10 per cent. of these would be out of the question, and I have generally found that the paper-maker and seller agree that 10 to 15 bales in all are sufficient to open. The sample should also be taken as early as possible after the arrival of the consignment, and it might be advisable in some cases to weigh each bale before opening to remove the sample, though it is scarcely within the province of the chemist to do so, and from the figure thus obtained the paper-maker can calculate the amount of moisture originally in the bale. Thus suppose 10 bales invoiced at 3 cwt. each were weighed before taking the sample and were found to average 2 cwt. 3 qrs. or a total of 1 ton 7 cwt. 2 qrs., this is a total loss in weight of 2 cwt. 2 qrs. If on testing the sample drawn from these bales 55 per cent. of moisture is found, then the actual weight of dry pulp in the 10 bales would be $\frac{45}{100}$ of 1 ton 7 cwt. 2 qrs. = 12 cwt. 1 qr. 14 lb., as the bales originally weighed 30 cwt. the amount of dry pulp then present was—

$$\frac{12 \text{ cwt. } 1 \text{ qr. } 14 \text{ lb.} \times 100}{30 \text{ cwt.}} = 41.08 \text{ per cent.}$$

It has been suggested that to obtain a sample a hollow steel punch should be driven through the bale, and the portion thus obtained transferred at once to a weighing bottle. Another method is to take a piece of the pulp from each sheet in the bale, but I think both these methods open to objection. The most satisfactory method is to open the bale to the middle, a sharp chisel being the best tool to use. Three strips 2 or 3 inches wide are then taken in every case right across the bale, from end to end. The first strip is taken from the external portion of the bale three or four layers deep, the second strip midway between the external and middle portions, and the third strip from the middle. 30 to 40 strips in all are thus taken. These are rapidly torn to pieces of about 1 in. square and thoroughly mixed, and from this a sample weighing 2 to 3 lb. removed to the laboratory for the analysis. The sample should be securely tied in oiled paper—this being more satisfactory than bottles—the loss of moisture not being more than a fraction of a per cent. In testing for moisture, weigh out 4,000 to 5,000 grains in a large beaker, dry for 22 hours in a water bath at 100° C. and weigh, and then again for a further two hours or till the weight is constant,

DISCUSSION.

Mr. IRVINE asked if the wood or straw pulp was sold on an absolutely dry basis, or as containing such a percentage of moisture as these fibrous materials attract to themselves? The reason he asked that question was, because he once knew a very serious lawsuit that arose over a somewhat similar case.

The CHAIRMAN asked how far in a matter of that kind atmospheric moisture made a difference? He noticed that certain kinds of writing paper took the ink differently on a dry day from a wet day.

Mr. GEMMELL said, in reply to Mr. Irvine, that the paper was always sold as containing a certain percentage of moisture. That basis varied. The Germans said that the paper absorbed 12 per cent., others said only 10 per cent., while paper-makers generally allowed 7, 8, or 9 per cent., at the most. As to the Chairman's question, the kind of weather made little difference in the amount of moisture absorbed, perhaps not more than 1 per cent.

Journal and Patent* Literature.

I.—GENERAL PLANT, APPARATUS, AND MACHINERY.

PATENTS.

Improvements in Refrigerating and Freezing Apparatus.
H. Puplett and J. L. Rigg, London. Eng. Pat. 507,
January 11, 1889. 8d.

This invention relates to improvements in that class of refrigerating apparatus in which a liquid is heated in one vessel, the gas or vapour being driven off into a second vessel, in which it liquefies by accumulated pressure and subsequent cooling. The first-named vessel being then cooled, and the pressure thereby reduced, the liquefied gas returns in the gaseous form, to assume which, it abstracts heat from the liquid surrounding the second vessel, being itself absorbed again by the mother-liquor remaining from the previous operation in the first vessel.

According to the inventors, an apparatus of this kind constructed in the ordinary way is liable to the danger of explosion from over-heating, to avoid which and to raise the general efficiency, they, instead of employing a liquid direct, use gas or vapour from an anhydrous liquid which readily gasifies, such as carbonic anhydride, ammonia, or ether. They next introduce into the first vessel, as an absorbent, any substance which does not evaporate, but possesses the property of readily absorbing the gas or vapour, such as charcoal, calcined clay or calcium chloride. They also prefer to make the first vessel in duplicate for working alternately,

* Any of these specifications may be obtained by post, by remitting the cost price, *plus* postage, to Mr. H. Reader Luck, Comptroller of the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. The amount of postage may be calculated as follows:—

If the price does not exceed 8d.	1d.
Above 8d., and not exceeding 1s. 6d.	1d.
" 1s. 6d., " " 2s. 4d.	1½d.
" 2s. 4d., " " 3s. 4d.	2d.

one being heated whilst the other is cooled. The specification is accompanied with one sheet of drawings on which two varieties of the improved apparatus are illustrated.—B.

Improved Means for Preventing Ignition, and Retarding Combustion. A. V. Newton, London. From A. Nobel, Paris, France. Eng. Pat. 568, January 11, 1889. 8d.

THE main object of this invention is to prevent the flame arising from the ignition of blasting charges in mines from communicating itself to the surrounding atmosphere and thereby igniting any fire-damp or combustible matters that may be suspended therein. It can also be applied to the protection of buildings from fire. To effect this, the air of the mine or building is saturated with water by means of a fine spray, thus rendering it incapable of supporting combustion, though mixed with volatile combustible liquids such as benzine (petroleum spirit), ether or bisulphide of carbon.

"Provided the dispersion is fine enough, no fire can be fed by atmospheric air holding its own weight of water in suspension."—E. S.

Improvements in the Method of and Means for Concentrating or Evaporating and Distilling Solutions for the Production of Dyes and other Bodies. J. Frost, Moldgreen. Eng. Pat. 1803, February 1, 1889. 8d.

THE improvements consist in the methods of heating the solutions and chemicals, and of promoting rapid concentration and evaporation, in order to economise time and labour, to prevent waste and to lessen the amount of heat required. A vertical coil formed of pipes of any suitable material has thin inclined plates fixed along each side of the pipes. The coil being heated by the passage of steam through it, the solution to be concentrated is allowed to flow on to the top of the first pipe, from thence on to those below in succession, and becoming gradually heated is "thrown off the pipes on to the thin plates, in the form of spray." The solution is thereby rapidly concentrated and ultimately falls into a receiver. Some modifications of the apparatus are shown on the two sheets of drawings attached to the specification. —E. S.

Improved Means and Apparatus for Softening and Purifying Water, and for the Removal and Prevention of Incrustation in Steam and other Boilers. E. Harrison, London. Eng. Pat. 1847, February 1, 1889. 8d.

A NUMBER of perforated central plates of copper and zinc of any suitable shape are arranged alternately, and placed between larger outer plates of perforated zinc or meshed wire, which are kept apart by studs, the whole apparatus being threaded on a central spindle provided with a nut and thumbscrew at the lower end, and a hooked head at the upper end, for readier transportation. The outer plates are cut radially, and are turned up in a fan-shape, the lower tips of the arms "forming feet upon which the apparatus stands upon an insulated base in the boiler," the whole, when in use, "inducing and establishing galvanic attractive action under the influence, and by the agency of the heat of the boiling water; and the incrustation of fur, instead of being deposited on the boiler plates, as usual, is deposited upon the meshed wire, &c., from which it is readily removed."—E. S.

Improvements in or Pertaining to Funnels or Reservoirs for Liquids. H. G. Payne, London. Eng. Pat. 1891, February 2, 1889. 6d.

THE lower part of the conical head of the funnel is closed with a diaphragm, in which a hole is left, closed by a valve.

The opening and closing of the valve is governed by a float, which is suspended in the narrow neck of the funnel, and

is acted upon by the liquid rising in the lower vessel as it is being filled, thereby preventing an overflow.—B.

Separating Liquids of two different Densities. Sir B. Samuelson, Bart., Banbury. Eng. Pat. 3016, February 20, 1889. 6d.

THIS invention relates to certain improvements in apparatus for separating liquids of different densities, such as milk and cream, and has reference more particularly to the position of the inlet and the outlet openings for the liquids, and to their adjustment. For details, the specification and drawing must be consulted.—B.

Improvements relating to Distillation, and Apparatus therefor. B. Hoff, Jaroslau, Austria. Eng. Pat. 3468, February 26, 1889. 8d.

THIS invention relates to the distillation or refining of liquids which are composed of fluids of various boiling points, the object being to obtain the purified product or products as a result of one distillation only, by means of inexpensive apparatus and without the use of cooling water.

The improvements consist in exposing to a succession of condensing surfaces of regulated areas the mixed vapours rising from a liquid under treatment, whereby, according to the principle upon which the improvements are based, the gases are condensed in the order of the boiling points of the resulting liquids, those possessing higher boiling points being condensed first, and those with the lowest last. The apparatus may consist of a number of upright cylindrical vessels conveniently grouped together, each vessel provided with a division or false bottom, on which the condensing material is placed, such as pebbles, shingle, or other silicious matter. Pipes connect the vessels to convey the vapours from the lower part of one to the upper part of the succeeding vessel, suitable valves being provided for drawing off the condensed liquor from each. The following examples are given of the extent of condensing surface required in the treatment of various liquors:—

To separate ethyl ether in a pure state (boiling point, 35.5° C. or 96° F.) from other vapours formed during its manufacture, which vapours generally consist of alcohol (boiling point, 78.4° C. or 173° F.) and steam (100° C.), 900 square metres (9,690 sq. ft.) of condensing surface are required when dealing with a volume of 100 cub. m. (3,532 cub. ft.) of the mixed vapours.

To separate pure wood spirit from water and the empyreumatic oils, 1,200 sq. m. (12,916 sq. ft.) are needed. The same for chloroform.

To separate benzene from toluene and its other attendant gases, 3,000 sq. m. (32,292 sq. ft.).

For aqueous sulphuric acid only 400 sq. m. (4,305 sq. ft.).

To separate petroleum vapour from steam, 14 sq. m. (150 sq. ft.) are requisite when obtaining a distillate having a boiling point of 150° to 170° C. (302° to 338° F.) and 0.82 sp. gr.—B.

A "Boiler Composition," for the Cleansing and Prevention of Incrustation of Steam Boilers. J. Parsons, Newnham. Eng. Pat. 8583, May 23, 1889. 4d.

This is a mixture of coal-tar, various oils, soda-ash, soap and tallow, which requires to be painted over the inside of the boiler.

It is claimed that the composition will in time fill up the pores of the plates, and so render the inside of the boiler "smooth and glass-like," and prevent oxidation and incrustation.—D. A. S.

Improvements in Apparatus for Determining the Quantity of Moisture in Steam. G. H. Barrus, Reading, Mass., U.S.A. Eng. Pat. 10,521, June 28, 1889. 8d.

In this invention the determination of the total quantity of moisture contained in steam is carried out in two stages. In the first, the steam drawn from the main is made to deposit part of its moisture by gravitation in a vessel which is provided with water-gauge and draw-off cock, whence the resulting deposit is run off and weighed. In the second stage the partially dried steam passes a thermometer previous to reaching a small orifice through which it issues into the atmosphere, whilst a second thermometer records the temperature of the issuing steam. As all the moisture remaining in the steam after the first deposition is evaporated during expansion, the issuing steam becomes superheated or attains a higher temperature than that due only to its density under atmospheric pressure. The difference of temperature recorded in this manner gives a measure of the amount of moisture left in the steam before expansion, and this added to the weight of water withdrawn from the depositing chamber determines the percentage of moisture as compared with the whole weight of steam passed through the apparatus. Numerical examples are given in the specification.—B.

Improvements in Furnaces or Kilns for Burning Bone-Black. A. Weber, New York, U.S.A. Eng. Pat. 12,070, July 30, 1889. 1s. 3d.

The furnace or kiln is constructed on the regenerative system and heated by means of gas generated in a separate furnace. The raw bones are fed automatically by gravity from stationary hoppers to the vertical retorts of the kiln. The bone-black retorts are oval-shaped, made of refractory material, and provided at their upper end with cast-iron mouthpieces which are closed by covers communicating by means of cast-iron sockets with feed pipes which are also connected with bottom openings of hoppers placed above the kiln. To the kiln placed vertically below the retorts are attached air-tight coolers fitted with dampers at their lower end, which are operated automatically by suitable mechanism so as to discharge the bone-black in small quantities at suitable intervals of time, a corresponding quantity of raw bones being fed through the feed pipes into the upper ends of the retorts. The gases of distillation in the retorts are drawn off by means of an exhaustor, and after the liquid products of distillation have been separated therefrom, the gas is reconducted to the furnace and utilised in heating the retorts. The tar obtained is also burned in the furnace and adds to the economic results obtained in working the kiln.

—F. S.

Improvements in Apparatus for Condensing Vapours and Cooling Gases or Liquids. J. Popper, Vienna, Austria. Eng. Pat. 16,763, October 23, 1889. 6d.

THE improvements "relate to air condensers and cooling apparatus, in which air is used as the cooling medium, and the liquid to be cooled does not come into direct contact with the cooling air itself, but is contained in a closed vessel." For the mode in which this is effected the drawings accompanying the specification must be consulted. —E. S.

An Improved Instrument for Sampling or Gauging the Depth of Liquids in Tanks, Vats, or other Vessels. E. E. Horley and F. Sedgley, London. Eng. Pat. 17,275, October 31, 1889. 8d.

THE instrument consists of a glass tube open at both ends, and having a valve adapted to close against the lower end. This valve hangs below the tube whilst it is descending through the liquid, but on reaching the bottom of the tank the progress of the valve is stopped; the glass tube, suitably weighted, continues its descent until it comes in contact with the valve, when a spring-catch retains the latter against the lower end of the tube. The instrument can then be withdrawn, when the nature and depth of the lower stratum of fluid, however small, being visible through the glass tube, can be measured by a scale.—E. S.

II.—FUEL, GAS, AND LIGHT.

Wery's Apparatus for Heating Retort Furnaces. L. Brémont. Journal des Usines à Gaz, 1889, 153; Proc. Inst. Civil Eng. 99, 49.

THE cost of fuel for heating retort furnaces is a most important expense in the manufacture of gas. Various recuperative furnaces for utilising the waste heat are known, likewise the non-conducting coverings of Le Treust and others, besides other means that have been proposed for economising the fuel. It costs the Paris Gas Company 14½d. for fuel for producing 35,300 cub. ft. of gas, while the cost to many other companies is double that amount, and, in small works, the cost rises to as much as 9s. 7d. per 35,300 cub. ft. These differences may be partly due to variations in the price of the fuel; the coke being, in some places, valued at the selling price, while others calculate it at a uniform and conventional rate. However this may be, considerable variations do exist in the quantity of fuel used for heating the furnaces, even in the best managed works of similar sizes, and the differences become enormous if small works are compared with large ones. It is therefore desirable to find a simple and inexpensive means for economising fuel, applicable to all gasworks, and Wery's apparatus fulfils these conditions, effecting a saving of from 15 to 20 per cent. in the fuel.

On behalf of the Mechanical Arts Committee of the "Société d'Encouragement," Mr. Pihet has reported on Wery's smoke-consuming chimney, the principles of which are simply to mix a certain quantity of relatively cold air with the furnace gases in the chimney; this is effected by the application of the principle of Giffard's injector; the air mixes with the hot gases in the chimney, passing through a circular orifice, reduced in section as much as possible, and proportional to the chimney. The current of cold air surrounds the furnace gases in motion, mixes with them, lowers their temperature and diminishes the velocity of the draught. Without considering the theory of the principle, or determining whether similar results could be obtained by carefully regulating the dimensions of the exit orifice, Mr. Pihet found, from two carefully-made experiments, that the Wery process was efficacious both for smoke-consumption and economy of fuel. He experimented with a 12-h.p. portable engine and a tubular boiler without return flues or artificial draught. The consumption of smoke was perfect,

and the economy of fuel, with Wery's apparatus, for an equal amount of work, and for the same quantity of water evaporated, amounted to 23 per cent.

Other trials were made by Mr. De Bange, General Director of the old Cail manufactory at Paris, with 20-h.p. and 80-h.p. engines, and with puddling furnace and generator furnaces. Decided economy of fuel was found and also a sensible reduction in the time required for getting up steam. With the steam boilers the saving was about 20 per cent., and with the puddling furnaces, in addition to the economy of fuel, the quality of the iron was superior to that obtained before using the apparatus. Mr. De Bange also made a trial to determine the quantity of water evaporated per pound of coal, with and without the apparatus, and found that the steam produced per pound of coal was increased by 28 per cent. by the apparatus.

Trials were also made at Denain by Mr. Jubean with a puddling furnace on two steel ingots, each weighing about 4 tons, in two similar furnaces, the one with, and the other without the apparatus; these showed an economy of fuel of 16·79 per cent. in favour of the apparatus.

Other trials have also been made by Mr. J. Gaudry in the shops of the Compagnie Transatlantique, at Penhoet, which gave 10·2 to 10·7 lb. of water evaporated per pound of coal with the apparatus as compared with 7·8 lb. of water per pound of coal without it.

As regards gasworks, the Wery apparatus produces a similar effect to that of Le Treust, which creates an intermittent draught in the chimney and drives the products of combustion back into the furnace when the register is closed. With the Wery chimney, vacuum and pressure are alternately seen, according to the condition of the fuel. No machinery or steam is required. It can be fixed to existing chimneys, but the most convenient plan is to construct a brick foundation and place the apparatus on it, surrounded by a sheet-iron chimney. An apparatus and chimney of a total height of 30 ft., and the chimney 11½ in. diameter, was substituted for a brick chimney 62 ft. high and 35½ in. diameter; so that such large chimneys are not required, and the flames are not seen escaping at the top. At the small gasworks where it is in use, and where the dampers have to be closed each evening until the following morning, the heat is maintained and the furnace regains its ordinary temperature in half the usual time; there was also an economy of 16 per cent. in the fuel in the month of March, with intermittent working; but it will be easily understood that in winter, when the furnace is working regularly day and night, the economy would be considerably greater, the more so because the apparatus gives better results when the outer temperature is low. This was proved at the same works during a 12 days' trial in November last, when the saving in fuel was 28 per cent., as compared with the corresponding period of the preceding year. The Wery apparatus is of very simple construction, and requires only occasional cleaning when coal or tar are used for fuel. It is destined to become generally used in gasworks, as it will effect considerable economies which have not hitherto been realised by any other system.

Storage of Petroleum used as an Illuminant for Prussian Lighthouses. Zeits. für Bauwesen, 1889, 397, and Proc. Inst. Civil Eng. 99, 51.

PETROLEUM is almost exclusively used as the illuminant for lighthouses on the Prussian seaboard, and a description of the various special store-tanks is given, and their efficiency is considered; the principal ends kept in view being the avoidance of waste by leakage, and in drawing supplies, and maintaining a low temperature.

The tanks are of wrought iron, and generally of a size sufficient for storing a year's supply. Their shape is cylindrical, the larger ones of 3 ft. 3 in. diameter, 5 ft. high, constructed of ⅜-in. to ¾-in. plates for the sides, ½-in. to ⅝-in. for the cover, and ⅜-in. to ½-in. for the base, that which is of the main importance being an efficient closing of the joints.

They are made in four different manners, viz.: 1st, of single plates with double-riveted joints; 2nd, of the same,

but with caulked joints; 3rd, of the same, but with brazed joints; and, 4th, with a double skin, forming a water-jacket, with single riveting and caulked or brazed joints. The third-mentioned method is that found to be the most efficient, although expensive. One objection to the water-jacketed tanks is that in frosty weather the water has to be let off.

Diagrams are given showing the various forms of tanks, and of the special brickwork cellars in which they are placed, these being generally isolated from the other buildings. The tanks are fitted with glass gauges, and are filled by a hose passed through a trap in the roof of the cellar.

For comparison with the present improved method of storage, a return is given relating to various lighthouse stations under the old system, when the oil was drawn direct from the casks, and varied from 5·4 to 13·7 per cent.

A tabular statement is given of the number of tanks and their form of construction at each of the 17 lighthouse stations, the names of the makers, the cost, cubical content, cost per litre, and percentage of loss per annum now and formerly, the greatest loss quoted being reduced from 13·7 to 1·01 per cent.

Particulars are also given of the cost of construction of the cellars at six stations.

PATENTS.

Improved Methods of producing Combustible Gases and in Apparatus therefor. R. H. Thwaites, Liverpool. Eng. Pat. 16,970, November 22, 1888. 8d.

The gas distilled from coal in the ordinary way is caused to pass through a second retort containing incandescent coke, the residue from an earlier distillation. When gas has nearly ceased to be evolved, valves are reversed, and superheated steam is driven through both retorts, entering the second one first. Any heavy hydrocarbons that may have deposited in this second retort "are broken up, and re-arranged" by the superheated steam, which, both here and in the first retort, is itself decomposed, yielding a considerable quantity of water-gas before the temperature falls below the point required for this operation. The gas produced after the admission of the superheated steam may either be mixed with the ordinary coal-gas first obtained, or employed separately. In place of coke broken brick may be used in the second retort.—A. R. D.

Improvements in Apparatus for the Manufacture of Gas for Illuminating and other Purposes, which Improvements also render said Apparatus suitable for other Uses. F. J. Jones, Leek, and L. Alexander, London. Eng. Pat. 17,613, December 3, 1888. 8d.

The process consists essentially in effecting the distillation of the coal or other material at a comparatively low temperature (so that the benzene and other hydrocarbons of high illuminating power may not be decomposed) by causing the gaseous products of combustion from a furnace to pass through a stratum of coal, so that the said products will be mixed with the gas and tarry vapours and other hydrocarbons which distil off, and in then superheating this mixture of gases and vapours, whereby the volatile constituents are converted into a rich permanent gas whilst the excess of carbon is deposited.

The gas, instead of being generated under the pressure necessary to force it through the hydraulic main and being allowed to cool down immediately after leaving the retort as in the ordinary retort system, passes freely or under exhaustion from the distilling chamber (no hydraulic main being used), and is then immediately superheated, "the gas passing from the superheater directly to the purifiers" (unless it is required to be cooled down, which may advantageously be done by passing the gas through a regenerator) after which it is ready for consumption.

The improved apparatus wherein this process is carried into practical effect is described, and drawings forming part of the specification are given, which it is necessary to consult in order to clearly understand.—F. S.

Improvements in Apparatus for Utilising Liquid Hydrocarbon for Lighting and Heating Purposes. E. B. Hill, London. Eng. Pat., 17,869, December 6, 1888. 11d.

Liquid hydrocarbon is forced by compressed air from a reservoir into an annular vaporising chamber which surrounds, or is surrounded by, an annular passage for the vapour from the chamber to the burner. This passage surrounds, or is surrounded by, another passage for the supply of atmospheric air to the burner. The chimney either extends upwards through the centre of vaporising chamber, or surrounds the air passage, thus enclosing the whole arrangement. The vapour and air currents travelling downwards meet under the vaporising chamber to form an annular flame, having a downward direction, and curling either outwards or inwards, according to the disposition of the chimney. It will be seen that the heated products of combustion, passing away up the chimney, may be made to heat the air required to support combustion, and to assist in the vaporising of the hydrocarbon, though this is chiefly effected by the action of the flame on the lower surface of the vaporising chamber.

—A. R. D.

Improvements in Regenerative Kilns. E. Brook and J. J. Brook, Huddersfield. Eng. Pat. 18,451, December 18, 1888. 11d.

The kilns are preferably built in sets of not less than four. Overhead run a main gas passage and a hot air flue. The upper part of each kiln constitutes a combustion chamber, and below this the goods to be fired are placed upon a floor perforated to allow connexion either with the chimney draught or with the outer air. The connexions and damper arrangements are such that while, say No. 1 kiln is being heated by the internal combustion of gas with hot air supplied from the overhead passages, the products of combustion escape through the perforated floor, and may be made to heat other kilns on their passage to the chimney. When the firing of No. 1 is finished, air is drawn in through the perforated bottom, and, passing through the kiln, reaches the hot air flue above in a highly heated state. It is now available either for supporting combustion in a kiln in course of firing, or for drying and heating goods in another kiln.

—A. R. D.

Improvements in the Production of Water-Gas and in obtaining Hydrogen, Carbonic Oxide, or Carbonic Acid, each separately therefrom, also obtaining certain By-products. C. F. Claus, London. Eng. Pat. 50, January 1, 1889. 8d.

THOUGH "water-gas" produced according to any method may be treated by this process for the separate recovery of its constituent gases, the patentee prefers to prepare it by passing superheated steam through a layer of fuel, the relative proportions of carbonic oxide, carbonic acid, hydrogen and ammonia produced depending upon the depth of the layer of fuel and upon the temperature of the steam. By this means a continuous current of "water-gas" can be obtained without the use of an air-blast and the previous ignition of the fuel.

The gases, after cooling, are scrubbed or washed with ammonia in order to recover the carbonic acid (ammonia being also retained) as sequicarbonate of ammonium, and then passed over oxide of iron after previously heating the gases to a temperature (400°—500° C.) at which oxide of iron is reduced by hydrogen but not by carbonic oxide. The carbonic oxide passes on to a gas-holder, while the hydrogen unites with the oxygen and leaves spongy metallic iron from which hydrogen is regenerated by means of superheated steam. Suitable apparatus is described for the continuous working of the process; for instance, the carbonic acid is driven off in a heating apparatus from its solution in ammonia, the ammonia being returned to the scrubbers for repeated use, while the carbonic acid, after passing through a tower containing sulphuric acid to retain any ammonia, and through an oxide of iron purifier, is led to the gas-holder. The process may be used in conjunction with the ammonia-soda process, the free ammonia produced in this

latter process being used for the removal of the carbonic acid from "water-gas," while the sequicarbonate of ammonium can be utilised in the ammonia-soda process.—O. H.

Improvements in Apparatus for Carburetting Gas. J. D. Hall, Liverpool. Eng. Pat. 387, January 9, 1889. 8d.

A CORREN box is divided into compartments by a number of perforated copper slides or partitions. Between the copper slides are also arranged a series of flannel curtains or diaphragms, the lower portions of which dip in any suitable hydrocarbon contained in the box. The gas to be carburetted traverses the apparatus from end to end, and in passing through the flannel becomes charged with the vapour of the hydrocarbon, this latter being constantly replenished from below by capillary attraction. At both inlet and outlet are situated catch-boxes to obviate any difficulties that might be caused by condensation.—A. R. D.

An Improved Composition of Artificial or Block Fuel. C. H. Mowll, Dover. Eng. Pat. 1806, February 1, 1889. 4d.

BRIQUETTES, which are stated to be less friable and of more value as a combustible than ordinary briquettes, are made by compressing a mixture of slack or small coal with pulverised peat. Cinders, ashes or calcined coal and an adhesive or agglomerative substance, such as pitch, may be added if desired, the mixture being moistened or slightly heated before compression.—O. H.

Improvements in or relating to the Generation of Gases known as Water-Gas, Siemens' Gas, and Producer-Gas, and in Apparatus connected therewith. J. von Langer and L. Cooper, Leeds. Eng. Pat. 7252, May 1, 1889. 11d.

THIS invention relates to improved forms of producers or gas generators, to the admission of air to the producer, and to improved valves and their arrangements, and mode of actuating valves in groups.

A is the producer, B the fire-bars, C the fire-cleaning doors, D the hearth, E the ash doors, F is an outlet for

Fig. 1.

water-gas, and G a corresponding outlet for Siemens or producer-gas. At the top of the producer (in some cases) an outlet H is provided to carry off the products of combustion when lighting up or cleaning the fire, and is closed by a suitable valve. Air is admitted to the fuel in the producer through a series of openings I I, at different planes in the circumference, controlled by suitable valves J J. A special or main supply of the air blast is indicated at K, entering beneath the green fuel and controlled by a suitable valve K' placed in the blast pipe, the producer-gas generated finding an outlet through the openings G G at the base. When the air is shut off and the steam is turned on at L, water-gas is likewise generated in passing downwards and finds an outlet at openings F F (not shown) at opposite points to G G.

In this figure the main blast enters the bottom of the producer at K and passes upward through H, controlled by valve H', while air is also admitted at points I I as in Fig. 1.

Fig. 2.

Steam is admitted at L, and the water gas outlet is at F. The fuel is fed through hopper M, dropping upon an inclined shelf, from which it falls gradually into the body of the producer.

The specification further contains drawings of a producer adapted to turn in a circular direction upon an axial bearing, and in doing so to open or close the inlets for steam and air, and outlets for the gases. Also a producer mounted upon the ram of a hydraulic press, and adapted to move up and down in a vertical line.

A suitable controlling valve and box for admitting air at several points to the producer, and a water-gas valve, are shown in the drawings by detailed sections.—F. S.

Improvements in Heating Boilers by Gaseous Fuel. O. Imray, London. From E. R. Ware, Chicago, U.S.A. Eng. Pat. 15,043, September 24, 1889. 8d.

This consists in a novel arrangement whereby the exit for the waste products of combustion is fixed in about the same horizontal plane with that part of the heating chamber at which the fuel is ignited, whereby the consumption of fuel is carried on without a direct draught through the heating chamber; the waste products of combustion escape from the combustion chamber only by passing downward below

the plane of ignition, and thence out below the lower edge of the "water leg." The specification is accompanied by drawings.—F. S.

Improved Gases or Gaseous Mixtures for Use in the Production of Light, Heat, and Power. E. Tatham, Balmain, New South Wales. Eng. Pat. 16,138, October 14, 1889. 4d.

THE improved gases or gaseous mixtures are called "Carburetted Hydro-oxy Gas" or "Bi-carburetted Hydro-oxy Gas." In practice they are produced in one way by charging the hydrocarbon gas or hydrocarbon vapour with "carburetted oxygen" as the coal-gas issues from its place of manufacture, and while still hot, but not above the temperature of, say, 300° F., and the proportions of the mixture are regulated according to the illuminating power required, that is, for a gas or gaseous mixture suitable for ordinary illuminating purposes, and for use in engines as a motive power, 2½ per cent. of oxygen is added to ordinary coal-gas of 16 candle power. It is preferable to add to gases of a greater specific gravity or containing a larger quantity of carbon than coal-gas an increased amount of the carburetted oxygen. The mixtures so produced are said to give a most brilliant light, and are more economical for heating and engine purposes than ordinary coal-gas.—F. S.

Improvements in Coal-Gas and like Gases, and in the Manufacture thereof. E. Tatham, Balmain, New South Wales. Eng. Pat. 16,142, October 14, 1889. 4d.

THE improvement consists in the admixture with coal-gas or similar gases of a reasonable quantity of oxygen during manufacture, preferably as it issues from the retorts, and in the conversion of the tar produced or other similar hydrocarbons into gas or vapour, which is admixed preferably while still hot with oxygen. (Compare Eng. Pat. 16,138 of 1889, preceding abstract).—F. S.

Improvements in the Manufacture of Gas. D. H. Knapp, Norwich, New York, U.S.A. Eng. Pat. 16,646, October 22, 1889. 6d.

A CYLINDRICAL retort is set upright in a furnace, and a hole in the cover allows a similar but smaller retort to hang suspended by a flange. The smaller retort has an upright pipe fixed to the bottom, and open at both ends. Oil being fed into the smaller retort becomes vaporised, and the vapours being conducted downwards by the upright pipe into the larger retort, are there converted into permanent gas for illuminating purposes.—G. H. B.

III.—DESTRUCTIVE DISTILLATION, TAR PRODUCTS, Etc.

PATENTS.

Improvements in Apparatus for the Production of Pyro-ligneous Acid. J. H. du Vivier, Paris, France. Eng. Pat. 2569, February 13, 1889. 8d.

See under VII., page 189.

Improvements relating to Distillation and Apparatus therefor. B. Hoff, Jaroslau, Austria. Eng. Pat. 3468, February 26, 1889. 8d.

See under I., page 167.

IV.—COLOURING MATTERS AND DYES.

PATENTS.

Improvements in the Method of and Means for Concentrating or Evaporating and Distilling Solutions for the Production of Dyes and other Bodies. J. Frost, Moldgreen. Eng. Pat. 1803, February 1, 1889. 8d.

See under I., page 167.

The Production of New Azo-Dyes, applicable for Dyeing and Printing. O. N. Witt, Charlottenburg, Germany. Eng. Pat. 2499, February 12, 1889. 6d.

THE patentee has discovered that α - β - α -dihydroxynaphthalene (β -naphthohydroquinone) will combine with diazo-compounds to form colouring matters capable of dyeing mordanted fabrics. In these combinations the diazo-compounds obtained from non-sulphonated amines are most suitable for preparing cotton dyestuffs, whilst the sulphonated compounds are used preferably in dyeing wool and silk. Ninety-three kilos. of aniline, 200 kilos. of hydrochloric acid (containing 37 per cent. of HCl), and 2,000 litres of water are diazotised at a temperature not exceeding 5° C. by the addition of an aqueous solution of 69 kilos. of sodium nitrite. This liquor is then run into a cold aqueous solution of 160 kilos. of dihydroxynaphthalene and 150 kilos. of crystallised sodium acetate in 2,000 litres of water. A dark orange precipitate is formed, which is filtered, washed and made into a paste with water. It may then be used for dyeing or printing on cotton in connexion with a suitable mordant. Alumina gives a bluish-pink, iron a greyish-violet, and chromium a purple. The following is an example of the method employed for preparing wool or silk dyestuffs:—184 kilos. of diazobenzene sulphonic acid (from sulphanilic acid) are suspended in water and added to the solution of dihydroxynaphthalene prepared as above. A dark orange solution results, and the dyestuff is salted out, forming an orange precipitate, which is filtered and dried. Its solution dyes wool mordanted with alum a dark bluish-red, whilst with chromium a bluish-purple. Other amines or their sulphonic acids may be employed in place of those already mentioned, such as toluidine, xyldine, α - and β -naphthylamines, or the nitro- and hydroxy-derivatives of aniline, Brömer's β -naphthylamine sulphonic acid or Piria's naphthionic acid.—T. A. L.

A New Colouring Matter for Dyeing and Printing Purposes, and its Method of Manufacture. R. Gnehm, Basle, Switzerland. Eng. Pat. 2635, February 14, 1889. 4d.

By heating dimethyl- or diethyl- m -amidophenol with succinic acid and zinc chloride, colouring matters are obtained which dye wool, silk and mordanted cotton red with a yellow fluorescence. 30 grms. of diethyl- m -amidophenol, 50 grms. of succinic acid, and 20 grms. of zinc chloride are heated for 15 minutes to 205°, or for 1–2 hours at 195°, allowed to cool, dissolved in 1 litre of water on the water-bath, and precipitated with 150 grms. of salt. The mother-liquor is decanted when cold, the precipitate again heated with 1 litre of water and 20 grms. of ammonium chloride, and reprecipitated with 150 grms. of salt. The mother-liquor is again decanted, and the semi-fluid residue dissolved in 10 cc. of hydrochloric acid and 1 litre of water, and evaporated to dryness. This colouring matter forms a very hygroscopic brownish-red powder soluble in water and spirit. The hydrochloride of the colouring matter obtained by heating equal weights of dimethyl- m -amidophenol, zinc chloride, and succinic acid anhydride to 190°–210°, forms green crystalline needles, also soluble in water and alcohol.

—T. A. L.

Production of Triphenylmethane Colours Dyeing with the Aid of Mordants. T. R. Shillito, London. From J. R. Geigy and Co., Basle, Switzerland. Eng. Pat. 3333, February 25, 1889. 4d.

A process for the synthesis of tricarboxylic acids of aurin and its homologues by oxidising salicylic acid or β -cresotinic acid (from o -cresol) together with bodies like methyl alcohol, formaldehyde, "methylal," dihydroxydiphenylmethanedicarboxylic acid, dihydroxyditolylmethanedicarboxylic acid in sulphuric acid solution with the aid of nitrous acid. Two kilos. of salicylic acid are dissolved in 15 kilos. of concentrated sulphuric acid and 4 kilos. of methyl alcohol. The solution is heated to about 70°, when 1.5 kilos. of sodium nitrite are added. After a short time the melt is poured into water, and the precipitate washed, neutralised with an alkali, and dried.—T. A. L.

Manufacture of Azo Colouring Matters. J. Imray, London. From "La Société Anonyme des Matières Colorantes et Produits Chimiques de St. Denis," A. F. Poirrier and D. A. Rosenstiehl, Paris, France. Eng. Pat. 4825, March 19, 1889. 4d.

COLOURING matters giving very deep colours extending to black are obtained by diazotising the mono- and disulphonic acids of aniline, of the toluidines, xyldines and naphthylamines, combining them with α -naphthylamine, rediazotising the compound obtained and combining it with the phenyl, tolyl, benzyl, xylyl, or naphthyl derivatives of m -phenylenediamine or with the corresponding secondary and tertiary derivatives of cresylene or "xylene diamine." 30 kilos. of sodium α -naphthylamine disulphonate are diazotised in an aqueous solution with 7 kilos. of sodium nitrite and 45 kilos. of hydrochloric acid and combined with 900 litres of a solution of α -naphthylamine hydrochloride containing 14.3 kilos. of α -naphthylamine. The compound thus obtained is again further diazotised by adding 20 kilos. of hydrochloric acid and subsequently 7 kilos. of sodium nitrite in 15 litres of water. The diazo compound which precipitates is filtered off and added as a paste to 26 kilos. of diphenyl- m -phenylene diamine in alcohol. After standing some hours the liquid is acidified and the colouring matter which precipitates is filtered off and converted into the sodium salt.—T. A. L.

Manufacture of Colouring Matters giving Grey, Brown, and Analogous Tints. J. Imray, London. From "La Société Anonyme des Matières Colorantes et Produits Chimiques de St. Denis." Eng. Pat. 5032, March 22, 1889. 4d.

THE nitroso-derivatives of secondary or tertiary aromatic amines, when heated, form basic colouring matters varying in shade from brown to grey. 10 kilos. of nitrosodimethylaniline hydrochloride are dissolved in 50 litres of water and the solution boiled for three hours. After cooling the product is run into 100 litres of water and the colouring matter precipitated by the addition of zinc chloride. Alcohol or benzene, toluene, or other hydrocarbons may be substituted for the water, and in place of dimethylaniline the nitroso-derivatives of other tertiary and secondary amines may be employed. The colouring matters form brown powders soluble in water, alcohol and acids. Their solutions are precipitated by alkalis and alkaline carbonates giving brown flakes soluble in hot and insoluble in cold water.—T. A. L.

Improvements in Colouring Matters. H. H. Leigh, London. From R. G. Williams, Albany, U.S.A. Eng. Pat. 11,795, July 24, 1889. 6d.

A process for obtaining cotton dyestuffs by combining one molecule of a tetrazo compound with two molecules of the alkylised acids of the orchella lichens or compounds of the same, and also by combining one molecule of a tetrazo compound with one molecule of a phenol or amine and reacting with this intermediate compound on one molecule of the alkylised acids of the orchella lichens. These acids

can be obtained by the direct action of alcohols on the lichens or else by digesting the orchella lichens for a short time with water in presence of lime, filtering and precipitating the orsellinic and other acids by the addition of hydrochloric acid. The acids thus obtained are filtered off, dried at a low temperature and boiled with an alcohol in order to produce the alkylised derivative. A colouring matter which dyes unmordanted cotton a scarlet shade from an alkaline or soap bath is obtained by diazotising 28 lb. of benzidine sulphate in the usual manner and running the solution into 36.4 lb. of the methylated acids of the lichens, 100 lb. of caustic soda and 100 gallons of water. The dye-stuff, forms immediately and is salted out, pressed, and dried. The following is an example of the method for obtaining a mixed azo colour. 30.2 lb. of toluidine sulphate are diazotised and run into 28 lb. of the sodium salt of α -naphthylamine mono-sulphonic acid, 30 lb. of sodium acetate and 100 gallons of water. The mixture is well stirred, and when the intermediate product is formed it is run into a solution of 18.2 lb. of the methylated lichen acids and 100 lb. of caustic soda. The colouring matter thus formed is similar to Benzopurpurin 4 B, but is faster to light.—T. A. L.

Improvements in Dye Colours. H. H. Leigh, London, From R. G. Williams, Albany, U.S.A. Eng. Pat. 14,294, September 10, 1889. 6d.

THIS is an extension of Eng. Pat. 12,767, 1889 (this Journal, 1889, 981), and describes the preparation of isomeric intermediate compounds which will combine with amines and phenols. The following example illustrates the method employed: 32 lb. of toluidine sulphate are diazotised with 14 lb. of sodium nitrite and combined with 25 lb. of sodium naphthionate in presence of sodium acetate. This compound is then combined with the diazo compound from 25 lb. of naphthionic acid, and when the combination is complete 25 lb. more of sodium naphthionate are added, and the mixture stirred until the colour is completely formed. The chief claim is substantially as follows: The production of colouring matters by combining one molecule of a tetrazo compound with one molecule of an amine, then combining one molecule of a diazotised amine with the primary intermediate product thus produced, and afterwards reacting on the secondary intermediate product thus obtained with one molecule of an amine or phenol.

—T. A. L.

Production of New Blue Colouring Matters. S. Pitt, Sutton. From L. Casella & Co., Frankfurt-on-the-Maine, Germany. Eng. Pat. 16,698, October 22, 1889. 4d.

BLUE colouring matters easily soluble in water are produced by the action of *p*-phenylene or *p*-tolylene diamine on certain basic substances which on reduction only yield polyamines. Those which have given the best results are the triamido-azobenzene (Ger. Pat. 32,502), and diamido-azoxybenzene (Ger. Pat. 44,045). The triamido-azobenzene has the formula $(p\text{-NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{C}_6\text{H}_4\cdot\text{NH}_2)_2(o\text{ and }p)$, and is obtained by the action of *p*-amidodiazobenzene on *m*-phenylenediamine. 10 kilos. of the hydrochloride of this base and an equal weight of *p*-phenylenediamine are heated for three hours to 130°–140°, and then for one hour to 160°–170° with agitation. The melt is dissolved in dilute hydrochloric acid, and the colouring matter precipitated with salt as a dark blue powder soluble in 5 times its weight of boiling water, and in 11 times its weight of water at 20°. It dyes mordanted cotton a deep blue fast to light and washing. The second method is to convert diamido-azobenzene ($m\text{-NH}_2\cdot\text{C}_6\text{H}_4\cdot\text{N}_2\cdot\text{O}$) into its hydrochloride and mix it with *p*-phenylenediamine in the proportion of 1 to 3 equivalents, heating the mixture to 160°. The operation is finished in 3–6 hours, water being given off, and the melt is sufficiently pure to be used directly. It may be purified by dissolving it in dilute hydrochloric acid and precipitating with salt.—T. A. L.

V.—TEXTILES: COTTON, WOOL, SILK, Etc.

PATENT.

Improvements in and relating to a New and Useful Fibre Produced from the Leaves or Needles of the Pinus Australis and other Coniferous Trees. W. Latimer, Wilmington, North Carolina, U.S.A. Eng. Pat. 13,127, August 20, 1889. 6d.

THE acicular leaves of the pine are first treated with an alkaline solution, washed and then passed through a decortiating machine, preferably that designed for the purpose (U.S. Patent 315,666, April 14, 1885). The fibre so prepared is carded or combed in any suitable machine, but preferably in that already mentioned, and is then dried, when it is ready to be spun and woven.—J. J. B.

VI.—DYEING, CALICO PRINTING, PAPER STAINING, AND BLEACHING.

PATENTS.

Improved Apparatus for Dyeing and Washing Hats and other Articles, applicable also to Veneering Hats. T. Wareham, Toronto, Canada. Eng. Pat. 14,606, October 11, 1888. 8d.

It is claimed that by means of this invention, which cannot be understood without reference to the drawings accompanying the specification, the operations of mordanting, rinsing, dyeing, exposing to the atmosphere, and veneering can be successively and uninterruptedly effected.—E. B.

Improvements in the Manufacture of Paperhangings, Curtains, Carpets, and other Articles or Coverings from Jute. H. Sauvage, Paris, France. Eng. Pat. 17,574, December 3, 1888. 4d.

JUTE textiles are rendered suitable for wall decorations, carpets, &c., by dyeing or printing the same after they have undergone the following preparation: scouring with alkalis, bleaching with "chlorozone," shearing, and stiffening with Curagheen moss and dextrin.—E. B.

An Improved Process for Dyeing Blue. E. Edwards, London. From Standaert Brothers, Hamme, Belgium. Eng. Pat. 18,709, December 21, 1888. 4d.

A STATE of blue resembling indigo is obtained on cotton by boiling the cotton material with a solution of extract of logwood and "soda salt," then working in a cold bath of ferrous sulphate, rinsing, passing again into the first bath, and tinting in a bath containing soap, salt, or sulphate of soda, and a colouring matter such as aniline blue. After being immersed in this bath for about an hour the material is rinsed and dried.—E. B.

Improvements in and connected with Indigo Dyeing. J. Cowan, Glasgow. Eng. Pat. 18,904, December 27, 1888. 6d.

INDIGO in a dry state is ground with zinc oxide or zinc powder, crystallised sugar and potassium carbonate. The mixture is suitable for making into parcels for sale. To set a vat the mixture is placed in a tub, water is added and then bisulphite of soda. The reduced indigo so prepared may, in a concentrated state, be supplied to dyers ready for their use. Instead of potassium carbonate other alkalis and alkaline salts may be used, and various other sugars are mentioned besides crystallised sugar. Sulphuric acid may, according to option, be added before or along with the bisulphite of soda.—E. B.

Processes for the Manufacture of New Chrome Mordanting Substances, and for the Application thereof for Dyeing and Printing Purposes. W. L. Wise, London. From M. von Gallois, Hoechst a/Main, Germany. Eng. Pat. 376, January 8, 1889. 6d.

NORMAL chromium chromate, $\text{Cr}_2(\text{CrO}_4)_3$, is prepared by dissolving chromic hydrate (1 mol.) in chromic acid (3 mols.); a basic chromium sulphate-chromate, of the composition $\text{Cr}_2(\text{SO}_4)(\text{CrO}_4)(\text{OH})_2$, is obtained by dissolving excess of chromic hydrate in a mixture of sulphuric and chromic acids or by double decomposition between solutions of basic chromium sulphate and potassium or sodium bichromate. An addition of magnesium or sodium acetate is made to these solutions before they are used. In mordanting for yarn or piece-dyeing the material is impregnated with the solution, squeezed, dried and aged or steamed. A printing colour is made by boiling and thickening a solution of basic chromium sulphate, cooling partially and adding potassium chromate and magnesium acetate, or the sulphate-chromate of chromium, made from the hydrate, may be used. The printed goods are dried and aged or steamed. Resists or discharges may be effected by printing thickened mixtures of organic acids, and when these are applied it is recommended to pass the pieces through a weak bath of carbonate of soda before dyeing.—E. B.

Improvements in Machinery for Printing Floorcloths or similar Materials. E. Ostlere, Kirkecaldy, and A. M. Strathern, Springburn. Eng. Pat. 1283, January 24, 1889. 11d.

THIS invention cannot be properly explained without reference to the drawings which accompany the specification.—E. B.

Improvements relating to the Washing or Scouring of Wool, Cotton Waste, and other Dirty Materials or Fabrics. J. Portella, Hornsey. Eng. Pat. 1453, January 26, 1889. 6d.

THE use is claimed of a scouring mixture composed of soap, ammonia and turpentine. An advantage attending the use of such a mixture is that the more valuable impurities, such as lanolin in wool and the oily matters in cotton waste, can be easily recovered. When the mixture is applied for the purpose of cleaning cotton waste a further addition of potash or soda is made.—E. B.

Improvements in Machinery for Printing Canvas, Floorcloth, Linoleum, and other Textile Fabrics specially prepared therefor. I. Heyde, Dundee. Eng. Pat. 1759, January 31, 1889. 6d.

THE improvements in question consist in the combination of both block and roller printing in the same machine. The printing rollers are mounted in suitable framework on the same level. The material to be printed passes under the printing rollers and is pressed against the same by a series of pressure rollers covered with an endless travelling band. It then passes on to the block printing machine where the remainder of the pattern is printed. A claim is made for a method of supplying the colour to the blocks. For details of the mechanical arrangements the original specification must be consulted.—E. B.

A Cold Process of Dyeing Hair and Feathers by means of Paraphenylenediamine or similar Bases. H. Erdmann, Halle, Germany. Eng. Pat. 2525, February 13, 1889. 4d.

AFTER imbuing the feathers or hair with the solution of a para-amidophenol or a paradiamine, they are treated with a solution of either benzo- or tolu-quinone or an oxidising agent, such as hydrogen peroxide, ferric chloride or a permanganate. The following phenols and amines are specified; para-amidophenol, symmetrical triamidophenol, paraphenylenediamine, toluylene-paradiamine, dimethylparaphenylenediamine and naphthylenediamine (1:5). In this way fast shades of brown to black are produced.—E. B.

Improvements in Dyeing Mixed Woven Fabrics. T. Ingham, Manchester. Eng. Pat. 2984, February 20, 1889. 6d.

By means of this invention animal and vegetable fibres in mixed fabrics can be simultaneously dyed black and other colours. The scoured goods are passed full width through a bath of one or more of the following colouring matters:—logwood, catechu, fustic, bark, berries, peachwood, with or without coal-tar dyes such as Benzo-azurine. After squeezing and drying, the colouring matter is oxidised and fixed by passing the cloth in the open state through a solution of any or mixture of some of the following:—bichromate of potash, bichromate of soda, bichromate of ammonia, chromic acid, nitrate of iron, sulphate of iron, sulphate of copper, carbonate of soda, or sulphate of soda. The dyed cloth is then rinsed or cleansed first in cold water and then in hot, or passed through a bath of carbonate of ammonia, carbonate of soda, or soap, finally being rinsed again in cold water before drying. Examples are given of the application of this method for dyeing black, blue-black, brown, and bronze, on fabrics composed of cotton and wool.—E. B.

Improved Cleansing, Scouring, and Bleaching Compound for Wool and other Fabrics, also applicable to Cleansing Purposes generally. A. H. Parker, London. Eng. Pat. 9410, June 6, 1889. 4d.

THE compound consists of a mixture of "pearlash, borax, ammonia, soft soap, Scotch soda, and Jeyes' disinfectant."—E. B.

Improvements in Dye-extracting Apparatus. F. Rhodes, Westfield. Eng. Pat. 15,558, October 3, 1889. 6d.

THIS invention relates to an improved form of apparatus used for extracting dye-woods. The improvements in question consist in employing, in combination with an ordinary dye-vat and appliances for heating and raising water, an extracting vessel of rectangular or cylindrical shape, one end of which is permanently closed, the other end being provided with a moveable steam-tight door. Water or liquor from the dye-vat is forced or pumped to the top of this vessel, and after passing through the dye-wood contained in it, flows back into the dye-vat. Several modifications of the arrangements are described.—E. B.

Improvements in Apparatus for Dyeing Skeins. J. C. Mewburn, London. From La Société Grandsire et Fils, Bolbec, France. Eng. Pat. 15,881, October 9, 1889. 6d.

THE skeins U are hung on the triangular reels J carried by the platform H, which slides on the square shaft C and is

counterbalanced by G. On the axis of each reel is fixed a pinion which, when H is lowered, gears with a crown wheel on the fixed platform N, so that the revolution of the platform H causes the rotation of the reels on their own axes. K K are bars for lowering the platform, O the annular dye vat, and M the footstep bearing for the vertical shaft. Instead of counter-balancing the platform, the shaft and the boss of the platform may be screwed, and friction rollers working on the edge of the vat may be substituted for the pinions on the reels and crown wheel on the fixed platform. In the Figure the platform is shown raised, in working the platform being lowered and fixed to ensure the contact of the pinions and crown wheel.—O. H.

Improvements in Machines for Dyeing Cotton and Analogous Materials. L. Weldon, Amsterdam, U.S.A. Eng. Pat. 18,973, November 26, 1889. 6d.

This invention relates to machines for dyeing raw or unmanufactured cotton. The improved machine consists of a perforated rotary cylinder or cage, which is placed in the dye-vat, so as to be partially submerged. The cylinder is provided with compartments, and at the centre of each compartment there is extended a rod armed with laterally-projecting pins or wings, termed a "breaker-bar." During the working of the machine the cotton contained in the compartments falls on the "breaker-bars," and is well distributed, so that even dyeing results.—E. B.

VII.—ACIDS, ALKALIS, AND SALTS.

Report by G. Wyss to the "Société Industrielle de Mulhouse" upon a Paper by E. Sorel, entitled "Etudes sur la fabrication de l'acide sulfurique." Bull. Soc. Ind. Mulhouse, 1889, 237—239.

In his historical résumé of the work already done by other workers in this field, Sorel has failed to mention some of Lunge's researches, and others of Hurter and Eschellmann.

Sorel has set himself the task of demonstrating that temperature plays a preponderating part in the formation of sulphuric acid, and he has brought to light the important fact that it is the fall of temperature at the walls of the chambers that restarts the process of manufacture. This function he has thoroughly studied, and his determination of the tension of aqueous vapour in the presence of sulphuric acid, and of the tension of the nitrous compounds in solution in sulphuric acid, are researches of fundamental importance, which must be taken into account in all future investigation in this direction.

Nevertheless, his theory of the sulphuric acid process is not new. Lunge published an identical view in 1885 (Ber. 18, 1391), and again, in a more complete form in 1887 (Ber. 21, 67; this Journal, 1888, 208), at about the same time that Sorel's memoir was presented at Cherbourg.

Among the reactions instanced as primary ones the following two—

should rather be looked upon as secondary. The author of this report points out also that Davy's theory is based upon the existence of hyponitric acid (nitrogen tetroxide) in the chamber gases, and that for this reason it is untenable, and not because, as stated by Sorel, it admits the formation of chamber crystals. In fact, the chamber crystals are nothing else but nitrosulphonic acid.

Lunge and Sorel are, therefore, the first propounders of the very probable theory that the sulphuric acid process does *not* depend essentially upon the reduction and oxidation

of the oxides of nitrogen, but upon the formation of nitrosulphonic acid and its decomposition by water, according to the equations—

The explanation of the reactions in the Glover tower are most interesting, and it can no longer be admitted that the affinity of NO for oxygen can produce of itself the formation of sulphuric acid in the tower, when the extremely short time, as calculated by Sorel, that the gases remain in the active zone of the tower is taken into consideration. The interpretation of the reactions in the first chamber is highly plausible.

It is evident that the cooling effect of the pipes connecting the chambers has a remarkable influence in facilitating the restarting of the process at the entrance of the second chamber. In this view Sorel agrees with Schertel (Chem. Ind. 12, 80; this Journal, 1889, 283). Lunge has ascribed this restarting of the process to the more complete mixing of the gases which would be brought about by passing through the pipes.

The application of his theory that Sorel proposes is certainly a possible one, and an economy in the first cost of plant will be realised by carrying out his ideas or in modifying their details. At any rate, it should be taken into consideration by every manufacturer desirous of keeping his methods of working up to date.—H. S. P.

The Manufacture of Sulphuric Acid. E. Sorel. Bull. Soc. Ind. Mulhouse, 1889, 240—293.

AFTER a short summary of the history of the sulphuric acid manufacture, and pointing out the progress that manufacturers have made up to the present time in the direction of economical working, showing that before the introduction of the Gay-Lussac and Glover towers only 1·75 kilos. of monohydrated acid (H_2SO_4) per cubic metre of chamber space were made as compared with 4·25 kilos. per cubic metre to-day, the author draws attention to the accompanying diagram, which is taken from a publication by Lunge and Naef (Chem. Ind. 1884, 5; this Journal, 1884, 633), and which shows the curves representing the progress of the oxidation of the SO_2 in the chambers of the Uetikon works. The ordinates of these curves represent the successive amounts of SO_2 that have been oxidised per 100 parts of SO_2 introduced into the chamber, and the abscissae the distances from the front wall of the first chamber. It is seen that the back parts of the apparatus do very little work, and that there are zones where the process is almost at a standstill. According to the author's own experience these curves fairly represent the general course of the process in the lead chamber. There is, therefore, room here for a further economy. But to know how to effect this, it is necessary to have a precise knowledge of the reactions that go on in the chamber, and of the causes which can modify these reactions. Upon this point the author maintains that the manufacturer has made scarcely any advance since the time of Clément and Desormes (1793), and he quotes from Scheurer-Kestner's article in Wurtz's dictionary to show this: "L'acide nitrique n'est que l'instrument de l'oxygénation complète du soufre: c'est sa base, le gaz nitreux, qui prend l'oxygène à l'air atmosphérique pour l'offrir dans un état qui lui convienne." After such an avowal of impotence, one can understand why manufacturers have had to renounce all originality of method, and to content themselves with perfecting themselves in the use of the apparatus bequeathed to them by their predecessors.

In considering the problem of the sulphuric acid process, the first thing to be noted is, that because the oxides of nitrogen act as a vehicle of oxygen, now removing it from the air and now giving it up to the SO_2 , they must exist in a condition allowing of their easy dissociation. There is, therefore, no question of sharply defined reactions taking

place, no matter what physico-chemical conditions may exist in the surrounding medium, but rather of a series of transformations absolutely dependent upon the medium that surrounds the reacting materials.

If it were possible to unite all the most favourable conditions in every part of the chamber, the speed of oxidation of the SO_2 at any part would be proportional to the SO_2 remaining

in the gases as they traversed that part. The two plain-line curves in Lunge and Naef's diagram show the theoretical curves corresponding to a final escape of SO_2 equal to 0.5 per cent. of sulphur burnt in one case and to 4 per cent. in the other; the broken line curves show the experimental data actually obtained for losses equal to 0.4 per cent. and 3.7 per cent. of sulphur burnt.

The theoretical and practical curves show a general concordance, but the differences that they do show are so sharp that it is not possible to look upon them as the result of chance. It is clear that we have to deal with conditions in certain zones of the chamber which hinder the progress of the reactions.

The conditions to be investigated are dependent upon variations in:—

- Temperature.
- Tension of aqueous vapour.
- Capacity of the nitrous products to combine with sulphuric acid.
- The relative proportions of oxygen and sulphurous acid in relation to the nitrous compounds.
- The reducing energy of sulphurous acid in relation to the nitrous compounds.

It is quite clear that oxidation and reduction of the nitrous compounds cannot take place simultaneously and in the same spot, nor can they occur in succession in the same spot unless the state of the surrounding medium at that spot varies.

A. *Temperature.*—There are three causes tending to produce a rise of temperature:—

- The continuous introduction of hot gases and of steam.
- The heat generated by the chemical reactions.
- The condensation of a part of the gaseous products.

The cause tending to produce a *fall* of temperature is the continuous radiation from the chamber walls. For each section of the chamber, therefore, a certain state of equilibrium will become established, and since of the three causes of rise of temperature that caused by the chemical reactions is the chief, the temperature inside the chamber will vary in degree above that of the air according as the chemical reactions are more or less intense in one part than the other. The temperature at the front of the chamber is therefore the highest.

But the walls do not transmit the whole of the heat produced in any one section, and consequently the temperature of the inner part of the chamber does not follow the same law, dependent upon the energy of the chemical reactions, and, as a matter of fact, at a height of 1.5 metres

from the floor of a No. 1 chamber there is only a difference of about 2°C . between the front and back of the chamber. At the surfaces of the walls, however, the gases are necessarily cooled. Moreover, within the chamber certain strata seem to be the chief seats of chemical activity, and sharp rises of temperature are indicated at such parts. Consequently, in a transverse section of a chamber we find different temperatures according to where the thermometer is plunged.

In a set producing about two kilos. of H_2SO_4 per cubic metre the following temperatures were indicated in the first chamber, at points 1.5, 11.5, and 21.5 metres respectively from the end-wall at the front of the chamber. At each distance two holes were made in the top of the chamber, one in the axis of the chamber (designated by *a*) and the other .5 metre from the side (designated *b*). The experiments were made in the summer, so that the temperatures are relatively very high. The temperature at the top of the chamber 0.1 metre from the wall was 87° .

	1.5 m. from fore-end.		11.5 m. from fore-end.		21.5 m. from fore-end.	
	<i>a.</i>	<i>b.</i>	<i>a.</i>	<i>b.</i>	<i>a.</i>	<i>b.</i>
0.50 m. from top of chamber.....	80	76	70.5	60	74	85
3.50 m. from top of chamber.....	86	81	83.5	83.5	86	85
6.00 m. from top of chamber.....	85.5	83	82	83	84	82
0.15 m. from top of chamber, i.e., at 0.1 m. above the acid on the floor.....	84	79	85.5	85.5	84.5	79.5

Thus in spite of the radiations from the side we find the temperature at certain parts near it notably higher than the interior temperature at the axis.

In a set making 3·25 kilos. H₂SO₄ per cubic metre, in which, of course, the temperatures were consequently very high, the author found in the first chamber, at 16 metres from the fore-end (0·4 of its total length), the following temperatures:—

(TEMPERATURE OF THE GASES IN THE INLET PIPE, 82·5°)

	At 0·15 m. from side.	At 0·50 m. from side.	In the Axis.
0·4 m. from top	91°	87·7°	83·4°
1·5 m. "	..	87°	83·9°
1·6 m. from floor.....	91°	..	..
0·5 m. "	..	88°	90·2°

At this distance from the fore-end, the highest temperature is seen to be close to the side.

In the same chamber the following temperatures were also noted:—

On the side wall.....	78·5 to 79·7
At 0·02 m. from side.....	84
0·04 m. "	91
0·06 m. "	95·25
0·08 m. "	95·25
0·10 m. "	98·5
0·12 m. "	97·3

The cooling influence of the side wall is therefore only felt close to the wall.

Such variations in temperature as are here indicated must cause movements in the gases which thoroughly mix them and give them a great uniformity of composition in each section. The author would agree with Abraham (Dingl. Polyt. J. 245, 414), that each molecule travels in a spiral round a horizontal axis from one extremity of the chamber to the other.

In these movements of the gases, the particles of liquid in suspension pass into zones of different temperatures, and consequently change their state of concentration and richness in nitrous products at each instant, so as to bring themselves into equilibrium with that portion of the gaseous atmosphere which surrounds them. Therein lies the secret of the rationale of the sulphuric acid process.

B. Tension of Aqueous Vapour in presence of Dilute Sulphuric Acid.—Heretofore we have only Regnault's experiments on this subject. But he only carried them up to a temperature of 35° C., which is much too low for the purpose under discussion. The author has extended his investigations to a temperature of 95°. Briefly stated, his method, which is more fully described in the original, consisted in aspirating an accurately measured volume of air very slowly over pumice-stone saturated with sulphuric acid of known strength, maintained at a constant and known temperature, and trapping the water-vapour carried over by the air, in a weighed Liebig's tube, filled with concentrated H₂SO₄.

The experiments were made at 45°, 60°, 77°, and 95°, with acids containing 50·25 per cent., 56·75 per cent., 65·75 per cent., 71·73 per cent., and 83·52 per cent. of pure monohydrated H₂SO₄. The results obtained and those obtained by Regnault for lower temperatures were expressed in curves, and the numbers contained in the accompanying table were then deduced by graphic interpolation.

TENSION OF AQUEOUS VAPOUR EMITTED BY DILUTE SULPHURIC ACID.

Percentage of H ₂ SO ₄ in Acid.	Temperatures.																	
	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°	95°
Per Cent. 44	mm. 4·4	mm. 6·1	mm. 8·5	mm. 11·5	mm. 15·5	mm. 20·9	mm. 28·1	mm. 37·4	mm. 48·3	mm. ..	mm. ..	mm. ..	mm. ..	mm. ..	mm. ..	mm. ..	mm. ..	mm. ..
46	4·0	5·5	7·7	10·5	14·5	19·7	26·3	33·6	41·4	50·6	70·5	90·4	..	..	..	..	..	..
48	3·7	5·0	7·1	9·6	13·4	18·1	23·9	30·5	40·1	53·5	69·0	86·8	107·2	132·1	..	..	..	..
50	3·3	4·5	6·5	8·8	12·0	16·4	21·4	27·4	35·9	47·4	61·3	77·0	95·6	118·1	152·0	192·0	230·7	..
52	3·0	4·0	5·8	7·9	10·9	14·5	18·9	24·1	31·5	41·5	54·0	67·9	84·5	104·5	131·2	166·5	207·9	251·5
54	2·6	3·6	5·0	7·0	9·5	12·5	16·5	21·3	27·8	36·2	47·2	59·9	74·8	92·6	116·1	146·8	183·5	222·0
56	2·2	3·1	4·3	6·0	8·1	11·0	14·2	18·5	24·1	31·0	41·6	51·6	65·0	80·6	100·9	128·2	160·0	195·0
58	1·9	2·6	3·5	5·1	7·2	9·1	12·0	15·8	20·4	26·1	34·5	44·0	55·4	68·4	86·2	110·6	138·5	169·5
60	1·6	2·1	3·0	4·3	6·1	7·5	10·0	13·0	16·9	21·6	28·7	36·7	46·1	56·7	72·3	94·0	118·7	146·0
62	1·4	1·8	2·6	3·6	5·0	6·5	8·1	10·5	13·0	17·7	23·9	30·0	37·7	46·2	56·7	73·2	100·7	125·0
64	1·2	1·6	2·2	3·0	4·0	5·5	6·5	8·2	10·9	14·0	18·7	23·9	30·3	37·4	45·0	63·8	83·7	105·0
66	1·1	1·4	1·8	2·5	3·5	4·5	5·4	6·5	8·9	11·5	15·2	19·1	24·2	30·3	39·0	52·5	70·0	88·0
68	0·9	1·2	1·5	2·1	3·0	3·8	4·5	5·4	7·2	9·5	12·3	15·4	19·4	24·4	31·4	42·5	56·0	72·0
70	0·8	1·0	1·3	1·8	2·5	3·3	3·8	4·4	5·9	7·5	9·5	12·1	15·5	19·8	25·5	33·9	44·4	57·0
72	0·7	0·8	1·0	1·4	2·0	2·8	3·2	3·6	4·8	6·0	7·5	9·5	12·0	15·4	20·0	26·2	33·7	43·4
74	0·5	0·6	0·6	1·2	1·7	2·1	2·6	3·1	3·9	4·9	6·0	7·5	9·5	12·1	15·4	19·5	24·5	31·5
76	0·4	0·4	0·5	1·0	1·4	1·8	2·1	2·5	3·0	4·0	4·8	5·9	7·5	9·5	11·8	15·0	18·5	22·0
78	0·3	0·3	0·4	0·8	1·1	1·4	1·7	2·1	2·4	3·0	3·5	4·0	5·7	7·0	8·5	10·5	13·0	15·8
80	0·2	0·2	0·3	0·6	0·8	1·1	1·3	1·6	1·9	2·4	2·9	3·3	4·1	5·0	6·2	7·5	9·3	11·0
82	0·1	0·1	0·2	0·4	0·5	0·5	0·9	1·1	1·4	1·7	2·0	2·3	2·7	3·2	3·9	4·7	5·6	6·8

It can be now seen how the differences of temperature shown to exist in the chamber will affect the concentration of the acid that is either held in suspension in the gases or collected in a thin film upon the walls.

Thus, referring to the temperatures given above at 16 metres from the fore-end of the chamber; the acid which was collected from the wall at this point showed an average of 52.5° B. = 66 per cent. H_2SO_4 , and the temperature on the chamber side was 78.5° C., which corresponds to a vapour-tension of 39 mm. At the interior temperature of 95° , acid having the same vapour-tension as this would show 56.6° B., and contain 72.33 per cent. H_2SO_4 . This agrees with practical experience, so that it may be concluded that the acids collected at different parts of the same transverse section are in equilibrium as regards the tension of the water-vapour they emit.

C. Tension of the Nitrous Products in presence of Dilute Sulphuric Acid at Various Temperatures.—By nitrous products the author designates all the oxides of nitrogen from nitric oxide (NO) to nitric acid, inclusive. He summarises the work done by previous chemists, chiefly by Lunge and Weber, and points out that they have shown that, in the presence of sulphuric acid in a suitable state of concentration, the oxides of nitrogen in contact with oxygen form nitrous acid, even when the oxygen is in excess, which then forms with the sulphuric acid a relatively stable compound. Further, Lunge has shown that nitrous acid which had previously been considered as quite unstable is nevertheless capable of existing at a temperature of 150° , and forms, with suitably concentrated sulphuric acid, a very stable compound under certain conditions, not reducible by sulphurous acid.

The author has attempted to show the conditions of equilibrium of this compound at various temperatures; and in order to avoid the influence of oxidising or reducing agents, he has employed an atmosphere of nitrogen.

He allowed a mixture of dilute sulphuric acid and of pure nitrous acid dissolved in concentrated sulphuric acid to flow, drop by drop, through a spiral tube 5 metres long immersed in a water-bath at a constant temperature, and passed a current of nitrogen in a contrary direction through the spiral; the quantity of nitrous acid in the mixture of acids before and after passing through the tube, and the volume of the nitrogen drawn through the tube being severally accurately determined, he was able to calculate the weight of nitrous acid given up by the mixture of acids used.

The following table shows the results he has obtained:—

Sp. Gr. of Sulphuric Acid.	Grammes N_2O_5 per Litre.	1 Litre of Nitrogen measured at 0° and 760 mm. Abstracts n mgrs. of N_2O_5 at a Temperature of t°	
		t	n
1.821	112.0	37°	mg. 0.079
1.791	28.4	41°	0.009
.. ..	.. ..	61°	0.019
1.771	28.4	40°	0.009
.. ..	.. ..	62°	0.005
.. ..	.. ..	89°	0.274
1.745	25.876	29°	0.011
.. ..	.. ..	61°	0.196
.. ..	.. ..	75°	0.402
.. ..	.. ..	88°	0.080
1.072	4.731	20°	0.20
.. ..	.. ..	40°	0.37
.. ..	.. ..	75°	1.20
.. ..	4.500	58°	0.51

Sp. Gr. of Sulphuric Acid.	Grammes N_2O_5 per Litre.	1 Litre of Nitrogen measured at 0° and 760 mm. Abstracts n mgrs. of N_2O_5 at a Temperature of t°	
		t	n
.. ..	4.610	90°	mg. 2.72
1.060	9.403	45°	2.69
.. ..	7.730	65°	9.59
1.612	14.652	28°	2.00
.. ..	.. ..	42°	4.58
.. ..	.. ..	63°	21.73
.. ..	.. ..	75°	56.58
1.621	9.995	90°	36.44
.. ..	10.795	89°	40.39
1.606	11.558	91°	61.38
1.603	1.259	70°	4.90
1.601	2.500	40°	0.94
.. ..	2.216	65°	7.29
1.597	1.792	90°	11.77
.. ..	12.500	80°	109.15

He intends to continue the research to see if a law connecting these results can be found. At present the conclusion can only be drawn that the acid mixture behaves like a solution of nitrous acid in sulphuric acid, rather than as a compound. The dissolution of the nitrous acid is very rapid with rise of temperature, and the richness of the sulphuric acid in nitrous acid is probably a function of the tension of the nitrous compounds in the surrounding atmosphere.

When the degree of dilution is moderately large, the tension of the nitrous acid at high temperatures is sensibly proportional to the richness of the sulphuric acid solution.

D. Influence of relative Proportions of Oxygen and Sulphurous Acid upon the Nitrous Compounds.—The tension of the nitrous products in the gases being related to the degree of concentration of the sulphuric acid and to the richness of the solution of nitrous acid in sulphuric acid, it is clear that the latter solution will become richer or poorer according to whether the oxides of nitrogen in the gases are able to pass into the form of nitrous acid or not.

Lunge has shown that, in the presence of concentrated sulphuric acid, NO and O, even when the O is in excess, only produce nitrous acid, which then enters into solution.

On the other hand, pure sulphurous acid, acting upon warm nitrous sulphuric acid, reduces the dissolved nitrous acid just as it reduces the gaseous acid.

If, then, we have a mixture of sulphurous acid, oxygen, and nitric oxide in the presence of nitrous sulphuric acid, there will either be a reduction of the dissolved N_2O_5 , or an oxidation of the NO, dependent upon the temperature, the degree of concentration of the sulphuric acid, and the relative proportions of sulphurous acid, oxygen, and of NO in the mixture.

Practice has shown that in extreme cases, with a high temperature, absence of oxygen, and excess of water, a reduction takes place, whilst when the oxygen is in excess, the acid concentrated, and the temperature low, there is oxidation.

The author has investigated, to a certain extent, the intermediate cases.

He caused measured quantities of a mixture of sulphurous acid, oxygen, nitric oxide, and water-vapour in known proportions to come in contact with nitrous sulphuric acid of various specific gravities, and containing various known quantities of nitrous acid at different temperatures, and

then determined the resulting amount of nitrous acid in the sulphuric acid.

The experiments showed that the reactions were complicated. The following points were, however, made clear. When the sulphuric acid has a higher specific gravity than 1.630, then sulphurous acid does not reduce nitrous acid, but forms with it in the presence of sulphuric acid a solution of nitrosulphonic acid, provided that there is an excess of oxygen and a greater quantity of nitrous acid present in the gases than corresponds to the tension of the nitrous acid held in solution by the sulphuric acid. In all other cases a reduction takes place. And that this statement also holds good when the specific gravity of the sulphuric acid is below 1.600, but only to a certain low limit of temperature (about 70° C.), beyond which a reduction takes place, even in the presence of an excess of oxygen and of nitrous acid.

E. The Reducing Energy of Sulphurous Acid in Relation to the Oxides of Nitrogen.—The author merely draws attention to the results already obtained, chiefly by Winckler, Weber, and Lunge.

Mixtures of NO, N₂O₃, and N₂O₄ are not reduced by SO₂ if the gases are dry. A small quantity of water causes the formation of crystals of nitrosulphonic acid at the expense of the higher oxides; the NO is not altered. A large quantity of water produces the formation of H₂SO₄, but in this case NO is reduced even in presence of excess of O. With dilute sulphuric acid instead of water, there is no reduction of NO at from 40°—50° C. if the acid be not below sp. gr. 1.32. A reduction takes place if the acid be weaker than this. When the acid is concentrated the reduction becomes more difficult as the concentration is greater.

Nitric acid much diluted with water or with sulphuric acid below sp. gr. 1.36 is not reduced at the ordinary temperature, but heat causes its reduction. When the density of the sulphuric acid is above 1.4, reduction takes place in the cold accompanied by the formation of N₂O₃; reduction then becomes more difficult as the concentration of the solvent increases. In an atmosphere rich in oxides of nitrogen, a little nitric acid is found to be dissolved along with N₂O₃.

Theory of the Sulphuric Acid Process.—It has been shown in the preceding that a solution of nitrous acid in sulphuric acid liberates a certain quantity of nitrous acid in an inert atmosphere. The quantity liberated depends upon the concentration of the sulphuric acid, the richness of the solution (below a certain degree of concentration of the sulphuric acid), and upon the temperature. Let us eliminate a certain quantity of the nitrous acid, either by actual removal of it or by reducing some of it to nitric oxide. The solution will then liberate a fresh quantity of nitrous acid and will go on impoverishing itself if this be again removed.

On the other hand, if we reoxidise the NO the solution may take up again the N₂O₃ formed.

If we raise the temperature of the solution the tension of the nitrous acid dissolved rapidly increases. If we dilute the solution the same result is observed, but the tension increases more rapidly.

It follows then that if, in an atmosphere containing a definite amount of nitrous acid, we bring together two solutions of nitrous acid in sulphuric acid at the same temperature, the one a solution in concentrated acid, and the other in dilute acid, the more concentrated acid solution will be enriched at the expense of the other. This might also take place if the temperature of the stronger acid were higher (to a certain limit) than that of the weaker acid.

Sulphurous acid does not hinder the dissolving of nitrous acid in sulphuric acid when the latter is of a suitable concentration, and if there is an excess of oxygen present, so long as the tension of the nitrous acid existing in the gaseous mixture, or capable of being formed in it by the oxidation of NO, is greater than the tension of the nitrous acid dissolved already in the sulphuric acid. But if the tension of the nitrous acid in the gases be less than that of the solution, then sulphurous acid facilitates the decomposition of the solution, whether we dilute the acid or raise the temperature.

Now let us suppose that we have a certain quantity of sulphuric acid of, say, 57° B., containing such an amount of nitrous acid as to be in equilibrium with the surrounding atmosphere at the temperature there existing, and let us suppose that this sulphuric acid is held in the state of mist in the atmosphere. Let us isolate a certain volume of the gaseous mass and cool it under constant pressure. A portion of the aqueous vapour in the atmosphere will thus be condensed both by the fall of temperature and by the contraction of the volume, and will consequently dilute the sulphuric acid suspended in the atmosphere. This dilution will at once destroy the equilibrium existing between the nitrous acid dissolved and that in the atmosphere, the sulphuric acid will liberate nitrous acid which will then be reduced by the sulphurous acid present, with formation of nitric oxide and sulphuric acid. The sulphuric acid formed will tend to again concentrate the acid solution. The reaction will therefore tend to stop when the quantity of acid formed and that submitted to the experiment approach each other.

Now let us assume that this same gaseous mass is brought back to the initial temperature. The acid will then liberate water-vapour so as to bring itself into equilibrium with the conditions of the higher temperature, and will become again concentrated to 57° B. It will then be able to fix more nitrous acid, and will thus determine the re-oxidation of the nitric oxide, provided there is still a sufficient quantity of oxygen present.

In these variations of concentration and of temperature we find the immediate cause that brings about the successive reduction and oxidation of the oxides of nitrogen and the consequent rapid oxidation of sulphurous acid.

The following equations represent the reactions:—

1ST SERIES.—FORMATION OF NITROSULPHONIC ACID.

a. By Direct and Simultaneous Oxidation.

b. By Indirect Oxidation of SO₂.

2ND SERIES.—LIBERATION OF N₂O₃.

To these may be added the less important or accidental reactions:—

The author remarks that his theory resembles those of Davy and Winckler, but differs from them in not assuming the intervention of any body whose existence in the chambers is hypothetical. Davy's theory rests upon the formation of chamber crystals, which only are found in very abnormal working; that of Winckler depends upon the formation of hyponitric acid (N₂O₄) which is only found under particular and well-known conditions. (Compare preceding abstract.)

The author then applies his theory to explain in detail the whole sulphuric acid process from the burners to the Gay-Lussac tower.

The Glover Tower.—Not only is the acid introduced into the Glover tower, denitrated and concentrated, but there takes place there a formation of sulphuric acid equal to 16 or 18 per cent. of the total production in small towers, and to as much as 24 per cent. in large towers (having a capacity of 8 or 10 cubic metres per 100 kilos. of

sulphur burnt), provided there is a plentiful supply of nitrous products.

According to Scheurer-Kestner (Compt. Rend. 1884, November 24, and 1885, March 2; this Journal, 1885, 457) from 1 to 9 per cent. of this sulphuric acid is contained as SO_2 in the burner gases, which becomes hydrated in the Glover tower. Taking the higher figure, 9 per cent., this leaves an actual production of sulphuric acid in the Glover tower of from 9 to 16 per cent.

These amounts correspond to an introduction of a quantity of recovered nitrous acid equal to 8 or 10 parts of commercial nitrate of soda in the one case, and to 22 or 24 parts of nitrate of soda per 100 parts of sulphur burnt, in the second case. In both cases it may be assumed that nitrous acid from 2.5 parts of nitrate of soda per 100 parts of sulphur burnt are introduced to make up for loss. We have, therefore, the following quantities of available oxygen:—

Oxygen from recovered nitrous acid.....	0.74	0.90	1.60	2.21
Oxygen from 2.5 parts NaNO_2	0.22	0.22	3.22	0.22
Total oxygen per 100 of sulphur burnt.....	0.96	1.12	1.82	2.43

Since 16 parts of oxygen are required to oxidise 32 parts of sulphur from SO_2 to SO_3 , it is evident that if a simple reduction of nitrous acid took place in the Glover tower there could only be produced there 0.48 or 0.56 to 0.91 or 1.22 per cent. of sulphuric acid. It is obvious, therefore, that the nitrous acid entering the tower must be successively reduced and oxidised, in round numbers, 20 times.

Take into account the fact that in the active zone of the Glover tower there is a maximum of 0.55 of empty space, and further that the denitration all takes place in the upper half of this zone; in the smaller towers, therefore, having from 4 to 6 cubic metres of working capacity, these successive oxidations and reductions must take place in a space of from 1 to $1\frac{1}{2}$ cubic metres, while in the larger towers, having a working capacity of from 8 to 10 cubic metres, they take place in a space of from 2 to $2\frac{1}{2}$ cubic metres (per 1,000 kilos. of sulphur burnt in 24 hours).

Assuming that there is admitted into the burners the minimum quantity of air compatible with good working, for every kilogramme of sulphur burnt there enters the tower 7,140 litres of gas measured at 0° and 760 mm. and in the dry state.

The composition of this gas will be—

	Litres.
SO_2	699.1
O	593.2
N	5,847.8
	<u>7,140.1</u>

In a tower producing 18 per cent. of the total yield, this volume of gas will be reduced to 6,951.3 litres, and in a tower producing 25 per cent. of the total yield will be reduced to 6,877.9 litres, or there will pass through the working zone of the smaller tower an average volume of 7,045 litres, and through that of the larger tower an average volume of 7,009 litres. In two towers working at these rates, it was found that the mean temperature of the gases issuing from the smaller one was 80° and from the other one 95° ; by referring to a table of the tensions of aqueous vapour, it is easy to calculate the actual volumes of the gases at these temperatures.

In the first case it is—

$$7,405 \times \frac{760}{760 - 35.5} \times (1 + 0.293) = 9,542 \text{ litres;}$$

and in the second case—

$$7,009 \times \frac{760}{760 - 43.4} \times (1 + 0.348) = 10,006 \text{ litres.}$$

The time that this volume of gas is in the working space of the Glover tower varies, therefore, from 9 to $21\frac{1}{2}$ seconds, and consequently each period of oxidation and reduction lasts from half a second to one second.

Such a phenomenon cannot be explained solely on the ground of the affinity of nitric oxide for the oxygen of the air. The author proceeds to show that it can be explained according to his theory.

He takes the actual case of an apparatus producing in winter 19,500 kilos. of H_2SO_4 per 24 hours. The Glover tower had a working space of 55 cubic metres (by working space is meant the total space occupied by the packing above the grate), with a height of 5.6 metres. This tower was fed by 62,000 litres of 60° B. acid from the Gay-Lussac tower, and by 10,000 litres of chamber acid of 55° B. It produced 4,900 kilos. of H_2SO_4 in the form of 60° B. acid per 24 hours.

Acid entering the tower:—

62,000 litres of 60° B.	= 106,082 kilos. of 60° B.
10,000 litres of 55° B.	= 14,426 kilos. of 60° B.
	<u>120,508 kilos. of 60° B.</u>

corresponding to—

82,850 kilos. H_2SO_4	+ 23,232 H_2O
11,301 kilos. H_2SO_4	+ 4,849 H_2O
94,151 kilos. H_2SO_4	+ <u>28,081 H_2O</u>

Acid leaving the tower:—

$$120,508 + (4,900 \times \frac{100}{78.1}) = 126,782 \text{ kilos. of } 60^\circ \text{ B.}$$

corresponding to—

$$100,017 \text{ kilos. } \text{H}_2\text{SO}_4 + 26,765 \text{ } \text{H}_2\text{O.}$$

There left the tower, therefore—

$$28,081 - 26,765 = 1,316 \text{ kilos. } \text{H}_2\text{O}$$

in the form of vapour. To this must be added the water introduced with the nitric acid, which was equal to 118 kilos., making a total of 1,434 kilos. of water-vapour.

This weight of vapour was held in solution by the gases. The temperature of these at the exit of the Glover tower was 95° . In the dry state, and measured at 0° and 760 mm., their volume was shown above to be 6,878 litres per kilo. of sulphur burnt. Assuming that 1 kilo. of sulphur produces 3 kilos. of H_2SO_4 , the total volume of gas on a total yield of 19,500 kilos. of H_2SO_4 is—

$$6,878 \times \frac{19,500}{3} = 44,708 \text{ cubic metres.}$$

The nitrous acid consumed in the tower was equivalent to 24 parts NaNO_2 per 100 of sulphur. Assuming that this left the tower entirely in the state of NO, there would leave

$$0.24 \times \frac{19,500}{3} \times \frac{30}{85} = 550.6 \text{ kilos. NO.}$$

If V = the actual volume of gas leaving the tower, f = the tension of the aqueous vapour, h = the tension of NO in the mixture, these values may be found from the equations—

$$V \times \frac{f}{760} \times \frac{0.805}{1.3477} = 1,434.$$

$$V \times \frac{h}{760} \times \frac{1.3434}{1.3477} = 550.6.$$

$$V \times \frac{760 - f - h}{760} \times \frac{1}{1.3477} = 44,708.$$

whence—

$$f = 28.8 \text{ mm., } h = 6.6 \text{ mm., } V = 62,355 \text{ cubic metres.}$$

Referring to the author's table of the tension of aqueous vapour emitted by sulphuric acid, it will be seen that if the acid introduced into the tower had the same temperature as the gases, viz., 95° , an aqueous vapour tension of 28.8 mm. would correspond to a strength of $74\frac{1}{2}$ per cent. H_2SO_4 = sp. gr. 1.671. If the temperature were 85° it would contain 71.2 per cent. H_2SO_4 = sp. gr. 1.64, if the temperature were 75° it would contain only 66.5 per cent. H_2SO_4 = sp. gr. 1.575. Such differences would produce very different working in the tower.

In the case under consideration we have—

$$550.6 \times \frac{38}{59} = 697.4 \text{ kilos.}$$

nitrous acid issuing from the tower in a volume of 44,708 cb. metres of gas measured at 6° and 760 mm. = 15.6 mgrm.

nitrous acid per litre of gas. Acid of sp. gr. 1.671, even at a temperature of 90° in an atmosphere containing this quantity of nitrous acid, would dissolve a very considerable quantity of the latter and carry it down to a lower stratum. There, owing to the higher temperature, the acid would be denitrated little by little, the sulphurous acid would be oxidised, and the NO produced would re-ascend to the higher stratum, become re-oxidised, fixed by the sulphuric acid, and carried down again. It is this continuous circulation of nitrous acid which explains the action of the Glover tower as a producer of sulphuric acid.

It is obvious that the more concentrated the acid introduced into the tower the larger is the zone of denitrification and the better chance the nitric oxide has of being re-oxidised, so as to be carried down again; and consequently the more acid would actually be manufactured in the Glover tower.

The author then proceeds to show that if the acid used in the tower is too dilute a too rapid reduction takes place, and the Glover tower ceases to be an important factor of production. But even if the acid used be concentrated, the result is not satisfactory if the top part of the packing is cold, as the acid will there become diluted. The cooling of the packing is produced by three causes:—

1. Too small a sectional area, in which case the acid falls in large quantities upon the first layers and cools them.
2. A too great height of packing, so that the gases get too cold before they reach the top.
3. Exposure of the tower to the wind.

With regard to the third cause, the author has found great improvement in the working of a Glover tower by shielding it from the wind.

Reactions in the First Chamber.—In order to prevent the lead of the chamber being too rapidly attacked, manufacturers keep the acid on the sides at between 51° and 53° B. (sp. gr. 1.540 to 1.580 = 64 per cent. to 67 per cent. H_2SO_4). Reference to the experiments of the author on the temperatures of the chamber show that the temperature of the wall is about 75° when that of the axis is 90°. For acid of 67 per cent. at the walls with a temperature of 75°, the tension of aqueous vapour is 27 mm.; the acid in suspension in the atmosphere having necessarily the same tension as this, but being at a temperature of 90°, must consequently contain 73 per cent. H_2SO_4 (57° B.). If the acid on the wall only contain 64 per cent. H_2SO_4 , the tension of its aqueous vapour will be 37.4 mm., and therefore the acid in the interior will contain 71 per cent. H_2SO_4 (55.7° B.). These theoretical figures agree with the result of practical tests, several instances of which the author quotes, and justify the assumption that throughout each transverse section there is equilibrium of aqueous vapour tension.

He explains the utility of the second half of a chamber as shown in Lunge and Naef's diagram, as follows. As the gases pass from one end of the chamber to the other they become poorer in SO_2 . We have seen that in the interior parts of the chamber the heat given out by the chemical reactions is not compensated for by the radiation from the walls, and in fact we find a marked elevation of temperature towards the middle of the chamber; but from this point to the end of the chamber there is no material change at the axis.

This is clearly shown by the following observations of temperature at the axis of a chamber at different distances from the fore-end:—

	0.5 m. from Top.	3.5 m. from Top.
1.5 m. from fore-end	° C. 77	° C. 80
11.5 " " "	81	80
21.5 " " " (steam jet)	80	91
31.5 " " "	83	90
42.5 " " " (steam jet)	84	91

In the neighbourhood of the walls the temperature is found to fall barely 2°. Owing, however, to the decrease of sulphurous acid in the gases, the production of sulphuric acid tends to decrease, and the acid which condenses on the walls is always a little weaker at the end than in the middle (about 1° B.). The tension of the aqueous vapour is consequently greater, and the acid in suspension in the interior must be weaker. It is therefore less capable of determining the oxidation of the nitric oxide, and consequently of sulphurous acid, and the fact of this taking place just when the oxidation of sulphurous acid becomes more difficult, owing to the smaller quantity present in the gases, is the explanation of Lunge and Naef's diagram.

Influence of the Connecting Pipes.—The author ascribes the renewed activity of sulphuric acid formation at the entrance of the second chamber not to the better mixing of the gases in the pipe, but to the cooling influence of the latter. The gasses being cooled there 20° or 30°, condensation of water takes place which dilutes the acid in suspension and suddenly liberates from it a large quantity of nitrous acid, which thereupon produces the rapid oxidation of the sulphurous acid.

Application of the preceding Views.—The author suggests the following apparatus:—A Glover tower capable of producing 25 per cent. of the total yield, a chamber capable of oxidising 75 per cent. of the sulphurous acid that enters it (Lunge and Naef's diagram shows that this chamber would be about a quarter the capacity of ordinary chambers); following upon this chamber, a series of cooling pipes and small towers, the latter traversed by acid of 60° B. from top to bottom, whilst the gas and steam are introduced at the bottom. Assuming that these towers have each a cubical content equal to half that of the Glover tower, he reckons that with three towers there would be produced 93.27 per cent. of the total theoretical yield with a saving of about 60 per cent. in the capacity of the apparatus used.

Conclusions.—The author draws the following conclusions from his investigations:—

1. The successive oxidations and reductions of the oxides of nitrogen which determine the transformation of sulphurous acid to sulphuric acid are brought about by the variations in degree of hydration of the sulphuric acid suspended in the gases.

2. In the apparatus ordinarily used these variations of hydration are brought about by changes of temperature and are in direct relation to these.

3. The working of a sulphuric acid apparatus can be advantageously modified by increasing artificially and at certain points the concentration of the acid in contact with the gases and denitrating this acid at neighbouring points so as to bring about an active circulation of the oxides of nitrogen between the neighbouring zones.

4. The application of this process on an industrial scale should permit of a decrease in the first cost of plant and assure greater regularity of working.—H. S. P.

Suggestions for the Improvement of the Sulphuric Acid Process. F. Bode. Zeits. f. angew. Chem. 1890, 11—13.

It was first pointed out by Lunge and Naef (Chem. Ind. 1884, 5; this Journal, 1884, 633), and afterwards by Schertel (Chem. Ind. 12, 80—81; this Journal, 1889, 283), that only the first half of the sulphuric acid chamber was efficient. Schertel says, "only in the first half of the first chamber does the sulphurous acid become oxidised, whilst in the second half the quantity of sulphurous acid in the gases undergoes no decrease. After passing into the second chamber a revivification of the process takes place, but dies out again as soon as the gases have passed through the first half of this chamber," and so on in the other chambers. Schertel then proposes to substitute a number of small chambers for the large systems now in use. Lunge (Zeits. f. angew. Chem. 1889, 385; this Journal, 1889, 774—775) thinks Schertel's proposal too crude, and suggests the adoption of a preliminary mixing apparatus for the gases, together with suitable means of cooling within the apparatus. Further, he proposes the use of towers or columns of perforated porcelain plates (plattenthürme) between the

chambers, in which the enfeebled reactions will again be set going.

Sorel (this Journal, 1890, 181) recommends a system of cooling tubes and towers down which 60° B. acid is allowed to percolate.

The author points out that Schertel's suggestion merely means the same thing as the subdivision of the existing length of chamber into two parts, so that each part then becomes a chamber—in other words, substituting two short chambers for one long one. The term "short" is, however, a relative one, and instead of decreasing the length we may make a short chamber by increasing the breadth. An extreme case would be that in which what is now called the length of a chamber would be considered its breadth and *vice versa*. In such a case the gases would enter at one of the long sides of a chamber and pass out at an opening in the opposite long side.

Schertel's plan involves an increased expenditure of sheet-lead, the author's a decreased expenditure. Supposing it is desired to convert a set of a total capacity of 3,240 cm., consisting, say, of three chambers each 6 x 6 x 30 m. Following Schertel's plan, and making it into six chambers, this would mean an increase of wall-surface in the ratio of 100:109. Adopting the author's plan we have: (a.) The number of chambers (three) remains unaltered, but the breadth of each is doubled; this means a decrease of wall-surface in the ratio of 100:86.4 (b.) Six chambers are made, each of 12 m. width; this means a slight increase of surface—about 4.5 per cent. If only five chambers be formed, however, the surface is the same as in the case of the original three chambers.—H. S. P.

The Formation of some Fluorine Salts and their Industrial Value. M. Netto. Zeits. f. angew. Chem. 1890, 45—46.

SODIUM fluoride melted with aluminium chloride forms cryolite and sodium chloride (G. Forster, this Journal, 1888, 851); melted with sulphate of alumina, cryolite and sodium sulphate result (Winkler); with aluminium hydrate, sodium fluoride forms cryolite and sodium aluminate, $3\text{Na}_2\text{O} \cdot \text{Al}_2\text{O}_3$ (Schuch); this, when extracted with water and treated with carbon dioxide, yields the hydrate of aluminium and sodium carbonate. Aqueous solutions of sodium fluoride and aluminium sulphate when mixed together form a fluorine aluminium hydrate, and this, when fused with sodium fluoride, also yields cryolite.

Magnesium salts behave in a similar manner to aluminium salts towards sodium fluoride. Aqueous solutions of sodium fluoride and magnesium sulphate give an amorphous precipitate of fluorine magnesium hydrate; when boiled with water and magnesia the analogue of cryolite ($3\text{NaF} \cdot \text{Al}_2\text{F}_6$) is formed— $3\text{NaF} \cdot \text{Mg}_2\text{F}_6$ (Tissier). Magnesium sulphate melted with sodium fluoride forms magnesium cryolite, $6\text{NaF} \cdot \text{Mg}_2\text{F}_6$ —a crystalline powder—the crystalloids being regular cubes. This body behaves like cryolite towards acids; treated with caustic soda magnesium hydrate is separated whilst cryolite dissolves completely.

In commenting on the possibility of replacing natural cryolite by artificial cryolite or by this magnesium cryolite, the author points out the advantage of the last when compared with the artificial cryolite in point of price, owing to the magnesium salts being cheaper than those of aluminium; further, that a cheap method of preparation of sodium fluoride is what is really required to make either process a success.

The direct preparation of cryolite according to either of the following equations is possible, but the reaction is incomplete and the mass gets thicker and thicker as the quantity of calcium carbonate formed increases:—

I.

II.

—C. A. K.

The Soda Industry in the Year 1889. A. Hasenclever. Chem. Ind. 12, 431—436.

BETTER competition among German manufacturers engaged in the soda industry has made business profitless to all. Repeated attempts to form a combination have failed through the pretentious claims of individual producers. The fact that in 1888 the exports, reckoned on 100 per cent. carbonate of soda, exceeded the imports by 18,000 tons is no criterion of the general sound development of the industry, and profitable working has occurred in only exceptional cases. A sound basis for a lasting export trade in soda is lacking in Germany. A superficial comparison of the more favourable conditions that obtain in England, with her extended water highways and over-sea communications, shows the great disadvantages under which Germans have to compete in all industries which depend upon the bringing of various raw materials of small value to one point. The low railway tariff in England, arising from the competition of private railway companies, gives a great advantage to English makers, whilst the German State railways maintain a high tariff. Were there cheap carriage of fuel alone in Germany, great benefit would follow, as industries would then be carried on more generally throughout the land instead of being concentrated in the vicinity of the coal-fields.

The soda industry has grown in England, as it has in Germany, from year to year, during the last decade. In England there were used in this manufacture 568,542 tons of salt in 1878, and 781,348 tons in 1888. The increased production in England is entirely due to the manufacture of ammonia-soda. Many of the smaller Leblanc-soda makers have stopped their works, whilst the larger ones have gone on as before, and have reaped a moderate profit by the aid of a combination to limit the production of bleaching powder. The production of ammonia-soda in England has been limited to about one-fifth of the total make of soda, and the price obtained has enabled the firm of Brunner, Mond, and Co., to divide a dividend of 25 per cent.

In France, where, owing to trade combination and the high import duties, the price of soda has been the highest for many years, there seems to be a falling off in demand. The Leblanc-soda makers have suffered most, as the ammonia-soda makers are guaranteed the sale of a fixed amount.

In Austria, a combination among soda manufacturers has reduced the yearly make of all the works, and there would seem to be in that country a prospect of future stability were it not that German competition appears to preclude any material rise in price.

If, under such unfavourable conditions, some makers have carried on their works at a profit, this has been due either to an increase in the value of by-products, or to the working of other branches of manufacture which permit of being carried on in connexion with the soda process.

After drawing attention to Mond's method of recovering ammonia and tar from fuel as carried out at Northwich (this Journal, 1889, 505), the author goes on to describe other processes that have been adopted in connexion with soda works.

The "Chemische Fabrik Rheinania" has been making sulphuric acid from zinc blende, in connexion with spelter works at Stolberg, Oberhausen, Hamborn, Bensberg, and Dortmund. Ten years ago 12,000 tons of sulphuric acid, 60° B., were made, and in 1888 the quantity reached 51,010 tons.

W. Grillo has worked out a process for making liquid sulphurous acid from blende, and at Lipine, in 1888, 1,141 tons of liquid sulphurous acid were thus made and found a ready sale enclosed in iron vessels; but in Silesia the process has not been profitable.

Since the consumption of sulphuric acid increases year by year, the author thinks that both in Silesia and Belgium, in the course of time, all zinc works will utilise the gases from blende roasters. One cause for an increased demand for sulphuric acid will be the increased manufacture of sulphate of ammonia from the ammonia recovered from fuel and from coke-ovens. In Silesia 120 new coke-ovens adapted to this purpose were erected in 1889.

Efforts on the part of ammonia-soda makers to combine the manufacture of chlorine with the ammonia-soda process have so far led to no practical results. In view of the present value of hydrochloric acid, the author has been of opinion that up to the present day in Germany, the Leblanc-soda manufacturer has had an advantage over the ammonia-soda maker, but owing to the enormous rise in the price of fuel and the fact that twice as much fuel is used in the Leblanc process as in the ammonia-soda process for a given weight of soda, he thinks that in 1890 the Leblanc-soda maker will be at a disadvantage. The increased price of salt will affect the old process more unfavourably than the new, since the ammonia-soda makers usually have their own brine. The value of bleaching powder and hydrochloric acid is also likely to fall, in view of the manufacture of hydrochloric acid and chlorine from magnesium chloride, the introduction of electrolytic methods of bleaching and the making of chlorine by Campbell and Boyd's process now being worked out at the North British Alkali Works in Glasgow (Eng. Pats. 10,187, July 13, 1888, and 18,056, December 11, 1888; this Journal 1889, 983).

Reference is next made to Chance's sulphur-recovery process (this Journal 1888, 162) and to the patents of Gossage, Rawes (Eng. Pat. 1393, March 22, 1882; this Journal, 1882, 451), and Opl (Ger. Pat. 23,142, October 8, 1882; this Journal, 1882, 452), and the author then proceeds to describe experiments that he has carried out on a manufacturing scale with the v. Miller and Opl process for recovering sulphur or sulphuretted hydrogen from soda-waste.

According to the method of von Miller and Opl (Eng. Pat. 2334, January 29, 1884; this Journal, 1884, 373, 393, 551) calcium sulphhydrate is decomposed by steam instead of by carbonic acid, as in Chance's patent.

The following considerations among others induced the author to attempt to carry out in a large scale the v. Miller and Opl process in preference to that of Chance:—1. By the v. Miller and Opl process, pure sulphuretted hydrogen is formed instead of a gas containing 33 per cent. H_2S as in Chance's process. 2. Calcium hydrate is formed in the former process, for which a use can be more easily found than for the calcium carbonate formed in the latter process. 3. The employment of lime kilns and blowing engines is avoided, and the employment of boilers for generating steam is a cheaper plan of working.

The heat required to carry out the reaction was estimated theoretically as follows:—

That is to say, for the recovery of every 64 kilos. of sulphur from CaS_2H_2 , 25,160 heat units must be supplied to complete the reaction, or for every 100 kilos. of S, 40,000 heat units are needed. Supposing that 1 kilo. of coal yields 5,000 heat units, then 8 kilos. of coal would be required to recover 100 kilos. of S. This amount left a wide margin for practical working. The apparatus consisted of horizontal wrought-iron cylinders, fitted with suitable appliances for agitating their contents. The accompanying Figure shows the arrangement.

The soda-waste is mixed with water in the mixing apparatus I., and passes thence into the cylinders II. and III., where it is subjected to the action of sulphuretted hydrogen, whereby calcium sulphhydrate is formed. The cylinder IV. is surrounded by a steam-jacket. In this cylinder the sulphhydrate is warmed up and then passes into the three lower cylinders V., VI., VII. where it is decomposed by steam. The steam enters the lowest cylinder VII. first, and then passes through into the two upper ones. The evolved H_2S , together with the excess of steam, then leave V. by a pipe and pass into the jacket round cylinder IV., where they warm up the calcium sulphhydrate contained in the cylinder. From the jacket the H_2S and uncondensed steam next pass into a condenser VIII. cooled with water, where the rest of the steam condenses, and the H_2S is then passed into the cylinders III. and II. Here half the H_2S is used to form

calcium sulphhydrate, $\text{CaS} + \text{H}_2\text{S} = \text{CaS}_2\text{H}_2$; the other half passes from the apparatus II. to be made further use of:—

The experiments that have been carried out show that the conversion of all the CaS into CaS_2H_2 is easily effected in the absorption cylinders, and that heat is evolved in the reaction, so that it is necessary to cool these cylinders with water. A liquor of 28°B. is easily obtained containing 212 grms. of sulphur per litre. The decomposition of the sulphhydrate by steam only takes place rapidly enough, however, when the solution is concentrated. The further the decomposition has been carried the slower it goes on. The author intends to publish a more detailed account of the experiments later. They have indeed shown that it is possible to recover nearly all the sulphur as H_2S by this method, but the quantity of coal used in generating the necessary quantity of steam was 90 times the theoretical quantity. A modified apparatus reduced this amount considerably, but nevertheless the reaction was too slow. He does not yet consider the experiments as completed, but does not think the future prospect is promising for the process.

The fact that by this process pure H_2S is obtained is on closer consideration not a great advantage, except that gasometers are not needed for collecting it. This is obvious from the fact that the gas from Chance's process, which contains 33 per H_2S , is quite suitable for burning to make sulphuric acid, and contains only about the same quantity of air as would be consumed in burning pure H_2S .

The question of using the H_2S for making S is one that must be considered, not on the basis of present prices, but in view of a considerable fall in price, due to the competition which would ensue were all Leblanc-soda makers to recover the sulphur from their waste. England alone would produce 142,000 tons, whereas her import of sulphur is now only 32,000 tons.

The cost of plant for working up the waste in a works using 1,000 tons of salt per week is reckoned in England at 1,000,000 marks. In that country the calcium carbonate produced (which is too fine for use in making soda) can be disposed of for cement-making more easily than in Germany, owing to the higher cost of carriage in the latter country. Moreover, English works are generally very limited in space, and have to pay a good deal to get the waste removed. Finally, taking into account the fact that, whilst in England to make 100 kilos. of S, 0.38 marks are reckoned for coal, whilst Germans have to pay twice that sum, it can easily be understood why German soda-makers are chary of setting up sulphur-recovery plant, whilst on the other hand in England there are three works already working the process, and many others engaged in erecting the necessary plant.—H. S. P.

On the Proportion of Water to Hydrochloric Acid formed by igniting Mixtures of Hydrogen, Oxygen, and Chlorine. P. Hautefeuille and J. Margottet. *Compt. Rend.* 109, 641—643.

THIS research is regarded as preliminary to an investigation of the decomposition of water by means of heat in the presence of chlorine and carbon monoxide.

In a first series of experiments, a known volume of chlorine was added to a given amount of gas obtained by the electrolysis of water. In a second series, a known volume of oxygen was added to the elements of hydrochloric acid. The mixtures were exploded in a thick glass tube containing about 80 cc. by means of a spark. The apparatus is not described in detail.

The pressures of the gases and the amount of chlorine before and after the explosion were determined, the residual chlorine being estimated by means of a solution of sodium arsenite.

These data enable one to deduce from them the amounts of water and of hydrochloric acid formed.

Let h be the pressure of the hydrogen, H the pressure of the chlorine, these being introduced into the eudiometer at the same temperature.

p the weight of hydrogen, P the weight of chlorine introduced.

p^1 the weight of hydrogen which unites with chlorine during the experiment.

P^1 the weight of chlorine which remains uncombined.

We have—

$$p = P \times \frac{0.069}{2.44} \times \frac{h}{H}.$$

Since p^1 is the weight of hydrogen which unites with chlorine, it is evident that $p - p^1$ = the weight of hydrogen which unites with oxygen and

$$\frac{p - p^1}{p^1} = \frac{\text{number of half molecules of water formed during the experiment.}}{\text{number of molecules of hydrochloric acid}}$$

The authors found that $\frac{p - p^1}{p^1}$ does not vary with the pressure between the limits of $\frac{1}{4}$ and $\frac{3}{8}$ of an atmosphere, nor with the nature of the spark.

SERIES I.—SYNTHESIS OF WATER IN THE PRESENCE OF CHLORINE.

Composition of the gaseous mixture.										
	Vol. of O	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
	Vol. of H	1	1	1	1	1	1	1	1	1
	Vol. of Cl	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	2
Value of $\frac{p - p^1}{p^1}$	$\frac{5}{4}$	$\frac{1}{1.8}$ to $\frac{1}{1.9}$	$\frac{1}{2.3}$ to $\frac{1}{2.5}$	$\frac{1}{3.8}$ to $\frac{1}{4.3}$	$\frac{1}{5.2}$ to $\frac{1}{5.7}$	$\frac{1}{9.2}$ to $\frac{1}{11.2}$	$\frac{1}{20}$	$\frac{1}{40}$		0

(1.) As soon as the volume of chlorine is greater than half the volume of hydrogen contained in the electrolytic gas, $\frac{p - p^1}{p^1}$ is less than unity, and diminishes rapidly with the increase in the proportion of chlorine, so that when

the volume of chlorine is double that of the hydrogen present, no water is formed at all.

(2.) Changes in the composition of the resultant mixture are gradual and not sudden as in Bunsen's experiments on mixtures of carbonic oxide, hydrogen, and oxygen.

SERIES II.—SYNTHESIS OF HYDROCHLORIC ACID IN THE PRESENCE OF OXYGEN.

Composition of mixture								
	Vol. of Cl	1	1	1	1	1	1	1
	Vol. of H	1	1	1	1	1	1	1
	Vol. of O	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	3
Value of $\frac{p - p^1}{p^1}$	$\frac{1}{7.2}$	$\frac{1}{4.3}$ to $\frac{1}{4.7}$	$\frac{1}{3.8}$ to $\frac{1}{4.3}$	$\frac{1}{3.4}$	$\frac{1}{5.1}$ to $\frac{1}{3.3}$	$\frac{1}{3.2}$	$\frac{1}{3.2}$	$\frac{1}{3.2}$

The ratio $\frac{p - p^1}{p^1}$ is always less than unity, and varies but little when the ratio, by volume, of oxygen to hydrogen present is increased from $\frac{1}{2}$ to 3.

The results may be put in the form of equations, e.g. :—

The temperatures to which these states of equilibrium correspond cannot be determined directly. The authors intend to estimate them by means of data furnished by Berthelot and Vieille, and also by some further experiments.

—P. J. H.

On the Distribution of Hydrogen between Chlorine and Oxygen. H. Le Chatelier. *Compt. Rend.* **109**, 664—667.

The experiments of Hautefeuille and Margottet (preceding abstract) on the distribution of hydrogen in presence of chlorine and oxygen supply important information respecting the general laws of chemical equilibrium. The author has been engaged upon similar researches (undertaken with the intention of applying the results to the Deacon process for the manufacture of chlorine), and points out how the value of the coefficients of distribution can be determined by calculation.

The formula for equilibrium in the case of a mixture of oxygen, chlorine, water, and HCl is—

$$\text{Log}_e \frac{p(\text{O}_2) \times p^1(\text{HCl})}{p^{1/2}(\text{Cl}_2) \times p^{1/2}(\text{H}_2\text{O}_2)} + 500 \int \frac{L dT}{T^2} = \text{const.}$$

L is the heat of reaction of 1 molecule of oxygen with 4 molecules of HCl; its value is 28 at ordinary temperatures, and does not vary much up to 1,000°. The value of the constant depends upon the composition of the mixture in equilibrium; its normal value in the Deacon process is 15. In order to apply the formula it is necessary to express the pressures as functions of the number of molecules of each substance.

If we denote these as follows :—

Substance H_2 O_2 Cl_2 H_2O_2 HCl N_2

Number of molecules 1 n n' x $2(1-x)$ N

and further denote the pressure (in atmospheres) of the mixture by P , the formula becomes—

$$\text{Log}_e P + \text{Log}_e \frac{16(2n-x)(1-x)^4}{(2n+2n'+2N+2-x)(n'-1+x)^2x^2} + \frac{1,400}{T} = 15.$$

This formula applies up to 1,000°, but is not rigorously correct at higher temperatures when the dissociation of the chlorine molecule becomes appreciable. The hygrometric state, which is of importance, has not been indicated in the experiments of Hautefeuille and Margottet. We must therefore assume that the gases were saturated with water-vapour at 15°, i.e., that they contained 2 per cent. by volume. The temperature of the mixture corresponding to the state of equilibrium has not been (and cannot be) determined. It depends upon the relative rapidities of the chemical reactions and the cooling effect. The former increases rapidly with the temperature, being practically zero at 500° and only acquiring a noticeable value above 800°. We can only suppose that the temperature in question is higher than 1,000° and lower than 2,000°.

Influence of Temperature.—The proportion of water produced ought to decrease as the temperature increases. The following table, calculated from the formula, gives the number x of molecules of water produced per molecule of hydrogen in a mixture containing equivalent proportions at the atmospheric pressure—

t	0°	300°	400°	650°	1,120°
x	0.009	0.00	0.30	0.50	0.20

The oxidation of HCl should therefore be practically complete at ordinary temperatures. This has already been proved by M. Berthelot.

Influence of Pressure.—The formula indicates a diminution in the proportion of water when the pressure diminishes. This diminution is small, because the change of volume accompanying the reaction is itself small. It must however occur, if the molecular volumes assigned to the various substances are correct, for it follows directly from the second law of thermodynamics. On the other hand the experiments of MM. Hautefeuille and Margottet show that change of pressure produces no effect. This shows that the molecule of chlorine is, under the given conditions,

partially dissociated; if it were completely dissociated the diminution of pressure would, on the contrary, increase the proportion of water produced.

Influence of the Relative Proportion of Elements present.—This is the most interesting point, for it enables us to test the correctness of the formula. The following table gives the calculated proportions of water produced from a mixture containing equivalent proportions, and also those obtained by MM. Hautefeuille and Margottet, allowing for 2 per cent. of water-vapour by volume:—

Cl ₂	1	1.25	1.50	2	1	1	1	4
H ₂	1	1.25	1.50	2	1	1	1	0.5
O ₂	0.5	0.5	0.5	0.5	0.25	1.25	3	0.5
H ₂	0.5	0.5	0.5	0.5	0.25	1.25	3	0.5
H ₂ O ₂ { calculated	0.238 {	0.15	0.07	0.06	0.19	0.25	0.27	0.63
H ₂ { observed		0.148	0.08	0.07	0.215	0.275	0.31	0.58

The agreement between the calculated and observed values is thus seen to be most satisfactory; it is even better than could have been expected, inasmuch as no allowance is made for possible dissociation of chlorine. The action of the excess of chlorine or oxygen depends, therefore, solely upon the relative volumes of the bodies present, and is in no way dependent upon their special chemical properties, for these do not enter at all into the formula.

The distribution of oxygen between carbon monoxide and hydrogen may be similarly represented—

$$\text{Loge} \frac{p(\text{C}_2\text{O}_2) \times p'(\text{H}_2\text{O}_2)}{p''(\text{H}_2) \times p'''(\text{C}_2\text{O}_1)} + 500 \int \frac{L dT}{T^2} = \text{const.}$$

or, neglecting the variation of L with temperature, and using the following notation for a mixture containing a semi-molecule of displaceable oxygen—

Substance..... CO₂ H₂ H₂O₂ C₂O₁
Number of molecules n n' x $1-x$.

$$\text{Loge} \frac{(n-1+x)x}{(n'-x)(1-x)} + \frac{5,000}{T} = \text{const.}$$

In this case it will be observed that the state of equilibrium is strictly independent of the pressure.—D. E. J.

The Preparation and Properties of Anhydrous Platinum Difluoride. H. Moissan. *Compt. Rend.* **109**, 807—809.

This body is prepared by passing fluorine over a bundle of platinum wires heated to about 500°—600° C., and placed in a stout platinum tube. If no hydrofluoric acid be present no reaction takes place at all up to 100° C. At ordinary temperatures platinum itself is entirely unacted upon by fluorine. A mixture of fluorine and hydrofluoric acid, however, is more energetic in its action than fluorine alone. The fluoride is obtained as a fused mass of a deep reddish colour or as small yellow crystals much resembling those of the dichloride. It is exceedingly hygroscopic and its reactions with water are very characteristic. If placed in a little water it dissolves, but the solution becomes hot and the hydrated oxide is then precipitated. With a comparatively large quantity of cold water the decomposition is retarded, but on warming the salt is at once decomposed. Its peculiar behaviour with water explains the fact long ago observed that the anhydrous difluoride cannot be obtained in the wet way, for, as seen, it rapidly decomposes water to form hydrofluoric acid and the brownish-yellow precipitate recalls to mind Frémy's hydrated dioxide PtO₂.H₂O₂. When raised to a bright red heat the fluoride readily splits up into fluorine and platinum, the latter presenting a distinctly crystalline appearance.

The salt was analysed by dissolving a portion in a large quantity of water, then pouring off from any slight insoluble residue and boiling the clear solution. On drying the precipitate and igniting, the weight of platinum thus obtained gave the formula PtF₂ for the new compound.—S. G. R.

Further Researches on the Preparation and on the Density of Fluorine. H. Moissan. *Compt. Rend.* **109**, 861—864.

The fluorine was obtained by the electrolysis of pure hydrofluoric acid, in quantities of about 100 cc. at a time, contained in the platinum apparatus similar to the one formerly described but of a capacity of about 160 cc. Lest the fluorine should carry over with it any traces of hydrofluoric acid, the products of electrolysis were passed through a platinum spiral placed in a bath of methyl chloride giving a temperature of about -50° C. or 70° C. below the boiling point of the acid. The gas then passed over sodium fluoride and, being considered pure, was led to the apparatus shown in the Figure.

This was a platinum flask of a capacity of about 100 cc. and weighing about 70 grms., and closed by a rounded perforated stopper accurately fitted to its seat and serving also as a stopcock. The flask was first filled with pure dry nitrogen and this in turn displaced by the fluorine which was passed in by a platinum tube fitting into A. After that silicon inflamed readily in the issuing gas the current was still continued for five minutes. The stopper was then turned round on itself and the plug being introduced into the tube A, all connexion with the exterior was cut off. The flask was then weighed on a balance turning readily with 0.0005 grm. and its capacity was also determined. From these data the density of fluorine was deduced as (1) 1.262; (2) 1.265; (3) 1.270, the figure adopted being 1.265. The theoretical density of fluorine is $0.06927 \times 19 = 1.316$. As was the case with phosphorus trifluoride the observed density is rather low, hence it seems possible that the accepted atomic weight of fluorine, namely 19, may be rather too high.—S. G. R.

The Colour and Spectrum of Fluorine. H. Moissan.
Compt. Rend. 109, 937—940.

By analogy it was considered likely that fluorine would possess very little if any colour, since it stands first in the halogen family and is followed by chlorine, possessed of no great depth of colour in comparison with the highly-coloured bromine and still more highly-coloured iodine. A tabular apparatus of platinum was used for the observation, and care was taken that it was perfectly dry, since water is speedily decomposed by fluorine. On looking through a depth of 0.5 metre of fluorine, it was observed that the gas possesses a greenish-yellow colour much more faint than that of chlorine regarded through a tube of similar depth, and being besides a tint more closely approaching yellow than the greenish-yellow tint of chlorine. Examined through a depth of 1 metre, fluorine was not observed to possess any absorption bands. The following singular observation was made. When the platinum apparatus was filled with fluorine, a very small quantity of water was added, which immediately decomposed with formation of hydrofluoric acid and ozone. This latter gas was produced in a state of such concentration that the whole of the tube assumed the indigo-blue tint observed in ozone of Hautefeuille and Chapuis. After a few minutes, owing to the temperature of the laboratory, the ozone was partly destroyed and the colour reduced; it thus gradually faded and at length disappeared. The spectrum of fluorine was also determined, and a large number of bands, upwards of 13, all in the red part of the spectrum, were found.

A New Process for the Utilisation of Atmospheric Oxygen and the Compounds upon which the Process is Based.
G. Kassner. Dingl. Polyt. J. 274, 136—142; 183—190; 226—231; 270—276.

Preparation and Properties of Compounds Used.—

The author found in 1884, when barium manganate was boiled with oxidisable bodies in aqueous solution it parted with its oxygen to these and was converted into a brown substance of the formula $MnO_2 \cdot Ba$, and that this on heating in air took up oxygen and was reconverted to barium manganate. Several drawbacks attended its use; amongst others, in presence of water barium hydrate was formed which rapidly absorbed carbonic acid, and so an increasing amount of barium carbonate was contained. The regeneration, moreover, was very slow.

The author working on the subject has produced three new compounds, and describes their preparation, properties, commercial application, and chemical relationship.

Barium Plumbate, Ba_2PbO_4 .—Barium hydrate and lead oxide were heated in a porcelain crucible over a Bunsen flame; a deep black substance was obtained. Dilute hydrochloric acid added to a portion caused effervescence as of carbonic acid; there was a strong odour of chlorine, and a yellow-green solution remained. Dilute nitric acid separated a brown powder. Sulphuric acid was without action until oxalic acid was added, when barium and lead sulphates were formed and carbon dioxide evolved. When oxalic acid was used with nitric acid a clear solution of the respective nitrates was obtained.

By mixing one equivalent of lead oxide and one equivalent of barium carbonate and heating as before, a glassy substance was produced, the colour deepening until quite black. It was powdered, and on testing showed by action of acids that carbonic acid still remained, that the whole of the lead oxide has not been converted into the dioxide, and that all the displaceable oxygen could not be obtained. The presence of lead oxide was proved by adding nitric acid and testing with sulphuretted hydrogen. The displaceable oxygen was determined by mixing three parts of the product with one part of pure oxalic acid and warming with dilute nitric acid till evolution of carbonic acid ceased, when the excess of oxalic acid was determined by titrating back with potassium permanganate, $H_2C_2O_4 + 2H_2O + O = 2CO_2 + 3H_2O$. Nitric acid is preferable for the determination, sulphuric acid causes separation of the sulphates, and acetic acid is unreliable.

The displaceable oxygen was found by two tests as 2.32 and 2.59 per cent.

The true barium plumbate was obtained by heating two equivalents of barium carbonate and one of lead oxide. The product was deep black, and contained only slight traces of carbonic acid and lead oxide. The displaceable oxygen was found to be 2.86; theoretically it should have been 2.94. Hypothesis points to a plumbic acid, H_2PbO_3 , the anhydride being PbO_2 .

Strontium plumbate, Sr_2PbO_4 .—Two equivalents of strontium carbonate and one equivalent of lead oxide treated in a similar way gave a deep-brown chocolate-coloured compound showing the same reactions.

Calcium plumbate, Ca_2PbO_4 .—This was made by heating two equivalents of calcium carbonate and one of lead oxide. A lesser heat was required than in case of the other two, and the conversion was effected in about five minutes, over the Bunsen flame. The compound was of a yellowish-red or flesh colour. The abundance and cheapness of calcium carbonate should render this the cheapest of the three compounds.

The properties of the three plumbates were similar, and all were insoluble in water. Examined microscopically, the last-mentioned was seen as an aggregate of yellowish crystals. On treatment with sodium bicarbonate, opaque brownish-black masses (PbO_2), having between them colourless crystals ($CaCO_3$), were obtained. The action of acids is similar on all three; nitric acid forms the brown lead dioxide and a nitrate of the alkaline earth. Dilute sulphuric acid gives also lead dioxide and a sulphate of the alkaline earth, though strong acid forms both sulphates. Dilute acetic acid has no action in the cold; on heating, dioxide and the acetate are formed. Hydrochloric acid dissolves them to a yellow-green liquid. To obtain a clear solution, nitric or acetic acids may be used with oxalic acid, or, preferably, hydrogen peroxide.

Carbonic acid or bicarbonates produce carbonates of the alkaline earths and lead dioxide. Sodium bicarbonate acts better than the potassium salt.

The author found that 350 grms. of calcium plumbate and 400 grms. of potassium bicarbonate in a little water, heated on the water-bath to the boiling point, gave a clear brown liquid deepening to black. The heavy powder, a mixture of lead dioxide and the corresponding carbonate, settled to the bottom, and on being dried and ignited formed again the plumbate. The soluble alkaline salts are easily removed by decanting and washing, and the alkaline carbonate can be obtained as a by-product.

Water alone, at a temperature of $150^\circ C$., under increased pressure, caused formation of the dioxide and the corresponding alkaline hydrate. Ammonium mono- and bicarbonates gave ammonia, carbonates of the alkaline earths and lead dioxide. Ammonium nitrate and acetate gave ammonia, lead dioxide, and the respective salts of the alkaline earths.

The Technical Application of these Compounds.—Calcium plumbate is most to be preferred, being not only the easiest and cheapest to produce, but because it contains proportionately the highest percentage of displaceable oxygen, viz., 4.56 per cent. It may be used directly, as in the glass industry, for production of lead and lime glass.

Its widest application is, however, indirectly by decomposition and formation of lead dioxide. This can be accomplished, as already noted, in many ways, e.g., by water or steam under increased pressure, by carbon dioxide, mono- or bicarbonates, ammonium salts, or lastly, by strong acids, such as acetic, nitric, sulphuric, &c.

The oxidation of potassium ferrocyanide (yellow prussiate) to potassium ferricyanide (red prussiate) is rapidly and completely accomplished by means of calcium plumbate and carbon dioxide.

In the presence of free caustic alkali the reaction is not complete, and excess of free alkali causes the re-formation of lead dioxide. The process is, however, cheaper than

that by means of chlorine, for the more valuable potassium carbonate is obtained instead of the chloride. Then the insoluble residue is easily separated, washed, and by subjection to a red heat in presence of air, calcium plumbate is regenerated.

Potassium ferriyanide with caustic alkali is known as an excellent oxidising agent, readily oxidising lead oxide to the dioxide, chromic hydroxide to chromic acid, and manganese sesquioxide to manganese dioxide. It has recently received wide application in organic chemistry; such a solution bleaches vegetable fibre as strongly and quickly as hydrogen peroxide (compare this Journal, 1890, 108). The price has hitherto been an obstacle. This objection is now removed, because by simply boiling the reduced solution with the decomposed plumbate, and introduction of carbon dioxide, ferriyanide is regenerated, and can thus be used again and again.

For the production of oxygen on the large scale the author recommends treating the plumbate with sodium bicarbonate, decanting off the soluble alkali, washing the insoluble residue, pressing into lumps, and drying these in the generating apparatus with superheated steam; as soon as dry, the steam is stopped, and, all air having thus been expelled, heat is applied, when the oxygen is freely given off.

The application of the barium and strontium plumbates is limited on account of the greater cost, the stronger heat required in formation, and the proportionately less amount of displaceable oxygen contained.

Although in the carefully prepared plumbates the lead oxide is entirely converted to plumbic acid, yet this is not so on the large scale, and therefore the alkali obtained (as a by-product) may contain lead in solution. The presence of so poisonous a substance in a compound having such wide applications is highly obnoxious, and care must be taken to eliminate it. This, however, is easily accomplished by means of hydrogen sulphide or any soluble sulphide with which the solution should always be tested. Barium or strontium hydrates should be treated with their respective sulphides. Another method is by electrolysis, when the insoluble dioxide is readily deposited on the anode.

The author contrasts his process with the older methods of Boussingault, of Weldon, and that of Brin's Oxygen Company.

He contends that barium dioxide becomes gradually more or less inert from formation of barium carbonate, and that it requires an extremely high heat to expel the oxygen. That by means of calcium plumbate pure oxygen is obtained; that the plumbate continues unaltered—that is the CaCO_3 and PbO remain in same proportions—and that the much lower heat at which oxygen is given off would mean the use of considerably less fuel. Further, it has a higher specific heat, and although it is heavier in proportion, yet a greater percentage of oxygen is obtained by use of calcium plumbate, while there is the production as a by-product of the alkaline carbonate.

For the much-spoken-of production of chlorine from magnesium chloride, the following simple process is applicable: (1) mixing with the magnesium salt; (2) drying to expel the water of crystallisation; (3) granulating and sifting the hard mass; (4) heating it at a high temperature; (5) collecting or absorbing the chlorine given off.

The author also shows the superiority of the plumbates to the barium manganate before described.

Chemical Relations of the New Bodies.—

Frémy (Ann. Chim. Phys. 12, 409) prepared a compound by mixing lead oxide and potassium hydrate in a little water and crystallising over sulphuric acid. It was obtained in colourless crystals of composition $\text{K}_2\text{PbO}_3 + 11\text{H}_2\text{O}$. Again, W. Crum (Ann. 55, 212) prepared an almost colourless compound of calcium and lead dioxide by mixing lead nitrate, milk of lime, and calcium chloride solution and heating for some time at 160°F . The formula assigned was $(\text{CaO}_2)\text{PbO}_2$.

There would seem to be two hypothetical acids—

Ortho-plumbic acid, $\text{Pb}(\text{OH})_4$,

Meta-plumbic acid, $\text{PbO}(\text{OH})_2$

The above bodies, Ca_2PbO_4 , Sr_2PbO_4 , and Ba_2PbO_4 would thus be *ortho-plumbates*. Red lead might be $\text{Pb}_2(\text{PbO}_4)$ (see this Journal, 1889, 468).

The *meta-plumbate* being the K_2PbO_3 prepared by Frémy, and also by Geuther (Annalen, 219, 68 and 69)—the latter by passing oxygen into a solution of oxide of lead in fused potassium hydrate—the sesqui-oxide may be written $\text{Pb}(\text{PbO}_3)$. The author concludes by pointing out that PbO_2 thus acts similar to SnO_2 and CO_2 , and indicating the correspondence in the periodic system of carbon, silicon, zinc and lead.—D. A. S.

PATENTS.

Improvements in the Treatment of Gases and Recovering of Sulphur from Sulphuretted Hydrogen evolved in various Manufacturing Processes. J. Barrow, Manchester. Eng. Pat. 17,528, December 1, 1888. 8d.

The gases are deprived of sulphuretted hydrogen by treatment in a scrubber with a solution of perchloride of iron or manganese or both. The precipitated sulphur is collected by settling and filtration. The reduced solutions are regenerated by treatment with peroxides of iron or manganese or with heated air. Plant for conducting the process is described.—G. H. B.

Improvements in the Manufacture of Chlorine and Chloride of Lime and in Apparatus therefor. Solvay and Co., Brussels, Belgium. Eng. Pat. 18,574, December 19, 1888. 6d.

A MODIFICATION of a process embodied in several previous patents for the production of chlorine from calcium chloride by heating it with silicious and aluminous materials. When clay is employed it is found desirable to calcine and powder it before admixture with calcium chloride, in order to drive off combined water, which, if present, would favour the production of hydrochloric acid rather than of chlorine in the subsequent reaction. Hitherto the furnacing of the mixture has been conducted in retorts heated externally, in order to avoid contact with combustible gases containing carbonic oxide, which has a great tendency to combine with the chlorine to form carbonyl chloride, from which chlorine cannot be again recovered in its active form. The amount of fuel required by this method of heating in closed retorts is obviously very considerable, and the chief object of the present patent is to provide a method of direct heating in which the formation of carbonyl chloride shall be reduced to insignificant proportions. To this end the decomposition is effected in a high tower of thick masonry filled with the material to be treated. Gases from a coke gasifier or gas generator are introduced through a ring of short branch pipes situated near the middle of the tower, whilst air is passed in at the bottom. The cold air becomes heated in its passage through the descending hot material until it meets with the generator gas, which is completely burnt in a short space above the supply pipes, termed the zone of combustion. Above this is the zone of decomposition, in which the hot gases containing an excess of air act on the descending material and produce an evolution of chlorine. The upper layers of material serve to abstract the heat of the gases in their passage through it. The tower thus serves as a regenerative element, cool gases leaving the top, whilst the exhausted material arrives cold at the bottom. The chlorine produced in this manner being contaminated with a considerable proportion of carbonic acid, is not suitable for the production of chloride of lime by the ordinary method. The gases are therefore passed into a solution of lime which absorbs all the chlorine, but only a part of the carbonic acid, and this part precipitates from the solution as carbonate of lime. The solution of chloride of lime is then decomposed by the hydrochloric acid which is unavoidably produced in small quantities in the principal reaction, and which is condensed from the chlorine simultaneously produced. Concentrated chlorine gas is thus obtained, which is then directed either upon lime in the ordinary way, or upon imperfect chloride of lime obtained with poor chlorine, and which may then be brought to the desired strength. The dilute chlorine mixed with carbonic acid may also be employed in the manufacture

of chlorates. This process and apparatus are not limited solely to the decomposition of calcium chloride, but are applicable also to the decomposition of magnesium chloride, and of chlorides generally by the dry process. (This Journal, 1885, 345 and 533; 1886, 451; 1887, 661.)—G. H. B.

Improvements in or relating to the Manufacture of White Lead. H. B. Condy, Battersen. Eng. Pat. 18,705, December 21, 1888. 6d.

See under XIII., page 199.

Improvements in Reconvertng and Utilising By-Products such as are Formed in Processes for Obtaining Chlorine. R. H. Steedman, Dalnuir, and A. J. Kirkpatrick, Glasgow. Eng. Pat. 18,921, December 28, 1888. 4d.

A SOLUTION of manganese sulphate is treated at a boiling temperature with magnesium carbonate, or magnesnia and carbonic acid, manganese carbonate being precipitated and magnesium sulphate remaining in solution.

The manganese carbonate, after filtration and washing, is calcined for the production of oxide suitable for generating chlorine. The solution of magnesium sulphate is evaporated and heated with sodium or potassium chloride, hydrochloric acid being evolved. The residue, consisting of magnesnia and sulphate of soda, is treated with water, which extracts sulphate of soda and leaves magnesnia ready for use again.

—G. H. B.

Improvements in the Method of Treating Alkaline Sulphides in Solution or an Aqueous Mixture of the same with Carbonic Acid Gas for the Production of Sulphuretted Hydrogen and in Apparatus therefor. E. W. Parnell and J. Simpson, Liverpool. Eng. Pat. 19,023, December 31, 1888. 8d.

A SOLUTION or aqueous mixture of alkaline sulphides is charged into a series of receptacles so connected that the contents may be subjected at will to the passage of either of two streams of carbonic acid gas containing an admixture of nitrogen or other inert gas. It is found convenient to have nine receptacles in one system, eight being in operation whilst the ninth is being emptied and refilled. Each stream of carbonic acid is passed through four receptacles at the same time. The first action of the dilute carbonic acid on the alkaline sulphide produces a gas containing very little sulphuretted hydrogen, and this is allowed to escape in any suitable way. As soon as sulphuretted hydrogen is perceptible in the issuing gas, the first receptacle in the series of four forming the preliminary series is disconnected and caused to be the last of the other or final series, whilst a freshly charged receptacle becomes the last in the preliminary series. The other stream of carbonic acid acting on the contents of the final series, each element of which has previously formed part of the preliminary series, produces a gas rich in sulphuretted hydrogen, which is conducted to a gasholder. When the sulphuretted hydrogen in this gas falls below a certain minimum, the first receptacle in the series is disconnected for emptying and recharging. In this way a continuous stream of carbonic acid gas is entering the receptacles at two places and continuous streams of nitrogen and of gases containing much sulphuretted hydrogen are being evolved. Among the advantages of this method of carbonating is the uniform pressure of the gas consequent on the current of carbonic acid gas always passing through the same number of carbonators. The pressure and strength of the sulphuretted hydrogen gas is almost uniform, and the whole plant is kept constantly working except the outstanding carbonator which is being emptied and filled.—G. H. B.

Improvements in Obtaining Chlorine and in Reconvertng and Utilising By-Products of the Processes. R. H. Steedman, Dalnuir, and A. J. Kirkpatrick, Glasgow. Eng. Pat. 881, January 17, 1889. 6d.

COMMON salt, manganese peroxide, and sulphuric acid are mixed together in suitable proportions and furnaceed for the production of chlorine. The residue, consisting of the

sulphates of soda and manganese, is then dissolved in water and the solution is treated by either of the following processes:—

1. The solution is mixed with magnesium carbonate and heated to boiling, manganese carbonate being precipitated. The solution is evaporated so that the sodium sulphate will crystallise out, leaving the magnesium sulphate in the solution, which is then treated by the process described in Eng. Pat. 18,921 of 1888 (preceding column).

2. The solution is treated with ammonium carbonate, manganese carbonate being precipitated. The solution is evaporated to dryness and heated in contact with steam and carbonic acid; ammonia is evolved and the residue, consisting of sodium bisulphate, is used to decompose sodium chloride in the first operation. Instead of evaporating the solution to dryness, it may be heated with magnesium carbonate for the recovery of the ammonia, the solution of magnesium and sodium sulphates being worked up as before.—G. H. B.

Improvements in the Manufacture of Salt and in Apparatus and Appliances employed therein. O. E. Pohl, Liverpool. Eng. Pat. 1007, January 19, 1889. 8d.

THE claims in this patent are very numerous and cannot be described without the drawings. The chief feature in the process is the employment of two evaporating pans, one above the other, for the concentration of brine. The two longest sides of the top pan are prolonged downwards so as to dip into the brine of the bottom pan. The products of combustion from the furnace pass through the space thus enclosed, that is, they pass over the surface of the brine in the bottom pan and along the bottom of the top pan, which is suspended in position by rods fixed to overhead cross beams. The ends of both pans are bolted on to the brickwork of the furnace.—G. H. B.

Improvements in and relating to the Production of Chlorine and to the Manufacture of Sulphate of Soda. T. Parker and A. E. Robinson, Wolverhampton. Eng. Pat. 2310, February 9, 1889. 4d.

A SUITABLE vessel is divided into two halves by a septum or porous diaphragm. In the one division is placed a solution about half saturated, preferably with sodium chloride, and in the other a similar solution of some sulphate, such as ferrous sulphate. On passing an electric current through the solution, chlorine is evolved at the positive electrode and iron is deposited at the negative, whilst the sulphuric acid which is liberated unites with the soda to form sulphate of soda or salt cake. The chlorine evolved is collected and utilised for manufacturing bleaching powder or for other purposes. (Compare this Journal, 1889, 817, and 1890, 67)

—S. G. R.

Improvements in Apparatus for the Production of Pyro-ligneous Acid. J. H. du Vivier, Paris, France. Eng. Pat. 2569, February 13, 1889. 8d.

THIS is a continuous method of treating wood. The retorts are portable and are introduced into and withdrawn from the furnaces by means of specially constructed trucks. The furnaces are set back to back and the waste heat utilised for drying the tarry products. There are six claims made, and two sheets of drawings accompany the specification.—D. A. S.

Improvements in the Manufacture of Chlorates, and of Magnesium Hydrate suitable for Use therein. E. K. Muspratt, Liverpool, and G. Eschellmann, Northwich. Eng. Pat. 2786, February 16, 1889. 4d.

THE patentees, in the manufacture of chlorates, prefer to use magnesium hydrate rather than magnesnia for the absorption of chlorine. The magnesium hydrate is prepared by treating the oxide or oxychloride, or a mixture of the two, with solutions of the chlorides of magnesium, calcium, strontium

and barium at a temperature of about 80° C. The hydrate formed, when washed and dried, is ready for use. This plan is adopted because the oxide alone does not hydrate itself readily when in contact with water (see this Journal, 1884, 319 and 445).—S. G. R.

Improvements in obtaining Cyanides from Residuary Liquors formed in Chemical Processes. J. S. MacArthur, Pollokshields. Eng. Pat. 3072, February 21, 1889. 6d.

THE cyanides may be present in the form of simple, double, or compound cyanides; if zinc be present this should be removed by the addition of ammonium sulphide. To the solution there is added enough acid to make it neutral. If it is alkaline from the presence of soluble carbonates, it can be, if required, made neutral by adding calcium chloride and boiling. To the neutral solution acid is added in sufficient quantity to decompose all the simple, double, and half the compound cyanides present. The solution is then suitably heated, and the evolved hydrocyanic acid absorbed by caustic alkali solutions. To the residual insoluble cyanide in the sludge caustic soda or milk of lime is added and the cyanide thus brought into solution, which after separating the insoluble portion may be either treated as before mentioned or evaporated down and crystallised.

—S. G. R.

VIII.—GLASS, POTTERY, AND EARTHENWARE.

PATENT.

Improvements in the Manufacture of Articles of Pressed Glass. T. Davidson, Gateshead-on-Tyne. Eng. Pat. 2641, February 14, 1889. 4d.

To the materials generally used for making flint-glass, *e.g.*, sand 560 lb., alkali 210 lb., nitrate of soda 84 lb., are added phosphate of lime 70 lb., "lime spar" 84 lb., and arsenic 35 lb., and the product melted and moulded in the ordinary way for making pressed glass. The articles formed are then exposed locally to a high temperature, when the parts most heated become opaque, those less so translucent, and those kept comparatively cool remain transparent.—B. B.

IX.—BUILDING MATERIALS, CLAYS, MORTARS, AND CEMENTS.

PATENTS.

An Improved Mode of and Means for Manufacturing Blocks of Artificial Stone. A. McLean, Brockley. Eng. Pat. 1262, January 23, 1889. 8d.

THE patentee uses a mixture of such materials, *e.g.*, granite chips and Portland cement, as are generally employed for making artificial stone, but adds a larger quantity of water than is customary. The plastic mass is subjected to a pressure of from 1 to 2½ tons per square inch, whereby a block is produced free from air holes and faced with a skin of fine cement, which may be retained or removed, exposing the granite. The press used has its cover provided with pinions working on racks, along which it can be run into place for pressing and removed after the operation. While in position it is held by tension bars actuated by eccentrics and rests, not on the pinions, but on the mould in which is the stone mixture. The head of the ram is fitted with a grooved and perforated plate covered with a sheet of

perforated zinc, above which is a layer of felt, and finally one of cotton or linen cloth; by this means the water expressed from the mixture is provided with an exit, while the cement is retained.—B. B.

Improvements relating to the Preparation of Silicious Materials used in the Manufacture of Artificial Stone.

A. C. Ponton, Parkstone, B. L. Moseley and C. Chambers, Hastings. Eng. Pat. 2718, February 15, 1889. 6d.

THE patent refers to the manufacture of the substance termed by the patentees "Tridymite" in Eng. Pat. 5808 of 1888 (this Journal, 1889, 462), and 15,256 of 1888, by which they mean the modification of silica obtained by strongly heating flint or sand, whereby the specific gravity is reduced to 2·3, and conversion into amorphous silica is effected. In order to facilitate the handling of the raw material it is, in the case of sand, slightly moistened with a weak solution of an alkaline silicate and moulded into blocks which can be burnt in a kiln until the change indicated above is produced, and then powdered.—B. B.

Improvements in and Relating to Blocks or Bricks composed of Silicious Materials. A. C. Ponton, Parkstone, B. L. Mosely and C. Chambers, Hastings. Eng. Pat. 3354, February 25, 1889. 4d.

A. C. Ponton, Parkstone, B. L. Mosely and C. Chambers, Hastings. Eng. Pat. 3354, February 25, 1889. 4d.

"SEA-GRIT, shingle, broken flints, or other similar sea or fresh-water-washed aggregates" are graded by sifting, made into a plastic mass by means of a solution of an alkaline silicate, formed into blocks, allowed to dry and fired.—B. B.

Improvements in the Process of Manufacturing Artificial Stone. H. H. Leigh, London. From L. H. Clausen,

Hamburg, and J. H. Ehlers, Bahrenfeld, Germany. Eng. Pat. 3357, February 25, 1889. 4d.

ONE part of finely powdered and well dried loam, clay, or chalk, is mixed with 1 part of "common resin" heated to about 212°–260° F., the product well stirred, the temperature raised to about 600° F., 4 parts of loam, chalk, or sand, gradually added and the whole stirred at that temperature for a quarter of an hour, after which it is poured on to polished plates or into moulds heated to 106°–150° F. The colour may be varied by suitable additions such as tar. A marbled appearance may be got by painting the interior of the moulds, which will cause a facsimile of the design thus painted to appear on the blocks; the effect of mosaic work may be obtained by inserting fragments of granite or marble previously oiled—with linseed or fish-oil—and parquetry for floors may be similarly produced. If the mixture be heated to about 940° F. for a quarter of an hour, and 5 parts of chalk, loam, or sand stirred in, the product is somewhat darker, durable, and elastic, and can be used for pavements instead of asphalt.—B. B.

X.—METALLURGY.

Iron in Spelter made from Blast-Furnace Flue-Dust. E. Jensch. Zeits. f. angew. Chem. 1890, 13—15.

IN Upper Silesia flue-dust from the blast furnaces of the iron works is largely used by spelter makers. It does not work well alone, partly owing to mechanical loss from its fine state of division, and partly because the sand and oxides of iron and lead it contains destroy the muffles, but it is a useful source of zinc when smelted with other ores, such as blende and silicite of zinc. If worked alone the spelter formed contains too large a proportion of iron—up to 0·71 per cent.—which renders it brittle and unfit for rolling. Spelter made from blende or silicite does not contain more than 0·02 per cent. of iron, the whole of which is derived from the iron tools, moulds, &c. employed, whilst that made from mixtures of blende or silicite, with from 6 to 8 per

cent. of flue-dust, contains no more than 0.04 per cent. of iron. The quantity of iron in the spelter increases as there is more flue-dust mixed with the ores.

The substitution of Cowper and other fire-brick heating stoves for the old cast-iron stoves in iron works has led to a more general recovery of the flue-dust, so that its importance as a source of zinc has lately become greater. But although there collects in certain parts of the flues a small quantity of dust very rich in zinc and almost free from iron, yet on the whole the dust recovered from the fire-brick stoves is much poorer in zinc and contains more iron than that formerly recovered when the old cast-iron stoves were in use. Not more than 20 per cent. of the flue-dust now recovered contains more than 20 per cent. of zinc, whereas formerly 80 per cent. of the flue-dust contained at least 20 per cent. of zinc. This increased percentage of iron in flue-dust is an important fact to spelter makers.

The author has made experiments to find out how the iron is carried over into the spelter. It seemed probable that it is either carried over mechanically in the form of finely-divided ferrous oxide, or that the presence of chlorides leads to the formation of ferrous chloride which volatilises and in contact with the metallic zinc is decomposed with formation of metallic iron and zinc chloride. By smelting various charges of flue-dust and silicate of zinc alone, and mixtures of these, and a mixture of silicate and ferric chloride, it was seen that the increase of iron in the spelter was to a very small degree due to the presence of chloride, and that this cause alone far from accounted for the whole of the iron carried over. The author ultimately discovered that the finest portions of flue-dust contained the largest proportion of iron, and he concludes that the iron contained in the spelter is to be ascribed to the carrying over of this fine dust by the vapours and gases evolved in the muffle. An attempt to show whether the iron was dissolved as metallic iron or as ferrous oxide, by heating the spelter in a stream of hydrogen, yielded an unsatisfactory result.

—H. S. P.

On the Influence of Sulphur in Spelter-making. E. Orgler. Zeits. f. angew. Chem. 1890, 15—17.

THE remarks contained in this paper are more or less a criticism of a paper by Voigt in the same Journal, 1889, 71 (this Journal, 1889, 986).

The author maintains that to smelters who use blende the presence of sulphur in roasted blende in the form of sulphide is of great importance, as such sulphur is combined with zinc and retains it in the residues. When lime is present in the ores, as occurs often in the case of silicates, especially of the poorer kind, and these ores are mixed with blende, any lime existing uncombined with sulphur exerts a material influence upon the yield of zinc, especially if the blende, from imperfect roasting, contains an undue proportion of sulphur. The lime in contact with zinc sulphide is converted into calcium sulphide and the zinc is liberated according to the reactions—

Voigt's analyses, showing that in zinc residues one-third of the zinc is combined with sulphur and two-thirds with oxygen, do not agree with numerous analyses relating to Rhenish-Westphalian works, where chiefly blende alone is smelted, which show on the contrary that two-thirds of the zinc in the residues are combined with sulphur, and only one-third with oxygen. The author explains this by the suggestion that, in Upper Silesia, to which Voigt's remarks refer, the ores, which there are found in the Muschelkalk, all contain large quantities of lime and magnesia. If, now, a roasted blende and a poor silicate (which class of ore is specially rich in lime) are smelted together, the lime decomposes any badly roasted blende; but if blende alone be smelted any sulphur present due to incomplete roasting remains in combination with its equivalent of zinc. The more "available" lime (i.e., lime not existing as sulphate or sulphide) there is in the ores smelted the less important is it to "dend-roast" the blende, an important point when it is remembered that the roasting is the most costly operation as regards both fuel and labour.—H. S. P.

Outbursts of Gas in Metalliferous Mines. B. H. Brough. Trans. North of England Institute of Mining and Mechanical Engineers, 1889, 59—72.

THIS paper is a collection of the various recorded instances in which gases have been discovered in metalliferous mines. Details of the circumstances attending these discoveries are given, and from a consideration of them the author concludes that the presence of gases in metalliferous mines is not in every case due to the same cause, but may be accounted for by the following hypotheses:—(1.) The decomposition of timber in a mine, and the accumulation of the fire-damp so produced in cavities that are ultimately broken into. (2.) In iron mines, where the iron is not entirely in the state of peroxide, water might be slowly decomposed with the production and accumulation of hydrogen. (3.) The production of fire-damp by the decomposition of the bituminous matter sometimes found in mineral veins or which may be present in beds underneath the ore deposit, the gas finding its way through fissures into the mine workings. (4.) The production of fire-damp by the decomposition of organic matter, in the same way as the hydrocarbons met with in salt mines. (5.) Outbursts of sulphuretted hydrogen, due to the action of acid waters on pyrites ore. (6.) The presence of carbonic acid caused by the action of acid waters, produced by the oxidation of pyrites on limestone or metalliferous carbonates.—A. W.

Loss on Roasting Gold Ores and the Volatility of Gold. S. B. Christy. Berg- und Hüttenm. Zeit. 1889, 224, 290, 318.

THE experiments showed that the volatility in a current of chlorine at 100° is almost nothing. Above this temperature the loss commences to be perceptible, and a maximum is reached at about 250° C., and diminishes to a minimum about the temperature below a red heat, and then again increases, although slowly, to a maximum at something above the fusion point. The increase of volatility is steady between a red and white heat. At incipient red heat the standard loss is nearly 0.05 per cent. in half an hour, at a lower red heat it amounts to the double of this, at a cherry-red to five up to seven times, at a yellow heat to eight times, and becomes at the fusion temperature almost 30 times as great.

From this it is seen how important it is to regulate the temperature in the case of a chlorination roasting process. The action of chlorine on other metals, such as silver, copper, iron, and lead is discussed.

The Behaviour of Copper at the Temperature of the Reverberatory Furnace. M. Stahl. Berg- und Hüttenm. 1889, 323.

WITH increasing temperature the formation of cuprous oxide diminishes, and in the case of very high reverberatory heats, takes place only to a very limited extent. On the contrary, the absorptive power of copper for gases at the different temperatures of the reverberatory furnace increases. It increases with the temperature and with the purity of the copper. These facts explain why one and the same kind of copper cast at different temperatures exhibits such entirely different properties.

Analysis of Tungsten, Ferro-Tungsten, Tungsten Steel, Ferro-Chromium and Chromium Steel. H. Ziegler. Dingl. Polyt. J. 274, 513—528.

See under XXIII., page 216.

Quicksilver Deposits on the Pacific Coast. Eng. and Min. J. 1890, 137.

THE United States Geological Survey has recently published monograph XIII. on the Geology of the Pacific Coast, by Mr. George F. Becker. This is a quarto volume of 486 pages, and is accompanied by an atlas of 14 sheets.

The investigation has been the most detailed of any yet made on the American quicksilver deposits, and for

comparison some of the more important European mines were visited and examined.

The scope of the work has been almost altogether limited to the geological, chemico-geological and lithological points involved.

The Engineering and Mining Journal criticises the report as follows:—

"In the determination of the geological age of the coast range and in his interpretation of the genesis of cinnabar ores, Mr. Becker takes ground at variance with Whitney and other geologists who have preceded him. The controversy about the geology of the portions of California related to the quicksilver districts is still an open one, and Mr. Becker's conclusions will probably be questioned and discussed by students in the same field. In the economic direction Mr. Becker raises a point in his first chapter which will cause some astonishment among mining men. In brief, it is an attempt to deduce the probable amount of quicksilver in the earth's crust, as compared with other valuable metals, from the relative price, cost of production and quantity produced, the conclusion being that quicksilver must be three or four times as abundant as silver, for example. Quicksilver deposits are far less numerous than occurrences of silver (of which latter metal it is very probable that enormous quantities are held in solution in sea water, to say nothing of the known ore deposits and associations with lead and copper ores). And if we compare it with gold, the facts are even more against the theory, for gold occurs in all, or nearly all, quartz, whether in veins, gravel or sand, and in great masses of eruptive, metamorphic and sedimentary rocks, though not in such concentrated form as to be available for mining. So also comparisons with many other metals of similarly wide distribution would be misleading. It so happens that cinnabar, meta-cinnabar, native mercury, &c. when found at all, are usually found in a relatively more bunched condition—that is, more favourably placed for the miner.

"Nor can we agree with Mr. Becker in the broad assertion that the price of a metal is only slightly in excess of its average cost of production. The author assumes a ratio of 100 to 90. Following this comparison out, it would, therefore, appear that the quicksilver which sold at 1.50 dols. must have cost 1.35 dols. per pound to produce; that at 1 dol. would have cost 90 cents; and that at 40 cents 36 cents only. This is manifestly not the case. The quicksilver market is peculiar in being one of limited and widely fluctuating demand, depending mainly on the amount which can be absorbed in amalgamating gold and silver, and in vermilion-making. It is also affected by the policy of foreign monopolies. If quicksilver were a metal of almost universal application, with a practically unlimited market, like iron and steel, there would be more force in the argument."

The following is a summary of Mr. Becker's principal conclusions:—

"Quicksilver appears to be rather more than three times as abundant in nature as silver. The quicksilver produced in the world from 1850 to 1885, inclusive, weighed 1.74 times as much as the silver produced, but the value of the silver was about 16.4 times that of the quicksilver. The great quicksilver-producing localities of the world have been Almaden in Spain, Idria in Austria, Huancavelica in Peru, California, and the province of Ewei-Chau in China. No statistics are known to exist of the Chinese product. The total known products of the other regions take rank in the order in which they are named above, but of late years Peru has produced nothing, and from 1850 to 1885 California yielded about half the total product. The production of Italy is more important than it is usually assumed to be. In 1886 the yield was 7,478 flasks. The production of California, which was nearly 80,000 flasks in 1877, was only about 30,000 in 1886. [It was 25,650 flasks in 1889:—*Ed. E. and M. J.*]

"A chain of quicksilver deposits of very greatly varying commercial importance almost girdles the world. Beginning in Spain, these deposits are distributed along the great chain, including the Alps, Caucasus, and Himalayas, to China; thence through Japan along the eastern edge of the Asiatic continent to the Arctic circle. Beginning again in Alaska,

the deposits follow the western Cordilleras down to Chili. Brief descriptions of the more important or more interesting of these deposits are given in Chapter II., and serve as an introduction to the discussion of the deposits of the Pacific slope.

"The sedimentary rocks of the coast ranges of California are almost all composed of granite detritus. A portion of these have been subjected to very intense metamorphism, and have been converted into thoroughly crystalline rocks, in part schistose. These rocks are of cretaceous age, and are grouped as pseudodiorite, pseudodiorite, glaucophane-schists, phthanites, and serpentine. Very elaborate field studies, microscopical examinations, and chemical analyses of these rocks are given in Chapter III., which is mainly devoted to the investigation of their origin and the processes by which they have become recrystalline. The conclusion reached is that dynamical action, together with warm waters carrying magnesium salts and silica in solution, effected the metamorphosis at the epoch of an exceedingly violent upheaval. This chapter also includes an investigation of concretions in sandstone, which are referred to the action of organic matter, and the analysis of the conditions under which decomposition will produce rounded nodules like pebbles.

"The massive rocks of the quicksilver areas include granite, ancient porphyrites, andesites, rhyolite, and basalt. A new group of andesites is discussed, for which the name *asperites* is suggested. It is shown that these rocks are of variable mineralogical composition, even in the same eruptions, while all of them share a trachytic habitus. The name is simply a latinised equivalent of trachyte. Very remarkable andesitic and basaltic glasses occur near Clear Lake in areas of unusual size. These glasses are extremely acid, but contain also a very high percentage of alkalis, and it is because of this peculiar chemical composition that they have failed to crystallise, not because they have cooled more rapidly or under less pressure than the accompanying crystalline rocks. An attempt is also made to show that the original crust of the earth was granite, and reasons are given for believing that the primeval rock is exposed in California. The lavas burst through the granite, and the conclusion is reached that they cannot possibly consist of remelted sediments.

"The historical and structural geology of the quicksilver belt is discussed in Chapter V. It is shown that the metamorphosed rocks pass over into early Cretaceous beds containing a very characteristic fossil of the genus *Aucella*. Soon after the era in which this mollusk lived—the Neocomian—occurred the great upheaval which induced the metamorphism. The next strata in point of age comprise a hitherto undetected group of the middle Cretaceous called the Walla beds. They were laid down unconformably on the already metamorphosed Neocomian. At the very end of the Cretaceous the Chico series were deposited for the most part on the metamorphic rocks and unconformably with them. Following the Chico are the Tejon beds, which are here regarded as Eocene; but there was continuity of life and of sedimentation from the Chico to the Tejon, or from the Cretaceous to the Tertiary—a state of things detected nowhere else in the Northern Hemisphere. Upon the Tejon lie the Miocene rocks with no notable nonconformity. The close of the Miocene was marked by an important upheaval, which was recognised by early observers. The volcanic period seems to have begun nearly at this time. The end of the Pliocene was also marked by disturbances, and most of the *asperites* seem to have been erupted at this epoch. The ore deposits stand in close relation to the volcanic phenomena and are probably nearly or quite all Post-Pliocene.

"The gold belt of California contains *Aucella*-bearing beds in Mariposa and Tuolumne counties. This shell is of the same species as that in the coast ranges, and the first known upheaval of these mountains was contemporaneous with an important addition to the Sierra Nevada. A description of various forms of *Aucella* from different portions of the world, by Dr. C. A. White, with plates, forms an appendix to this chapter.

"Descriptive chapters follow dealing with the various districts, of which detailed surveys were made. Each of these districts affords special facilities for the study of some

special topic. The Clear Lake region contains freshwater Pliocene beds, and in it the age of andesites can be determined. It also contains remarkable areas of volcanic glass. At Sulphur Bank cinnabar is being precipitated from heated waters largely by the action of ammonia. At Knoxville, besides the ore deposits, there are admirable opportunities for determining the age of the metamorphic rocks and for studying the process of alteration. At New Idria the nonconformity between the metamorphic rocks and the Chico and the continuity between the Chico and Tejon appear. The New Almaden mine is particularly well adapted for the study of the structure of the ore deposits. At Steamboat Springs cinnabar is being deposited without the complications introduced by the presence of ammonia.

"In Chapter XII. the Great Western, Great Eastern and Napa consolidated mines are described, and in the next chapter more or less information is giving concerning each of over fifty minor deposits on the Pacific slope. Some of these have been productive mines, while others are mere prospects of only a geological interest.

"A general description of the deposits described follows, including the enumeration of the gangue minerals, the microscopical character of ores, &c. It appears that the cinnabar has been deposited solely in pre-existing openings, and never by substitution for rock. The fissure systems, which are always present, are very irregular, and deposits cannot be conveniently classified according to existing systems. A new descriptive term, 'chambered vein,' is suggested, which would include nearly all the deposits. A chambered vein is defined as a deposit consisting of an ore-bearing fissure and of ore bodies contiguous with the fissure which extend into the country rock. It appears that all of the deposits described have probably been deposited in the same way from hot sulphur springs.

"Chapter XV. deals with the processes by which the ore has been dissolved and precipitated in nature. It is shown by experiment and analysis that cinnabar unites with sodium sulphide in various proportions, forming soluble double sulphides, and that these compounds can exist in such waters as flow from Sulphur Bank and Steamboat Springs either at ordinary temperatures or above the boiling point. Metallic gold, iron pyrites, copper pyrites, and other minerals found with cinnabar are also soluble in the same solutions.

"A discussion of the origin of the ore concludes the investigation. It is shown that the quicksilver is probably derived from granitic rocks by the action of heated sulphur waters which rise through the granite from the foci of volcanic activity below that rock.

"For the convenience of those who consult the report the separate chapters are made as far as possible independent of one another, a plan involving a certain amount of repetition. Further, to facilitate the use of the volume, the last chapter presents a summary of those which precede it."

PATENTS.

Improvements in the Manufacture of Iron and Steel alloyed with Nickel. H. Schneider, Le Creusot, France. Eng. Pat. 16,567, November 14, 1888. 4d.

NICKEL scrap in any form is melted in any suitable furnace with cast iron or steel, with the production of alloys of steel and nickel containing from 5 to 30 per cent. of the latter. These alloys are said to be suitable for the manufacture of armour plates, projectiles, &c.—A. W.

Improvements in the Manufacture of Iron and Steel alloyed with Copper. H. Schneider, Le Creusot, France. Eng. Pat. 16,568, November 14, 1888. 6d.

THE patentee claims the manufacture in a blast-, cupola-, or reverberatory furnace, of cast iron or steel, containing variable percentages of copper, such alloys being applicable to the production of armour plates, &c. Copper ore, scrap, or a mixture of matte and scrap, may be introduced into the ordinary blast furnace or cupola, or the copper may be first made into a cuprous coke. The product generally contains from 5 to 20 per cent. of copper, but the patent is not confined to these proportions.—A. W.

Improvements in the Wet Method of extracting Gold from Crushed Ores or other finely divided Auriferous Material. J. H. Pollok, Glasgow. Eng. Pat. 16,796, November 19, 1888. 4d.

THE patent relates to the extraction of gold from crushed quartz or other auriferous material and especially from refractory ores, float gold ores or tailings, more particularly in connexion with the process of extracting gold from crushed ores by means of chlorination under hydraulic pressure as described in Eng. Pat. 17,495 of 1887 (this Journal, 1888, 678). The improvements consist in removing the air from the vessel in which the ore is placed for chlorination, and in forcing in water heated to about 60° C.

The ore, suitably crushed, and if desirable concentrated and roasted, with or without salt or other reagent according to its nature, is charged together with the requisite reagents into a suitable revolving cylinder properly protected from the corrosive action of the chlorine evolved in the operation. The reagents used to generate chlorine are charged into the cylinder, the one before and the other after the ore, to avoid the liberation of chlorine before the closing of the cylinder and the revolving of the same. After the ore and reagents have been charged, the air is removed from the cylinder by a suitable stop-cock placed for that purpose, and this is effected either by any air-removing device such as an air-pump or by driving out the air by the admission of water. After the air is removed, or simultaneously with its removal, water is forced into the cylinder, and this water is heated to 60° C. either during its introduction (by means of a steam injector) or previously to or during the revolution of the cylinder. "As soon as the cylinder is completely filled with ore, reagents, and water, the steam acts as a very convenient and economical water-forcing device for it presses on the condensed water in the supply pipe, and forces it into the cylinder, thus exerting hydraulic pressure in the cylinder equal to the steam pressure in the boiler." The cylinder is next revolved, and in the absence of air and at or about the temperature of 60° C., and under the hydraulic pressure, the chlorinating liquid rapidly attacks and dissolves the gold. When the action is complete the chlorine is blown or aspirated off and the ore and solution discharged into a suitable filter. In cases where copper and silver are present with the gold the liquid may be made, by means of a steam ejector, to circulate through the ore in a hot state for some time before removal from the filter, as this greatly assists the solution of the silver.

This method is equally applicable when bromine or iodine is used in the place of chlorine.—H. S. P.

An Improved Process of Extracting Iron from its Ore and of Refining or Purifying Iron. L. Q. and A. Brin, London. Eng. Pat. 17,858, December 6, 1888. 4d.

IRON ore, charcoal, lime, and sodium chloride are heated together in any convenient furnace. The nascent chlorine from the salt is stated to remove the impurities from the iron, especially the phosphorus and the sulphur. The process can also be applied to the purification of wrought iron and the refining of steel.—A. W.

A New or Improved Apparatus for Treatment of Auriferous Sand and other Matters containing Free Gold. A. Clément-Conti, Foletto, Italy. Eng. Pat. 18,004, December 10, 1888. 8d.

THIS is an apparatus, which is said to be inexpensive and portable, for washing auriferous sand or other alluvial deposits, or mixtures containing particles of free gold. The sand is first introduced upon a wooden or metallic shoot, and is then washed over a grating, so as to separate pebbles and coarse sand. The fine sand and gold which pass through the grating are then carried by the flow of water into a funnel provided with two overflows, so as to keep the level of the water in it constant, and to obviate vibration and regulate the force of water passing through the funnel. This funnel is adapted to a tube passing nearly to the bottom of a cylindrical vessel, and it can be raised or lowered so as to regulate the water-pressure in the cylinder.

The floor of the cylinder is in the shape of an inverted cone, and a plug is fitted into a hole at the apex. The particles of gold settle on this floor, whilst the lighter sand passes out of the cylinder by a number of syphons, which empty into an annular trough surrounding the cylinder, in which some mercury is placed, to catch any fine particles of gold that pass over with the sand. On the top of the cylinder is placed a trough or cistern, kept filled with water, which is allowed to flow into the cylinder by pipes passing through the bottom of the trough, and reaching nearly to the bottom of the cylinder. More water being allowed to flow into the cylinder than can be carried away by the syphons, overflow pipes are fitted at a level near the top of the cylinder, which discharge into the same annular trough as the syphons. The gold which collects on the floor of the cylinder is, when necessary, allowed to pass into a receiver placed below by removing the plug in the cylinder-bottom. The operation may be carried on by a successive number of concentrations.

Drawings of the apparatus accompany the specification. The size of cylinder represented is only 36 centimetres in diameter, but this size is calculated to treat 10,800 litres of sand passing through the sieves in 10 hours. These 10,800 litres of sand are reduced to 10 litres of rich sand, and this is then treated in a much smaller apparatus, where it is reduced to $\frac{1}{2}$ or $\frac{3}{4}$ litre, and then again in a still smaller apparatus to 50 cc., consisting of gold and iron, and a few grains of sand. It is then dried, and the iron removed by a magnet.

Another way of using the apparatus is to introduce mercury into the washing cylinder.—H. S. P.

Improvements relating to the Extraction of Gold, Silver, and Lead from Substances containing the same, and to Apparatus therefor. A. B. Cunningham, Islington. Eng. Pat. 28, January 1, 1889. 8d.

THE ore is heated with caustic soda or potash to fusion of the caustic alkali. If an insufficient quantity of lead be present, a requisite quantity of galena or other substance containing lead is added.

The operation may be carried out on the hearth of an open reverberatory furnace provided with an iron bottom and sides, or lined with a fused caustic bottom, or with any other lining calculated to resist the action of caustic alkali. But in preference it should be carried out in a cast-iron (or wrought-iron) vessel or pot. When sulphides are treated, this pot is lined with rings of cast iron, placed one on top of the other, and adapted to the internal form of the pot. This lining is easy of adjustment, and can be replaced when required. A drawing of a suitable pot and furnace for heating the pot accompanies the specification.

In treating galena, the patentee finds 30 per cent. by weight of caustic alkali gives a good result. The lead collects at the bottom of the vessel, and carries down with it the gold and silver, which is then recovered by cupellation or other suitable process.—H. S. P.

Improvements relating to the Extraction of Aluminium from Cryolite and other Substances. C. Netto, Dresden, Germany. Eng. Pat. 359, January 8, 1889. 6d.

THE basis of this patent is founded on the fact that during the extraction of aluminium by sodium the impurities generally associated with the alumina are reduced in the early stages of the operation. The process, therefore, is divided into two parts. The mixture of cryolite and salt is first treated with one-third of the theoretical amount of sodium and is then run off from the metal containing the impurities thus produced, and subjected to the action of the remainder of the sodium, in which latter operation pure aluminium, containing only 0.5 to 1.0 per cent. of impurities, is obtained. This fractional reduction, which is not necessarily confined to two parts, or to the division of the sodium as above, is claimed for application to all processes for obtaining aluminium. The crucibles or other vessels in which the operations are performed are preferably lined with basic material as a safeguard against silicon and other impurities.—A. W.

Improved Means of Extracting Precious Metals from Ores. J. H. Hannay, Loch Long. Eng. Pat. 841, January 16, 1889. 8d.

RELATES especially to the extraction of gold from its ores in the form of chloride. The patent is for an apparatus devised for this purpose, which consists of a chlorinating vessel, a set of circulating pumps, a filter-press, and a chlorine pump, or sets of these with suitable communicating pipes, cocks, and valves. The ore is first reduced to a fine powder and then mixed with water or chlorinated water, so as to form a sludge capable of being pumped. The chlorinating vessel is charged with this sludge, and the pumps cause the latter to circulate by drawing it from the upper part and discharging it into the lower part of the vessel. Meanwhile, chlorine gas is pumped into the vessel, preferably at a pressure considerably above that of the atmosphere. After circulation has gone on until the most part of the gold is dissolved, the sludge is delivered by the circulating pumps to the filter-press, additional pressure being obtained if needed by using the chlorine pumps to force air into the upper part of the vessel. The liquid issuing from the filter-press may be treated in any of the known ways for separating the gold from it, or it may be used over again with a fresh quantity of ground ore until it is of a desirable strength. It is advantageous to charge the chlorinating vessel with an excess of chlorine above that required for combination with the gold contained in the sludge; and to recover this excess, before discharging the contents of the chlorinating vessel into the filter, a little steam is blown into the vessel and the expelled chlorine collected in a gasholder or led to another chlorinating vessel; or an aspirator may be used for drawing off the excess of chlorine. When silver is present the blocks which are taken from the filter-press are reduced again to a sludge and subjected to a similar treatment with a suitable solvent instead of chlorine. Other means of filtering may be used instead of a filter-press.—H. S. P.

An Improved Method and Means for separating Metals and Heavy Minerals from Ores. R. Stanfield and T. Clarkson, Battersea. Eng. Pat. 890, January 17, 1889. 8d.

THE ore, after being brought to a fine state of division, is fed, with or without water (preferably without water) into a suitable receptacle revolving about a vertical or suitably-inclined axis, and provided at its circumference with holes through which the particles of ore are ejected. These holes may be straight or curved and arranged radially or otherwise, and may be in one place so as to project the material horizontally, or on the surface of a cone so as to project it upwards or downwards as desired. The vessel may be also arranged with straight or curved projecting tubular arms. If the particles of ore are of the same size they will be separated according to their densities—the denser particles being projected furthest; if, however, the particles differ in size, it is advisable to perform a preliminary sizing operation. A receiver is placed around this centrifugal separator at a lower level. This receiver may be divided into any convenient number of concentric compartments, so as to divide the material deposited upon it into any required number of parts, and brushes or scrapers may be provided to remove the contents of each division of the receiver. The receiver may also be kept moist by water or steam or any other suitable fluid. A current of air may be made to operate upon the particles of ore as they fly from the rotating vessels so as to assist their deposition upon the receiver.

The separation may be assisted by adding a heavy substance (such as mercury) which would combine with the metallic portion of the material.

The machine is applicable to ores of gold, silver, tin, lead, copper, or any other metal. It may be either used for sizing purposes or for separating metals and minerals from ores, and the improved receiver may be used with any form of centrifugal separator or sizing apparatus.—H. S. P.

Improvements in the Manufacture of Iron and Steel. J. Richardson, Pocklington. Eng. Pat. 1099, January 21, 1889. 4d.

THREE solutions are prepared: the first is prepared by dissolving in water with the aid of heat certain proportions of nitrate of soda, nitrate, prussiate, and bichromate of potash, and mixing with the solution "naphtha, paraffin, or certain other hydrocarbons;" the second solution is made by dissolving gum catechu and raw sugar in water; and the third is a solution in water of pearlash, acetic acid and chloride of lime. These three solutions are mixed together and fed into a boiler, and there heated. The vapour obtained is then passed through, over or under the molten iron, until the quality of the metal is sufficiently improved.—A. W.

Improvements in or appertaining to the Process of Galvanising Iron and Steel. T. B. Saunders, Cleckheaton. Eng. Pat. 1571, January 29, 1889. 6d.

THE improvements relate to the removal and recovery of the ammoniacal fumes formed in the galvanising tank when sal-ammoniac is being used. The tank is covered with a convenient hood, connected by means of a pipe with a condensing tower. The fumes are drawn through into the latter, where they are condensed by means of water or acid spray.—A. W.

Improvements in the Manufacture of Aluminium and Alloys thereof. L. Petit-Devaucelle, Paris, France. Eng. Pat. 7013, April 26, 1889. 8d.

THE metal with which the aluminium is to be alloyed is melted in a suitable furnace, preferably in a rotatory furnace such as a Dank's furnace, the aluminium being then added in the form of a salt of aluminium. To assist the thorough mixing of the contents of the furnace, a helical rib or flange is fixed upon the inside wall of the furnace. This rib may be made of iron or fire-brick.

For producing alloys of iron and aluminium, any of the ordinary compounds or substances containing aluminium may be used with the iron; for alloys of aluminium with other metals, for example, copper, a silicate of aluminium only should be used.

If it is desired to obtain the aluminium in an unalloyed condition, the aluminium is recovered from the alloy by liquation, distillation, or oxidation of the metal used to form the alloy, the aluminium remaining as a residuum.

—H. S. P.

An Improved Process for the Treatment of Auriferous and Argentiferous Antimony Ores. C. Schreiber and H. Knutsen, Broken Hill, New South Wales. Eng. Pat. 14,235, September 10, 1889. 6d.

IS the usual method of roasting these ores before amalgamation there is a considerable loss of both gold and antimony. The gold occurs in metallic state, and generally on the surface of the antimony at the points of contact with the quartz. During the roasting the particles of gold become coated with a film of oxide of antimony which prevents the subsequent action of the mercury. Moreover, a certain quantity of antimony becomes amalgamated, and causes the mercury to "sicken." If the ore be roasted with salt a basic chloride of antimony is formed which forms a protective coating on the particles of gold, so that a similar difficulty in amalgamating is experienced.

The improved process consists in "leaching" or lixiviating the sulphides and oxides of antimony with a solution of a sulphide of the alkalis or alkaline earths, preferably with a solution of sodium sulphide.

The ore is first hand-picked into three classes, more or less, viz., No. 1 ore containing upwards of 25 per cent. of antimony; No. 2, containing from 5 to 25 per cent.; and No. 3, containing less than 5 per cent. It is then crushed and passed through a sieve of not less than 900 meshes to the square inch. It is then taken to the lixiviating pans or agitators, where it is treated with a solution containing

sulphide of sodium in a rather larger proportion than is required by the equation $\text{Sb}_2\text{S}_3 + 3 \text{Na}_2\text{S} = 2 \text{SbNa}_2\text{S}_3$; e.g., in the proportion of 12 parts of Na_2S to 17 parts of Sb_2S_3 . If sulphide of barium or calcium be used an amount is taken proportionate to the molecular weight of the salt used.

In practice, to obtain a concentrated solution of the antimony double salt, it is best to wash the ore first with a solution that has been twice used, then with one that has been once used, and finally with fresh liquor.

The ore being now free from antimony can be easily amalgamated for the recovery of the gold and silver.

The antimony is recovered from the solution of the double salt by means of electrolysis. For this purpose care must be taken to regulate the strength of the current to the degree of concentration of the solution. The reaction at the cathode may be represented by the equation—

and at the anode by—

During the process a quantity of caustic soda is from time to time added to convert the sodium bisulphide into sodium sulphide:— $\text{Na}_2\text{S}_2 + 2 \text{NaOH} + 2 \text{H} = 2 \text{Na}_2\text{S} + \text{H}_2\text{O}$.

To increase the conductivity of the solution a small quantity of common salt is added to it. The liquors are circulated continuously from cell to cell, until the whole or nearly the whole of the antimony is precipitated. The residual solution of sodium sulphide is then returned to the lixiviating pans. "In practice it is considered that all solutions containing a certain quantity of the double salt of antimony will repay treatment by electrolysis," strong solutions being diluted with weak ones, and weaker ones increased in strength by dissolving in them sulphide of antimony from another part of the process. In the third class the liquor obtained by treating 5 per cent. and lower grade ores is worked otherwise. From this it is proposed to separate the antimony by allowing the solution to drip continuously down a tower about 20 ft. high, so as to come in contact with carbonic acid, or preferably with sulphurous acid, which is allowed to enter at the bottom of the tower.

The reactions are represented as follows:—

When carbonic acid is used, and especially in the case when sulphide of calcium or barium is employed, the precipitate at the bottom of the tower contains insoluble carbonates. The whole precipitate is then reduced in a muffle or reverberatory furnace and smelted for antimony. But when sulphurous acid is used there are formed soluble hyposulphite and bisulphite of sodium, from which the precipitated sulphide of antimony is removed by filtration and the whole of the sodium sulphide originally used can be recovered from the filtrate by evaporation and reduction with powdered coke or charcoal. The sulphide of antimony is placed in canvas bags and suspended in the electrolytic cells for strengthening a weak solution or for replacing the dissociated trisulphide. The metallic antimony is collected, washed with hot water, pressed into cakes, and smelted in crucibles for the market.—H. S. P.

Improvements in the Manufacture of Iron and Steel. G. Archbold, New York, U.S.A. Eng. Pat. 15,824, October 8, 1889. 4d.

WITHERITE or other salt of barium is introduced with the ordinary charge into the blast furnace with the object of removing the phosphorus and sulphur and producing pig iron free therefrom. These impurities can also be removed from iron by treating the latter with the barium salt in the Bessemer or other converter, the quantity used being the theoretical amount necessary to produce sulphide and phosphide of barium. The theory is as follows: The barium is converted at the temperature of the furnace

into cyanide which reacts on the iron phosphide, producing barium phosphide and ferrocyanide of iron, which latter is converted into "refractory carbide of iron which mixes with the slag." When much silicon is present it is found advantageous to use also barium nitrate in addition to the carbonate.—A. W.

Improvements in the Manufacture of Iron and Steel. R. F. Ludlow, Springfield, U.S.A. Eng. Pat. 16,474, October 18, 1889. 8d.

This patent applies to the oxidation of the impurities in iron by air, the claim being that instead of the air being directed on to or through the metal from any one position, it is blown upon the surface at an angle and at constantly varying places, which gives the mass a "practically uniform disturbance."—A. W.

XI.—ELECTRO-CHEMISTRY AND ELECTRO-METALLURGY.

PATENTS.

Improvements in the Method of and Means for separating Matters in Solution by Osmose, Dialysis, or Diffusion, or by Electrolysis, or by a Combination of those Processes. J. Marx, Ulm, Germany. Eng. Pat. 2367, February 16, 1888. Amended October 22, 1889. 8d.

These improvements have been already described in this Journal, 1889, 288. The emendations appear to consist in the correction of printer's errors in the text of the original specification—no alteration being made in the claims.—O. H.

Improvements in the Production of Oxygen and Hydrogen in Large Quantities by Means of the Electrolysis of Water, applicable for Ballooning and other Uses. D. Latchinoff, St. Petersburg, Russia. Eng. Pat. 15,935, November 3, 1888. 11d.

To obtain oxygen and hydrogen in large quantities a large current, say 600 amperes at a potential difference of 110 volts, is led through three parallel set of electrolytic baths, each set containing 44 separate cells connected in series for this particular number of volts. Each cell contains either water acidulated with sulphuric acid or a 10 per cent. solution of caustic soda, and immersed in the solution are two carbon cathodes and a lead anode, or iron plates may be used. Suitable gas collectors are arranged over each cell enabling the two gases to be dried and carried off to suitable gas-holders. By this means, the patentee states, 640 cubic metres of hydrogen can be obtained in 60 hours, and the value of the oxygen at the current price more than pays all expenses.—B. T.

Improvements in Electro-Chemical Generators. F. J. Brougham, London. From La Société Perreux Lloyd and Fils, Paris, France. Eng. Pat. 18,858, December 24, 1888. 8d.

A NOVEL form of battery is described in which the heat generated by the internal electrical resistance is utilised to heat and concentrate the solutions employed to such a degree that the salts formed will crystallise out upon cooling. The battery is so constructed that the solutions can be heated by steam if the heat obtained electrically be not sufficient. The salts obtained are of more value than the original materials employed, so that the electricity is obtained as a by-product. The depolariser, nitric acid, is used over and over again, the nitric oxide formed being converted by the oxygen of the air into hyponitric acid, and then reconverted into nitric acid in suitable condensing towers.—B. T.

Improvements in and Appertaining to the Manufacture of Metals or Metallic Alloys by Means of Electricity. G. C. Dymond, Liverpool. From J. M. A. G. Lescuyer, Courbevoie, France. Eng. Pat. December 29, 1888. 8d.

The raw material is incorporated with carbon and made into electrodes; an electric arc is then formed between a pair of these electrodes over the bed of a reverberatory furnace. The ore in the electrodes is reduced and the metal falls into the hot bed of the furnace. In some cases alloys are formed by mixing other metals, as powders, with the materials of which the electrodes are composed. Details of construction of apparatus are described, one of which consists of jointing on fresh electrodes to the unburnt ends of the partially used ones, so as to enable the process to go on continuously.—E. T.

Improvements in Secondary or Storage Batteries. T. Catriss, Leeds. Eng. Pat. 997, January 19, 1889. 6d.

A PLUG or core is put into the containing vessel, of such a size and shape as to leave a narrow space all round between it and the walls of the vessel. This space is then filled with a paste of oxide of lead and sulphuric acid, which when hardened forms the active material of one electrode of the cell. When the containing vessel is non-metallic it is lined with platinum or lead, or strips of these materials are bedded into the paste so as to make good electrical contact with it.—E. T.

Improvements in Secondary Battery Plates, Elements, or Supports. J. S. Sellon, London. Eng. Pat. 1460, January 26, 1889. 6d.

To prevent the active material falling out of the plates a compound plate is used, so constructed that the ribs on one side are not coincident with those on the other, but are situated reversely so that the active material interlaces between these ribs, and is at the same time made up of one continuous mass instead of being made up of separate individual pellets as usually constructed.—B. T.

Improvements in the Construction of Secondary Batteries. G. Philippart, Paris, France. Eng. Pat. 1673, January 30, 1889. 8d.

The supports are made of lead, compressed, or cast under pressure. The active materials are made into a thin paste with glycerin or some such substance and spread over a piece of fabric, such as felt, asbestos cloth, &c. This layer of paste is pressed into the fabric, the prepared fabric being then heavily pressed into contact with the lead supporting plate. The layer of active material may be further protected by an external sheet of perforated celluloid or such material, and the electrodes may be of any desired shape.—E. T.

Improvements in and Relating to the Production of Chlorine and the Manufacture of Sulphate of Soda. T. Parker and A. E. Robinson, Wolverhampton. Eng. Pat. 2310, February 9, 1889. 4d.

See under VII., page 189.

Improvements in Electrical Accumulators or Secondary Batteries. W. E. Langdon, Derby. Eng. Pat. 5816, April 5, 1889. 8d.

The object is to get rid of the spray given off during charging. Each cell has a cover whose edge fits into a groove running all round the top of the cell, and filled with liquid. The cover has a small aperture in the crown, through which any spray-laden gas passes into a "decomposing cell." This cell may be said to consist of three concentric tubes. The first, or innermost, is covered as by a cap, by the second, which is closed at the top. The gas given off passes up the first tube, down between the first and the second, and then up between the second and third. The space between the two latter is packed with lime or some such material capable of absorbing the spray.—E. T.

Improved Supports of Secondary Batteries. G. E. Heyl, Charlottenburg, Germany. Eng. Pat. 13,800, September 2, 1889. 6d.

THE object of the improvement is to get an elastic support that can expand and contract with the active material. Using a perforated plate, the ribs forming the boundary of each mesh, are themselves perforated by narrow slits so as to split what was a common boundary to two adjacent meshes into two distinct boundaries, one for each mesh. The thin boundary walls may afterwards be turned inwards so as to make the opening to each mesh smaller than the interior. Neither the perforations nor the slits need extend right through the plate, and there may, if preferred, be perforations and slits on each side separated from each other by a thin continuous septum of lead.

—E. T.

Improvements in Thermostats. H. Cortland, Toronto, Canada. Eng. Pat. 15,800, October 8, 1889. 6d.

A METALLIC tongue free at one end but fixed at the other is stretched diametrically across an annular metal case, but electrically insulated from the case, the tongue carrying at its centre an adjustable screw, one end of which presses against the centre, on the concave side, of a concavo-convex hard rubber diaphragm carried by the same metal case. As the diaphragm expands or contracts with changes of temperature, the position of the free end of the tongue alters and makes or breaks an electrical contact, which can be used to give a signal in any well-known way.—B. T.

Improvements in Devices for Connecting the Plates of one Electrical Battery with another Battery or Batteries, and with a Switch-board or Transmitting Device. W. F. Smith, Philadelphia, U.S.A. Eng. Pat. 15,819, October 8, 1889. 8d.

THE coupling device is such as might be made in the following manner. A short length of tube, screwed over a part or the whole of its outside, is split longitudinally into two, and one-half attached perpendicularly, near its middle, to the end of the strip from one cell, while the other half is similarly connected to the strip from an adjacent cell. To couple the two cells the two halves of the tube—each attached to its strip—are brought together and a "thimble" screwed over them, so as to connect them rigidly together. Instead of the outside of the tube and the inside of the thimble being screwed, they may be slightly coned to fit each other. A little mercury is put at the bottom of the thimble to ensure good connexion, and any parts may be electro-plated to resist amalgamation. Branch or other connexions can be made by a plug fitting into the jointed tube and provided with a flexible conductor.—E. T.

Improvements in Frames for Supporting the Plates or Elements of a Secondary or Storage Battery. W. F. Smith, Philadelphia, U.S.A. Eng. Pat. 15,820, October 8, 1889. 8d.

A FRAME of lead or suitable material is used to support a series of plates to be formed, the said frame being provided with a lug for connecting up in the usual manner, and also with an auxiliary loop or extension, two forms of which are shown, to be used during the process of formation of the plates, both as a connexion and also as a means of lifting the plates, thus avoiding all damage to the lug which is to be used when the plates are in their finished state.—B. T.

Improvements in the Method of Electrolytically Reducing Plates of Metallic Salts to a Metal State to "Form" the Electrodes of Secondary or Storage Batteries. S. C. C. Currie, Philadelphia, U.S.A. Eng. Pat. 15,821, October 8, 1889. 8d.

IN the ordinary methods of reducing a salt of lead to the metallic state, the salt is held in a stout frame of suitable metal and treated electrolytically; as, however, the salt is usually a poor conductor, the formation is but slow, and

does not take place uniformly throughout the plate. To obviate this, and to accelerate the formation, a perforated plate of conducting metal is pressed down upon the surface of the salt, and the whole is treated electrolytically in the usual manner, the plate to be formed being connected to the negative pole of the source of electricity.—B. T.

Improvements in Galvanic Batteries. W. E. Irish, Brooklyn Village, Ohio, U.S.A. Eng. Pat. 16,036, October 11, 1889. 8d.

ZINC treated with an amalgam of mercury and tallow is used for the positive electrode, and is immersed in a solution of sulphuric acid, Meera, or other suitable oil, and sodium sulphate in suitable proportions, while the negative electrodes are composed of carbon in the form of plates or pencils. Similar plates or pencils of carbon are also placed outside the porous pots, close to but not in contact with the zincs, to reduce the resistance of the element, or, auxiliary plates of iron are used adjacent to and connected with the zinc in order to prevent waste of the latter while the battery is not working.

The negative electrode is immersed in a solution containing the following in suitable proportions:—Bichromate of potash, chlorate of potash, nitrate of soda, flour of sulphur, chromic acid, nitric and sulphuric acids. The battery solutions may be covered with a suitable oil or paraffin wax to prevent escape of fumes.—B. T.

Improvements in Moulds for Casting the Plates of Secondary or Storage Batteries. W. Shapleigh, Camden, New Jersey, U.S.A. Eng. Pat. 16,662, October 22, 1889. 8d.

THE improvements are for casting small blocks or plates of active material, round which a frame of better conducting material may afterwards be cast. The mould is made in two symmetrical parts hinged together. The liquid material is poured down a central feeder to the bottom of the mould, and thence passes into vertical risers. "Knife edge" slits extend from the sides of these risers to the matrices in which the blocks are to be cast, and branch air-ways extend from the top of each matrix, to which they are connected by other knife-edge slits, to vertical main air-ways communicating with the exterior. It is claimed for this mould that very solid homogeneous blocks can be cast without air-bubbles forming, and that such blocks can be readily separated from the mould and from each other.—E. T.

Improvements in Treating and Rectifying or Ageing Alcohol or Alcoholic Liquors or the like by Electricity. A. de Meritens, Paris, France. Eng. Pat. 16,947, October 26, 1889. 4d.

See under XVII., page 205.

XII.—FATS, OILS, AND SOAP MANUFACTURE.

Mineral Lubricating Oils. A. Kunkler. Dingl. Polyt. J. 274, 276—284.

THE author, in giving his experience of testing oils, does not consider an oil-testing machine necessary.

He gives in tabular form the results obtained on testing a large number of Russian, American, and German mineral oils, and also of rape, olive, castor, linseed, and other oils.

The points determined were:—1. Specific gravity at 17.5° C., in most cases by the pycnometer, in a few by the Westphal balance. 2. The temperature at which vapour is first given off. 3. The flashing point. 4. The burning point. Both the latter were determined in a small porcelain

crucible. 5. The freezing point was taken in an ordinary sized test-tube. 6. The colour. 7. The viscosity at 20°, 30°, 50°, 60°, 70°, 100°, and 150°, the viscosimeter used being that of C. Engler. The following are some of the results obtained:—

Class of Oil.	Sp. Gr. at 17·5°.	Flashing Point.	Viscosity.	
			50°	100°
Russian cylinder oils.	911—923	183°—238°	10·2—16·2	2—2·8
Russian machine oils.	893—920	138°—197°	5·8—6·3	1·5—1·8
Russian spindle oils..	893—895	163°—167°	3·1—3·4	1·4—1·5
American cylinder oils	886—899	250°—233°	..	4·1—4·8
American machine oils	884—920	187°—206°	4·2	1·6
American spindle oils	903—911	187°—200°	3·1—3·3	1·4—1·6
Rapo oil, crude.....	920	265°	4·0	1·7
Rapo oil, refined	911	305°	4·9	2·0
Olive oil	914	205°	3·7	1·8
Castor oil	963	275°	16·4	3·0
Linseed oil.....	930	285°	3·2	1·7
Tallow.....	951	295°	5·2	2·5

—D. A. S.

Mineral Lubricating Oils. A. Kunkler. Dingl. Polyt. J. 274, 323—328.

For the first portion of this article, see preceding abstract. From the considerations previously adduced, it appears that the ordinary method of judging the lubricating value of an oil from its specific gravity is untrustworthy, and does not permit the classification of oils from various sources as light, normal, and heavy oils. Even in conjunction with the flashing point, a separation into groups is not practicable in the case of American oils; with Russian oils a partial classification is possible. The experiments show that no direct relation exists between the viscosities and flashing-points of oils, even from the same source. American and Russian oils may be distinguished by their behaviour on cooling. American oils all solidify at about 0° C., previously depositing solid paraffin and, in the case of clear samples, becoming turbid. Most Russian oils remain liquid down to about -10° C., and solidify to a clear transparent mass, without previous precipitation of paraffin. Cylinder oils contain, on an average, 23 per cent. by volume of substances boiling at 310° C.; whilst machine oils only contain 7 per cent. of these bodies. The variations in colour of the different oils is very slight. Dark oils exhibit a greenish fluorescence, and in thin layers appear blackish-brown and transparent. The paler shaft and machine oils of American origin generally possess a greenish fluorescence; whilst those of Russian origin have a bluish fluorescence. Pale Russian cylinder oils exhibit a blue shine, whilst the American oils have no fluorescence. American oils may be often distinguished by their superior purity as regards taste, smell, and colour. Pale Russian oils of 0·903 to 0·909 sp. gr., almost without exception, give a flocculent precipitate on standing; and many samples are not clear and possess a disagreeable sweet odour.

The temperature at which vapour is formed can only be approximately determined, and in conjunction with the flashing and burning points affords the means of judging the volatility of an oil, i.e., its stability as a lubricant. Below are given the vapour evolution temperatures, the differences between these and the flashing points, and the differences between the flashing points and the burning points respectively, for two oils of each variety:—For Russian shaft oil, 105°—110°, 54°—62°, 26°—29°; for American, 110°—112°, 77°—80°, 40°—47°; for pale Russian machine oil, 120°—128°, 60°—75°, 37°—45°; for American, 125°, 81°, 39°; for

Russian cylinder oil, 110°—142°, 76°—108°, 27°—58°; for American, 185°—185°, 100°—103°, 53°—64°.

The determination of viscosity gives a means of dividing oils into groups according to their lubricative value. Oils possessing the same specific gravity, flashing point, &c., may yet differ considerably in viscosity. The probable source of an oil may be deduced from its viscosity and other data. Cylinder oils and dark machine oils of Russian origin exhibit with a higher flashing point and specific gravity, also a higher viscosity; whilst American oils possess with a higher viscosity and flashing point, a lower specific gravity. Pale Russian machine oils compared with American samples of the same flashing points and specific gravities, possess a distinctly higher viscosity. The German mineral oils from Alsace and Oelheim (Hanover) are similar to the Russian oils in so far that the viscosity increases with the specific gravity and flashing point. As regards their behaviour on cooling, they approximate more to American oils. Concerning the diminution of viscosity with increase of temperature, it is to be noted that between the temperatures 20°—50° C. and 50°—100° C. it is more rapid for Russian shaft and pale machine oils than for the corresponding American oils. On the other hand the viscosity of American cylinder oil diminishes more rapidly than that of Russian cylinder oil between the temperatures of 70°—100° C. and 100°—150° C. The diminution in viscosity is proportionately larger for cylinder oil between 70°—100° C.; and for shaft oil between 20°—50° C., than between 100°—150° C. and 50°—100° C. respectively. Several animal and vegetable oils used for lubricating purposes were examined. It was found that, with the exception of castor oil, they all had at 50° C., a smaller viscosity than mineral oil of the same or lower specific gravity. On the other hand there was a much less tendency to vaporisation, and, particularly at high temperatures, a smaller diminution in viscosity than in the case of mineral oils. Finally, the author describes some precautions to be observed in the determination of viscosity at different temperatures.—H. T. P.

PATENTS.

Improvements in the Preparation or Manufacture of Petroleum for Domestic and other Purposes. P. Smith and J. Pearson, Manchester. Eng. Pat. 3044, February 20, 1889. 8d.

This invention is for making solid or semi-solid petroleum or paraffin oils. After the oil has been deodorised by electrolysis, it is heated to 250° F., and 3 to 5 per cent. of powdered desiccated soap is stirred in, the temperature raised to 400° F. for a few minutes, and the product run into moulds to cool, when it solidifies.

The claim is made for the products and for the method of preparation.—D. A. S.

Improved Cleansing, Scouring and Bleaching Compound for Wool and other Fabrics, also applicable to Cleansing Purposes generally. A. H. Parker, London. Eng. Pat. 9410, June 6, 1889. 4d.

See under VI., page 174.

XIII.—PAINTS, PIGMENTS, VARNISHES, AND RESINS.

PATENTS.

Improvements in or relating to the Manufacture of White Lead. H. B. Condy, Battersea. Eng. Pat. 18,705, December 21, 1888. 6d.

LEAD suitably granulated is covered with dilute acetic acid, which is run off after 4 to 6 hours, and the lead left to oxidise by contact with air during another 4 to 6 hours. On covering the metal again with the dilute acetic acid, the oxide formed becomes dissolved and a fresh quantity is produced by running off the acid and further exposure to air. The treatment is continued until the solution of basic acetate of lead has acquired a specific gravity of 1.145, when it is treated in a separate vessel with carbonic acid. The carbonate of lead is separated in a filter and then suspended in water, to which sufficient alkaline carbonate is added to ensure precipitation of all soluble lead compounds. The white lead is finally filter-pressed and dried. Carbonic acid may be obtained by heating bicarbonate of soda, which yields the readily saleable carbonate as a by-product, or from well washed chimney gases. The liquor filtered from the washed white lead is evaporated for the recovery of the acetate of the alkali.—G. H. B.

Improvements in the Manufacture of Paints and Pigments. R. Stone, London. Eng. Pat. 1578, January 29, 1889. 4d.

THE "invention consists in novel methods of manufacturing paint for general purposes," "China clay, marble, spar, shale, partly matured river mud, Devonshire or Staffordshire clay, or any other substance of a fine or silky nature," being used for the body of the paint; one or more of these substances is then mixed with one or more of the following liquids:—petroleum oil, petroleum spirit, sulphuric acid, nitric acid or sodium silicate. After burning, the material is ground and mixed with oil and dryers, or with sodium silicate only in the usual manner. One ton of the clay or marble, &c. requires about 12 gallons of any of the liquids.—W. M.

Improvements in and relating to Plastics, more especially designed for Imparting to Glue a Permanent Elasticity, and adapted to be used for various Purposes. R. W. Johnson, New Brunswick, New Jersey, U.S.A. Eng. Pat. 18,503, November 19, 1889. 4d.

THE composition consists of glue or gelatin, glycerin, and sulpho-oleate of sodium or potassium. When the composition is to be used for printers' rollers, stoppers, &c. the proportions taken are: 1 lb. of glue and $\frac{3}{4}$ lb. each of glycerin and sulpho-oleate of sodium or potassium. To prepare the compound, the glue is dissolved in as small a quantity of hot water as possible, the glycerin added, and the two thoroughly mixed. The sulpho-oleate is then added, and the mixture heated till all the water used to dissolve the glue has been driven off.

For many purposes the glycerin may be omitted, and the composition be made of 1 part of glue to $1\frac{1}{2}$ —2 parts of sulpho-oleate of sodium. The composition may also be used as an ointment, in combination with vaselin or oil or other fat and suitable drugs.—B. H.

A New Composition to be used as a Substitute for Ivory, and for other Purposes. I. Appletree, Sheffield. Eng. Pat. 18,090, November 13, 1889. 4d.

THE material is composed of the following constituents:—granulated or pulverised ivory, 80 parts; isinglass, 20 parts; French chalk, 5 parts; water, 40 parts; gin, 2 parts; cotton wool, 2 parts. The mixture is placed in a boiler, heated, and constantly stirred for about 10 hours, until it assumes the consistency of paste. It is then removed from the

boiler, placed upon a cool slab, and subjected to a short process of rolling. The prepared paste is then put into a suitable mould or moulds, and subjected to great pressure. Instead of genuine ivory dust, that from walrus or similar teeth may be used, and for an inferior quality, the ivory may be substituted by bone of the kind now used for handles.—B. H.

XIV.—TANNING, LEATHER, GLUE, AND SIZE.

PATENTS.

A New or Improved Machine for Extracting the Hair from Skins. L. D. S. Cufflin and G. Hughes, London. Eng. Pat. 16,545, November 14, 1888. 8d.

THIS invention relates to an improved machine for extracting the hair from skins. The skin is carried along on a band or web of leather or other suitable material, mounted on a frame, to which it is held by a clip, between two feeding rollers. The front end of the frame is provided with a roller of india-rubber, over which operates a helicoidal nipping and pulling device, furnished with four blunt knives, and revolving in a reverse direction to that of the india-rubber roller. A curved knife is mounted on the frame, and serves to raise the hair on its way to the pulling device. Drawings are given.—B. H.

Improvements in or connected with Cylinders or Rotating Vessels for Use in Tanning or otherwise Treating Hides or Skins, Washing, Emulsifying, Churning, or like Operations, applicable also for the Treatment of Materials in Vacuo or under Fluid Pressure or the like. B. Nicholson, South Norwood, and T. Palmer, Sevenoaks. Eng. Pat. 1345, January 24, 1889. 11d.

THE object of this invention is to provide cylinders or drums for use in treating hides or skins. The cylinder or drum is provided with hollow axles at one or both ends, through which a pipe, divided by a longitudinal partition into two passages, passes to the interior of the drum, through one of which passages air or other fluid pressure may be introduced or withdrawn, the other passage being employed for the introduction or withdrawal of the tanning or other liquor employed. The hides are supported in the drum by means of buttons carried on angled rods attached to lengths of tubing mounted on the tie-rods, which are connected to the opposite heads or ends of the drum.

For details, the drawings accompanying the specification must be consulted.—B. H.

A New Process for "Discolouring" Tannic Acid Solutions. H. J. Haddan, London. From J. Landini, Hamburg, Germany. Eng. Pat. 17,436, November 2, 1889. 4d.

THE object of this invention is to "discolour" tannin solutions, such as are used in tanneries, by treatment with nitrate of lead, afterwards adding alum and borax. The nitrate of lead solution is added to the boiling solution of tannin in small quantities at a time, and with continual agitation, till the "discolouring" is complete. The solution is then withdrawn, cooled down, neutralised, and filtered.

—B. H.

XV.—AGRICULTURE, MANURES, Etc.

On the Relation between the Physical Characteristics of Plants and the Richness of the Soil in Fertile Constituents. G. Ville. *Compt. Rend.* **109**, 628—631. (Compare this Journal, 1890, 85.)

THE author wishes to determine the changes undergone by plants when the soil is deficient in some one of the four constituents necessary to vegetable life, viz., phosphate of lime, potash, lime, and nitrogenous matter. The characteristics studied are—

(1) Colour; (2) Height; (3) Total weight; (4) General appearance. The plant chosen as the type for experiment was hemp.

(1.) *Colour*.—This subject has been dealt with in the former note, and the author only adds that the effects of change of nutrition on colour are generally most evident at some particular period of its development for each plant; for certain species the month following germination gives the maximum of contrast.

(2.) *Height*.—A most important characteristic, affording a good criterion of the fertility of the soil. The height of each plant under similar conditions varies but little from one year to another if taken at the same period of each year. The same order of height is maintained throughout the year by plants under dissimilar conditions. With plants of which the nitrogenous matter is the most important constituent, the want of this matter makes the greatest difference in the height.

(3.) *Weight*.—The weight of the crop in the dry state gives no less sure an indication than colour and height. The variations in absolute weight from one year to another of plants under the same treatment amount to from one

on two tenths; but as before, the relative order for plants under different treatment is the same.

(4.) *General Appearance*.—Determined by photography. A coloured plate is inserted in the text showing the photographs, the colour, height and weight of yield of hemp plants grown under different conditions in the year 1884.

—	Height in Metres.	Weight of Yield in Kilogrammes.
Manure, "stimulating" (100 kilos. of nitrogen)	1.53	11.220
Manure, "complete" (75 kilos. of nitrogen)	1.20	11.150
Manure containing no nitrogen ..	0.61	4.740
Manure containing no phosphates	0.97	8.220
Manure containing no potash	0.40	5.220
Manure containing no lime	1.15	10.570
Soil without manure	0.18	2.175

The author has found that the amounts of carotene and chlorophyll in plants seem to be always proportional to one another, and afford a further criterion with regard to the nature and quantity of the fertile constituents contained in the soil.

It remains to be decided if the colour of chlorophyll solutions is proportional to their strength, as is the case with carotene. By a colorimetric method $\frac{1}{100}$ milligramme of carotene can be estimated in its solution in bisulphide of carbon. [Carotene is extracted from the plant by petroleum ether, and after evaporation *in vacuo* the residue is redissolved in bisulphide of carbon to form an orange solution.]

ESTIMATION OF CAROTENE (in milligrammes per 100 grms. of leaves) IN THE FOLLOWING PLANTS:—

	Plants in which the Nitrogenous Matter predominates.				Plants in which the Potash predominates.	
	Hemp.	Wheat.	Rape.	Beetroot.	Potato.	Vine.
Manure, "stimulating"	350	195	183	183	204	..
Manure, "complete"	315	167	..	164	173	200
Manure containing no nitrogen	199	74	144	120	159	177
Manure containing no phosphates	281	97	..	131	162	179
Manure containing no potash	254	104	..	140	124	125
Manure containing no lime	21	114	..	183	164	107
Soil without manure	250	60	..	143	91	121

The author hopes that farmers will adopt his plan of observing the four chief characteristics of plants to define the nature of their crops each year. He proposes to continue his researches on the estimation of carotene and chlorophyll.—P. J. H.

On the Role of Ammonia in the Nutrition of the Higher Forms of Plant Life. A. Müntz. *Compt. Rend.* **109**, 646—648.

THE object of this paper is to prove that plants can obtain their nitrogen directly from ammonium salts without these being first converted into nitrates.

Kuhlmann at one time maintained that nitrates were always converted into ammonium salts (by means of

reducing actions going on in the soil) before they could yield their nitrogen to plants, and these views were held even after Boussingault had shown that nitrates are directly absorbable by plants.

At the present time the exactly opposite theory tends to prevail, and it is generally supposed that ammoniacal nitrogen must be converted into nitrate before it can be absorbed.

The difficulty of deciding as to the correctness of this theory lies in the presence of the nitrification ferment, which always converts a certain portion of the ammonium salt used as manure into nitrate.

The author has therefore devised the following means for growing plants on a soil in which the only nitrogen supplied as manure is in the form of sulphate of ammonia, all nitrification being prevented.

A certain quantity of natural soil was freed from nitrates by washing, manured with sulphate of ammonia, put into large pots, and then heated in an oven to 100°, a temperature amply sufficient to kill the nitrification ferment. To prevent future inoculation by the ferment the pots were placed in large cages partly closed in with glass and partly with cloths, which served to filter the air from all germs. The sides of the cage were smeared with glycerin, so that the arrangement was exactly similar to that devised by Tyndall.

The seeds were immersed for a short time in boiling water before being sown, so as to sterilise their surfaces. All these operations were performed in a closed room, of which the atmosphere had been purified by spraying with water, and then leaving the dust to settle. The cages containing the pots were put under an open shed, and were watered with sterilised water.

In order to have some means of comparison, another set of pots was prepared in exactly the same way, and these were then inoculated with the nitrification ferment by means of a minute quantity of compost.

Experiments carried out during the years 1885—88 gave identical results. No trace of nitrate was ever formed in the sterilised pots. Two examples are quoted in illustration. The results are given in milligrammes of nitric acid per kilogramme of earth.

Earth free from Nitrification Ferment.		Earth inoculated with Nitrification Ferment.	
Initial State.	Final State.	Initial State.	Final State.
Mgr. 0.0	Mgr. 0.0	Mgr. 0.0	Mgr. 91.2
0.0	0.0	0.0	420.0

The growth of the plants was as a rule satisfactory, maize, the bean, kidney bean, and hemp attaining a height of over 1 metre.

By determining the proportion of nitrogen in specimens of the plant, and subtracting the amount present in the seed, the total quantity directly absorbed in the form of ammoniacal nitrogen could be determined. The following examples are quoted:—

	Nitrogen		
	In the Seed.	In the Plant.	Derived from Ammonium Salt.
Bean.....	37	956	915
Kidney bean....	16	105	89
Maize.....	3	211	208
Barley.....	7	50	40.3
Hemp.....	5	115	114.5

These experiments prove conclusively that the higher plants are capable of absorbing ammoniacal nitrogen directly by means of their roots, and hence that the nitrification of ammonia manures is not an indispensable condition for their being utilised.—P. J. H.

The Artificial Manure Manufacture. W. Cohn. Chem. Ind. 12, 459—461.

As the author predicted two years ago (Chem. Ind. 10, 444), the successful use of the cheaper potash salts and Thomas phosphate powder has been accompanied by an increase in the use of artificial manures generally. In 1888, 3,508,450 centner (about 173,650 tons) of Chili salt-petre was imported into Hamburg; in 1887 the imports of this article had been as much as 5,084,850 centner (250,325 tons); and in 1889 the imports had again increased over 1888; at the beginning of September the amount was 4,427,900 centner (217,896 tons).

The use of sulphate of ammonia has increased in like manner, and renewed efforts have been made to collect the ammonia formed in the process of coke-burning, efforts which are becoming more and more successful. Maereker has recently (Deut. landw. gesell. Mittheil. 11, 1889—1890) published the results of experiments on the effect of nitrate of soda and sulphate of ammonia when used both in small and large quantities for corn, beetroot, and potato crops, which show that ammonium sulphate has at least an equal value to the sodium nitrate. In the case of superphosphates an improvement in the process of manufacture is hardly looked for. In the price, however, such an improvement has been realised, the manufacturers having combined together to obtain a proper remuneration for capital invested. Bone meals, both raw and boiled, continue to hold the position they have attained, the steamed bone being more and more sought after. At the recent annual meeting of the Deutsche Versuchs Stationen at Speyer the question of adulteration of bone meals was fully discussed and a definition of what bone meal should be was arrived at. The property of absorbing ammonia said to be possessed by gypsum formed in the manufacture of superphosphates, has encouraged several manufacturers to introduce this waste material into the market.—J. W. L.

PATENTS.

Improvements in the Means or Method of Treating or Preparing certain Refuse Matter to increase its Fertilising Properties. W. Riddiough, Bradford. Eng. Pat. 1710, January 31, 1889. 4d.

The improvement consists in grinding or crushing "night-soil," whereby its activity and value as a manure are increased.—E. J. B.

A Compound of Animal Substances and Earths containing Phosphate of Iron or Alumina for Fertilising Purposes. N. B. Powter, New York, U.S.A. Eng. Pat. 14,633, September 17, 1889. 4d.

The fertilising compound is formed by mixing some powdered phosphatic rock containing alumina or iron, such as Redonda phosphate, with acid and wet animal matter such as undried meat, skin, blood, hair, animal filth, &c.

—E. J. B.

A New or Improved Insecticide for the Treatment of the Diseases of the Vine and other Trees and Plants. J. B. Alzugaray, Porto, Portugal. Eng. Pat. 15,539, October 3, 1889. 4d.

This insecticide, entitled "Phylloxerine or Anti-phylloxeric Liquor," consists of a mixture of petroleum, shale or tar oils, with sulphur or sulphides of calcium or sodium.

—D. A. S.

Improvements in Fertilisers. E. and H. Saxl, Vienna, Austria. Eng. Pat. 18,918, November 25, 1889. 4d.

This invention consists in drying and then pressing into cakes the excrements of domestic animals, in which form the material can be easily and cheaply transported. The cakes may be ground and reduced to powder of any required degree of fineness.—W. M.

XVI.—SUGAR, STARCH, GUM, Etc.

New Relation between Sugars and Furfuryl Derivatives. Constitution of Methylfurfural and Isodulcitol. Maquenne. *Compt. Rend.* **109**, 603—606.

THE author has shown (this Journal, 1889, 974) that *fucus* when distilled with dilute sulphuric acid yields furfural and methylfurfural. There are four possible formulae for this latter, one in which a CH_2 group is introduced into the side chain, and the other three in which a CH_3 group is attached to one of the carbon atoms of the ring, thus displacing a hydrogen atom. It yields acetic acid on oxidation, and so it must be one of these latter.

Isodulcitol distilled with four times its weight of sulphuric acid $15^\circ\text{--}20^\circ\text{B.}$, yields a methylfurfural identical with that obtained as above, together with small quantities of acetone, but not a trace of furfural. Fischer and Tafel have shown that isodulcitol is an aldehyde of normal hexane, and Herzig found that it yielded acetic acid on oxidation, showing that it contained a methyl group at the extremity of the chain. The production of methylfurfural from isodulcitol must be brought about by joining the chain so that this methylfurfural must be represented by the formula—

As arabinose yields, by similar treatment, furfural, isodulcitol may be considered as ω -methylarabinose.

Although the yield of methylfurfural from isodulcitol is small, yet its production may be employed as a test when it is not possible to crystallise the sugar.

On distilling a quantity of any body containing isodulcitol with sulphuric acid (20°B.), the less volatile portion of the oily distillate gives a green colouration with alcohol and sulphuric acid, which is characteristic of methylfurfural.

—A. L. S.

On the Fermentation of Raffinose in Presence of different Kinds of Yeast. D. Loisean. *Compt. Rend.* **109**, 614—615.

THE author gives extracts from a sealed paper deposited by him with the Academy in March 1888, which contains an account of similar experiments to those described recently by Berthelot (this Journal, 1889, 933), showing that raffinose under the influence of a weak yeast yields a glucose and saccharose, the former of which only ferments.

—A. L. S.

On Two New Sugars from Quebracho Bark. G. Tannet. *Compt. Rend.* **109**, 908—910.

COARSELY powdered quebracho-bark (*Aspidosperma quebracho*) is mixed with milk of lime and lixiviated with 50 per cent. alcohol. The solution is reduced by distillation and evaporation to a bulk of 500 cc. per kilo. of bark used, neutralised with acetic acid and treated with "Extract of Saturn." From the filtered liquid the sugar is precipitated by means of ammoniacal lead acetate. The lead precipitate is decomposed with dilute sulphuric acid, the solution is concentrated to a syrup, and then dissolved in the least possible quantity of 90 per cent. alcohol. Ether is now added, which precipitates a sticky mass. The precipitate is redissolved in water, concentrated and left in a cool place for several days, when fine crystals separate. The crystals are washed with a little dilute alcohol, dissolved in water and decolourised by means of animal charcoal. The concentrated solution is dissolved in boiling 60 per cent. alcohol, which on concentration deposits crystals of the new sugar. The yield is about 1 gm. per kilo. of bark used. The author names this sugar *Quebrachite*. Its

formula is $\text{C}_7\text{H}_{11}\text{O}_6$. It crystallises in anhydrous rhombic prisms, and is very sweet to the taste. It is very soluble in water, and pretty soluble in boiling alcohol, even when absolute, but insoluble in ether. Its density is 1.54. It melts at $186^\circ\text{--}187^\circ\text{C.}$, and boils in vacuo at about 210°C. , at the same time subliming in beautiful needles. It is levo-rotary, $(\alpha)_D = -80^\circ$.

Quebrachite is only fermentable under the action of beer-yeast. It has no action on Fehling's solution, but reduces ammoniacal silver nitrate in the cold. Boiling dilute solutions of acids and alkalis appear to have no effect on it. It is not precipitated by basic acetate of lead, but only by ammoniacal lead acetate. Strong sulphuric acid dissolves it very slowly at ordinary temperatures with but little colouration; but at 100°C. it dissolves more quickly, quebracho-sulphuric acid being formed. This acid is levo-rotary and forms soluble uncrystallisable calcium and barium salts. Quebrachite yields an acetic ether melting at 89°C. , and also a very unstable nitro-derivative, both of these compounds are levo-rotary. Heated with hydriodic acid, quebrachite forms methyl iodide and a new inosite, thus:—

This body crystallises in brilliant prismatic needles, containing two molecules of water of crystallisation, which it loses rapidly on exposure to air. The author names it "*Levo-inosite*." It is soluble in 2.3 parts of water at 12°C. , slightly soluble in boiling alcohol, but insoluble in ether. It melts at 238°C. , and boils in vacuo at 250°C. with volatilisation, being, however, less volatile than quebrachite. Its rotary power, $(\alpha)_D$, is -55° .—H. T. P.

Advances in the Manufacture of Starch, Dextrin, Glucose, &c. Dingl. Polyt. J. **274**, 328—334.

THE combined grater and grinding mill used in the manufacture of potato starch seems to have no mean rival in the shape of H. Schmidt's *compound-grater* (Ger. Pat. 45,284). O. Saare (*Zeits. f. Spiritusind.* **12**, No. 24) publishes the results of a number of comparative trials made with the two forms of apparatus at H. Schmidt's experimental works. The compound-grater employed consisted of a mantle of perforated sheet-iron surrounding the inner rasping drum. The mantle was grated alternately inside and outside by striking the perforations alternately from the outside and inside respectively. The whole apparatus was so arranged that the compound-grater could be fixed in its place or removed with very little trouble. The rasping drum had a diameter of 400 mm., and was provided with new gratings having 18 teeth to the inch. Four experiments were made, 10 kilos. of washed and superficially dried potatoes being used each time. The potatoes contained 17.7—17.9 per cent. of starch. The rate of grinding was the same in each case. The ground potatoes and washings were collected in a barrel and filtered through two sieves, the second being the finer of the two. The milky filtrate was allowed to settle for a day in another barrel, when the starch was separated, dried, and weighed. The pulp remaining on the sieves was also dried and weighed, and the starch left in it estimated. The first experiment was made with a carefully-mounted rasping drum without the compound-grater; the second was made with a well-set drum fitted with the compound apparatus. The third and fourth experiments were made with a badly-fitted-up rasping drum, provided without and with the compound-grater respectively. The results obtained are given below. In the first experiment there were obtained 395.5 grms. of pulp and 1,521.9 grms. of starch; in the second trial 356.3 grms. of pulp and 1,563 grms. of starch. Further, in the first case, the pulp contained 264 grms. of bound starch, and, in the second case, 223 grms. of bound starch. The third experiment yielded 446.5 grms. of course and 42.8 grms. of fine pulp, and 1,428.4 grms. of starch. The fourth trial gave 346.1 grms. of course and 46.3 grms. of fine pulp, and 1,532.5 grms. of starch. These results show that the compound-grater compensates for the defects of a badly-mounted rasping drum, and raises the yield of starch on a level with that obtained by means of a first-class

rasp. As regards the extra power required on addition of the compound-grater, experiments show it to be 1·2 indicated horse-power, whilst a grinding mill requires 1·5—2 horse-power. Saare condemns the use of centrifugal machines in damp-starch factories, chiefly on economical grounds; besides which centrifugal starch is said to become mouldy very readily.—H. T. P.

XVII.—BREWING, WINES, SPIRITS, Etc.

PATENTS.

Improvements in the Treatment of Commercial Alcohol. H. E. Sorel, Paris, France. Eng. Pat. 17,338, November 28, 1888. 11d.

In this invention the following two operations are carried on concurrently:—

- (1.) Partial and successive distillations of concentrated products.
- (2.) Partial and successive condensations at high temperature.

These two operations follow from the same physical law, which may be stated:—There exists for each volatile body, and for each temperature, in the presence of a given solvent which does not act chemically on the body when brought to the same temperature, a definite and fixed relation between the quantity of body existing in the form of vapour in a certain weight of vapour in contact with the liquid, and the quantity of the same body dissolved in the same weight of the liquid. This relation is defined as the *partage coefficient*. When the partage coefficients of a volatile liquid and its solvent are very nearly equal, it is impossible to separate them by distillation.

Now, by so arranging the strength of the alcoholic liquid to be treated, the temperature of distillation can be varied between 79° and 100° C., and so the relative partage coefficients may be altered as desired.

Under the conditions under which the invention is worked, alcohol of such a concentration is used that one-half or two-thirds of the alcohol may be distilled off without materially altering the boiling point.

Employing a continuous distillation column, the walls of which are protected from radiation, and passing into it at the top alcohol, between 90° and 70° Gay-Lussac, previously raised to its boiling point, the alcohol passing from shelf to shelf to the boiler at the bottom, the inventor has verified the following relation:—

$$S_1 = S_m \left\{ 1 + \frac{\left(\frac{Kp}{P}\right)^m - 1}{\frac{Kp}{P} - 1} \right\}$$

between S_1 = the proportion of a certain impurity existing in a state of solution in the liquid of the first upper shelf, and S_m = the proportion of the same impurity in the liquid of m^{th} shelf, K being the partage coefficient for the liquid and P being the proportion of this impurity in the vapours passing from bottom to top to that in the liquid passing from top to bottom.

The inventor has verified this in practice, and finds that he obtains under the above conditions all the impurities having a partage coefficient greater than unity in the products of distillation, whilst those having a partage coefficient less than unity are obtained in the non-distilled alcohol.

It must be noted that in this case the distillation column does not work as an ordinary distillation column because there is not, so to speak, any expenditure of liquid until it arrives in the vaporising boiler. The vapour traverses all the shelves without notable condensation, and the proportion between the amount of vapour and liquid remains approximately constant.

The vapour escaping from the top of the distillation column, and containing, as above stated, only those impurities having a partage coefficient greater than unity, are either passed into an ordinary distillation column worked in the usual way or into the partial condensers. These consist of a series of tubes of elliptical section arranged so that the liquid condensed in each series may be collected separately. They are immersed in water contained in a series of tanks, the temperature of the one containing the condenser into which the vapours first pass is kept at 77°—79° C., and the temperature of each succeeding one a few degrees lower until the last one, which is kept cold.

The inventor even finds it advantageous to so arrange the heating of the tanks that the bottom of one is kept at the same temperature as the top of the next, the temperature gradually rising from the bottom to the top of each tank and he separates the series of condensers contained in each tank into elements, each element consisting of one horizontal layer of pipe, and the liquid from each element is collected separately.

The products condensed at a low temperature, and containing a large quantity of volatile products, are treated with oxide of lead, or plumbate of soda or potash. As there is some difficulty in separating the lead by filtration, he adds some such neutral salts as chloride of magnesium or manganese, soluble in alcohol, and capable of forming a flocculent precipitate with the alkaline earths or their carbonates.

One of these chlorides is added to the liquid containing the lead and then milk of lime or some similar substance, when a flocculent precipitate is formed which rapidly settles, taking the lead with it. The clear liquid may now be distilled.

The claims are:—

"1. Partial distillation in a continuous distillation column of the crude phlegms or alcohols in course of manufacture more or less diluted with water, so as to separate these phlegms or alcohols into vaporised products containing principally the more volatile constituents of the mixture, and non-vaporised products containing principally the less volatile constituents.

"2. Application to distilling apparatus and to rectifiers, of condensers forming series, each maintained at a constant temperature, each condenser of each series having its separate outlet.

"3. Successive additions to the crude phlegms or alcohols in course of treatment of a composition of oxide of lead, then of a salt soluble in alcohol and capable of being precipitated in flakes by magnesia, lime, the alkalis or the alkaline carbonates, and, finally, one of these reagents; this succession of chemical operations having for its object the combination into a filterable precipitate, of a part of the ethers and analogous bodies."—A. L. S.

Improved Process for Aërating and Purifying Beer Worts and Apparatus therefor. O. Imray, London. From A. Bergh, Copenhagen, Denmark. Eng. Pat. 86, January 2, 1889. 8d.

In order to effect the cooling and aërating of wort in a sterile condition, the hot wort is led into a rotating centrifugal machine which is contained in a closed case. From this the wort is taken by a pipe, whose inlet is placed just below the rim of the machine, into some convenient closed cooling apparatus and thence to the fermenting vessels. The wort is free from grounds as these remain behind in the centrifugal machine. Air is admitted into the case surrounding the centrifugal machine through a cotton-wool filter and the whole apparatus is sterilised by steam before use.

The centrifugal machine is also useful for removing the yeast remaining when fermentation has proceeded as far as necessary, the after-fermentation being brought about by the introduction of a suitable quantity of some pure ferment.—A. L. S.

A Vinegar Generator and Filter. R. H. Herder, Chicago, U.S.A. Eng. Pat. 570, January 11, 1889. 8d.

This patent has for its object the more speedy acetification of the mash and the filtration of the product. The apparatus consists of a cask hung on trunnions so as to swing in a vertical position. At one end of the cask are fitted three perforated false bottoms, the space between the two nearest the head of the cask is filled with some filtering material, such as sand, charcoal, &c. Bungholes and stoppers are inserted where necessary. The interior between the inside false bottom and the opposite head is filled with wood shavings. Four check-valves for admitting air are inserted, one in each head and the other two in the side of the cask about two-fifths of the length of the cask from each end, and they are so arranged that the two lower ones are always closed and the two upper ones open. The cask is half filled from the top with a suitable fermented or distilled mash. Acetification takes place rapidly in the upper part, where a certain amount of liquid adheres to the shavings, the air finding its way in through the check-valves. After four hours or so the cask is inverted and acetification takes place in the other half of the cask, the other pair of check-valves coming into operation, and so on until the acetification is completed, when the vinegar is run out through the filter at the bottom of the cask.

—A. L. S.

Improvements in the Treatment of Commercial Alcohols. H. E. Sorel, Paris, France. Eng. Pat. 770, January 15, 1889. 8d.

According to the formula given in Eng. Pat. 17,338 of 1888 (see previous page) for determining the ratio between the impurities on an upper stage of the column to the impurities on a lower stage, i.e., the velocity of conveyance of impurities from the bottom to the top of the column, it is seen that this ratio is not dependent on the term K , p , P , taken separately, but on the ratio $K \frac{p}{P}$. The inventor has

found by experiment that the ratio $\frac{p}{P}$ is almost independent of the absolute value of the reflux returning from the top of the column, but depends essentially on the temperature; being low, between 95° and 100° C., increasing very rapidly to 80°–82° C., and then decreasing rapidly; whilst as the temperature falls K diminishes. On the whole the ratio $K \frac{p}{P}$ increases from 90° to 80°–82° C., and then decreases very rapidly to 78·7° C., the boiling point of strong alcohol. So, the lower the temperature of the lower stages of the rectification column, the better will the tail products be retained, as the term $K \frac{p}{P}$ is then kept as small as possible.

It may also be noted from the above considerations that the stage where the temperature of the column ranges from 80°–81° C. serves to mark off the part where the tail products are constantly returned and turned back towards the bottom, and that part where they tend to rise faster than the alcohol; so that it is advantageous to be able to separate the vapours condensing at this stage from the rest.

In putting these considerations into practice the inventor reduces the functions of the analyser to simply maintaining the temperature of the vapours at the proper point, and so create as little reflux as possible. The portion of the column which is not refrigerated is surrounded with some non-conducting covering.

The vapours enter at the bottom of the column, passing over the surface of the return liquids; they then rise into the regulating refrigerator which consists of two sections. The lower one is filled with a number of hollow earthenware cylinders, open top and bottom, and arranged in quineux form, one above the other in horizontal stages. The upper section contains several horizontal series of copper tubes, traversed by hot water from the analyser, the tubes being placed very close together and their surfaces phited and undulated, so as to distribute the condensed liquid as regularly as possible over the cylinders of the lower stage.

Between these two sections the temperature is 80°–81° C., the stage at which it is pointed out above the tail products tend to accumulate, and an arrangement is inserted for separating off at will the liquid condensing here.

The vapours then enter the rectifying column properly so called, which consists of two sections of similar construction to those forming the regulating refrigerator, except that the one filled with the earthenware cylinders is longer. The vapours issuing from the top of the column are either passed into an ordinary refrigerator or some such arrangement as is described in the abstract above referred to.

The claims are:—

“1. The improvement in rectification or dephlegmation columns for the treatment of commercial alcohols consisting in adapting at the lower part thereof a refrigerating apparatus.

“2. In combination with refrigerating apparatus applied as aforesaid, provision for the continuous withdrawal of impure alcohol.

“3. The method of and the apparatus for the treatment of commercial alcohols.”—A. L. S.

Improved Alcoholic Beverages. A. Malzy, London. Eng. Pat. 962, January 18, 1889. 4d.

THE invention consists in the preparation of mixtures of alcoholic liquids and aerated or other waters in definite proportions, having regard to quantity and quality, in vessels so that the liquid can be easily and quickly retailed ready mixed. The process of mixing can be effected before, during, or after aëration. (Compare this Journal, 1887, 221.)

—A. L. S.

Improvements in Apparatus for promoting Circulation and Aëration of Brewer Worts. G. G. Cave, Fenny Stratford, and J. H. Howell, Bristol. Eng. Pat. 1942, February 4, 1889. 6d.

Two “steam boiling coppers” are employed, they are placed side by side, and are surmounted by a “curb” or pan which extends over both vessels, communication being maintained between the bottom of the coppers by a pipe. The wort in one of the coppers is maintained at a higher temperature than the other, and consequently in boiling overflows and is conducted by the “curb” into the other copper, whilst an equal quantity passes by the pipe into the first copper, thus maintaining a constant circulation. A second pipe provided with a valve connects the coppers just below the curb, so that when, owing to evaporation, the contents of the first copper do not overflow into the second, the circulation may still be kept up by opening up this pipe. Instead of using two coppers the low-temperature one may be replaced by a vat or other vessel of copper or any other suitable material.—A. L. S.

Improvements in Shavings for Vinegar Generators and for Clarifying Beer. R. H. Herder, Chicago, U.S.A. Eng. Pat. 3362, February 25, 1889. 8d.

THE improvements consist in the production of shavings to be used in the manufacture of vinegar, &c., which shall expose more surface than the ordinary flat coiled shaving.

To this end the shavings are planed with transverse or longitudinal ribs, with corrugations, serrations, or any combination of these. In this way there remain, when the shavings are coiled, channels between the coils formed by the ribs, &c., through which the wort and air may pass. The patentee claims that the wort takes much longer to trickle over these shavings, thus exposing it a much longer time to the atmosphere and thereby increasing the working capacity of the generator.—A. L. S.

Improvements in or relating to the Preservation of Beer and the like. A. J. Boulton, London. From H. F. L. Otto and G. B. Schwerdtfeger, Doebeln, Saxony. Eng. Pat. 15,401, October 1, 1889. 4d.

THE inventors coat the interior of the cask with paraffin wax which has been impregnated with salicylic acid, which they state prevent the entrance of all organisms from the exterior air into the beer.—A. L. S.

A New or Improved Pasteurising Apparatus. W. A. Vollmer, Apenrade, Germany. Eng. Pat. 15,810, October 8, 1889. 6d.

This apparatus is for the pasteurising of beer in bulk. It consists of an air-tight vessel surrounded on all sides except the front by a water-jacket, the temperature of which may be raised or lowered by passing steam or cold water through a coil contained in it. Two thermometers, a manometer, a gauge for determining the level of the liquid, a safety-valve, and manhole are attached to the front of the vessel.

The apparatus is filled with beer and the temperature raised by the steam coil to 60° F. and kept constant for some little time, and then by replacing the steam by cold water the beer is cooled until the manometer indicates the normal pressure.—A. L. S.

Improvements in the Treatment of Brewers' Grains for Cattle Food. C. P. Goode, London. Eng. Pat. 16,325, October 16, 1889. 4d.

The dried grains, whilst still hot, are subjected to great pressure in a mould divided into compartments; by this treatment the grains adhere and when cooled form dry coherent cakes suited for transport. When the grains to be treated are cold, they must be heated in the mould. In some cases other nutritious matters are added to the grains before compression.—A. L. S.

Improvements in Treating and Rectifying or Ageing Alcohol or Alcoholic Liquors or the like by Electricity. A. de Meritens, Paris, France. Eng. Pat. 16,947, October 26, 1889. 4d.

The present patent has reference to Eng. Pat. 13,293 of 1888 (this Journal, 1888, 860). The inventor states that alternating electric currents assist chemical combination between bodies which are in a condition to combine; and that ammonia, aniline, the phenylene diamines, &c., which will combine with the aldehydes at 80° to 100° C. combine at ordinary temperatures with the help of an alternating current. He therefore adds to the alcoholic liquor two equivalents of ammonia or aniline, &c., to each equivalent of aldehyde to be combined, and passes an alternating current, when combination and consequent neutralisation immediately take place.—E. T.

XVIII.—CHEMISTRY OF FOODS, SANITARY CHEMISTRY, AND DISINFECTANTS.

(A)—CHEMISTRY OF FOOD.

Foods and Food Adulterants. Investigations made under direction of Dr. H. W. Wiley, Chief Chemist. Part Fifth. *Baking Powders.* C. A. Crampton, Assistant Chemist, United States Department of Agriculture; Division of Chemistry; Bulletin 13, 1889, 557—627.

No recognised standard for the composition of a baking powder exists, and as long therefore as no injurious ingredients are present in such a powder it cannot properly be looked upon as adulterated, whatever its composition. In a case like this, therefore, of a food adjunct, the composition of which is to a certain extent arbitrary, it is desirable that the public should be in possession of data which will enable it to form some opinion as to the relative value of a baking powder. At present the sale of baking powders is not regulated, but it seems desirable that manufacturers should be required by law to use a label giving approximately the composition or analysis of the powder sold. Some regulation of this sort seems only fair to the consumer and the manufacturers of a first-class and therefore high-priced article.

The bulletin under consideration is a step in the right direction, for before useful legislation can be carried out on a matter like this, it is necessary that analytical data should be carefully collected and discussed.

The oldest, and in a sense the best method of leavening bread is by means of yeast. By its means the carbohydrates of the flour are partially decomposed, and the carbonic acid evolved in the process lightens or "leavens" the dough. Excepting the yeast no foreign materials are introduced into the bread, but the process is a slow one, and the road has therefore been paved for the introduction of mechanical and chemical methods to accomplish the aëration, or charging of the dough with gas, more rapidly. One advantage of yeast-raised bread is that the albuminoids get peptonised. In Daughlish's method of aërating, the dough is made in a closed vessel, with water charged with carbonic acid under pressure. When the pressure is relieved the expansion of the gas leavens the bread. A weak wort, in which fermentation has set in, and which absorbs the carbonic acid gas more readily, is also used instead of water. The above method of leavening is therefore largely a mechanical one.

No reliable data exist with regard to the consumption of baking powders; there seems, however, some ground for believing that some 25,000,000 dols. are paid annually for baking powders by consumers in the United States. Baking powders consist essentially of an alkaline carbonate—bicarbonate of soda is almost exclusively used for this, sometimes bicarbonate of ammonia—mixed with a solid acid or acid salt. Usually some dry inert material, such as starch, is added to prevent action between the chemicals during the time the powder is kept. This is called the "filling."

Baking powders can be broadly and conveniently classified according to their acid constituents:—

- (1.) Tartrate powders.
- (2.) Phosphate powders.
- (3.) Alum powders.

Many powders are mixtures of at least two of these three classes.

Tartrate Powders.—In these bitartrate of potassium or "cream of tartar" is usually employed to supply the acid. Sometimes free tartaric acid is used. The reaction brought about on the addition of water to dissolve the constituents would be—

The products of the reaction are therefore potassium, sodium tartrate (Rochelle salt), carbon dioxide and water.

With free tartaric acid the reaction is—

Here the products of the reaction are sodium tartrate and carbon dioxide. Both sodium tartrate and Rochelle salt are slight purgatives. The quantity of Rochelle salt present in a loaf of bread (2 teaspoonfuls of powder to a quart of flour) is probably somewhat more than would be contained in a seidlitz powder. In other respects these salts are harmless, and the tartrate baking powders may on the whole be looked upon as the most satisfactory class of baking powders. Tartrate powders prepared with free tartaric acid probably do not keep so well as those in which the bitartrate of potash is used, hence the latter class is almost invariably met with.

Phosphate Powders.—In these monocalcium phosphate is the acid salt employed. It is difficult, however, to obtain this salt pure, and most phosphate powders therefore contain a considerable amount of sulphate of lime. The following equation, probably, fairly well represents the reaction which takes place with these powders:—

The phosphate of soda is a mild purgative, but otherwise, no particular objection can be raised to these powders, and perhaps, in cases of malnutrition, scrofula, rickets, phthisis, &c., the presence of phosphates may be advantageous. Acid phosphate of soda is said to have been used in former years as a constituent of baking powders, but appears to have been entirely superseded by the lime salt.

Alum Powders.—In these the salt used in place of an acid is either potash alum ($K_2Al_2(SO_4)_4 \cdot 24 H_2O$), or ammonia alum ($(NH_4)_2Al_2(SO_4)_4 \cdot 24 H_2O$) according to their relative cheapness. At present the ammonia alum is exclusively used. As burnt alum, *i.e.*, alum deprived of its water of crystallisation, dissolves more slowly in water; it is probably in this condition that it is used for baking powders. The reaction would be—

The residue therefore consists of sulphate of soda, ammonium sulphate and alumina. Sodium sulphate is a slight aperient. Little is known about the physiological action of ammonium sulphate. With regard to the alumina the following conclusions are drawn:

- (a.) It must be expected that small quantities, at least, of alum will be absorbed by the digestive fluids, where any form of powder containing it is used.
- (b.) Whether the absorption of small quantities of alum into the human system would be productive of serious effects is still an open question, and one that careful physiological experiments alone can decide.
- (c.) That form of alum powder in which sufficient phosphate is added to combine with all the aluminium present is a better form, and less apt to bring alum into the system than where alum alone is used.

Most American alum powders are of this latter description. There are few "straight" alum powders, *i.e.*, alum powders containing alum only as the salt which reacts with the carbonate.

In England and France, which have food adulteration laws, the use of alum in bread-making is prohibited.

Sometimes tartaric acid or bitartrate is added to alum powders. This practice is objectionable, as the acid tends to prevent the precipitation of the aluminium hydrate and facilitates the absorption of alumina into the system.

Conclusion (c.) above has reference to the mixed alum and phosphate baking powders. In this case the character of an alum powder would, it seems, be improved. The reaction would be—

and, as will be seen, insoluble calcium sulphate partially replaces sodium sulphate, and the less soluble aluminium phosphate will to a greater or less extent replace alumina.

The following comparison of the different classes of powders is then given: "It is assumed, of course, that the ingredients are combined in exactly the proper proportions, and that all the chemicals used are of full purity and strength.

Powders.	Carbon Dioxide.	Total Residue of the Weight of Chemicals used.
	Per Cent.	Per Cent.
Tartrate	18	104
Phosphate	22	123
Alum	27	128
Alum and phosphate	17	111

"From this it will be seen that a tartrate powder, theoretically, gives the lowest percentage of carbonic acid gas in proportion to the weight of chemicals used in its composition, together with the least weight of residue. It is assumed that burnt alum is used in both the alum and the alum and phosphate powders. The residues are calculated to hydrated salts in all cases. No account is made of inert "filling," as that would be the same in each case. It should, of course, be remembered that in the above calculation the *total weight* of residue is reckoned in each case without regard to solubility or relative effect upon the system of the various salts formed."

Carbonate of ammonia is sometimes used alone by bakers as a chemical aerating agent. If it were entirely driven off during the baking of the bread there would be no objection to its use. But that this is the case is open to doubt, and it is not therefore advisable to use it alone in baking. An objection can hardly, however, be raised to the small quantities of this substance present in some baking powders.

Then follow analyses of baking powders found in the market and their discussion by Professor H. A. Weber, forming part of the annual report of the Ohio State Dairy and Food Commissioners for 1887. The discussion does not add materially to what has been said so far, and the analyses of 30 samples cannot, of course, be given. Of these, Mr. Crampton says: "Professor Weber's analyses are rather superficial and incomplete, probably being made under conditions that did not admit of thorough quantitative work. He has overlooked entirely, for instance, the fact of the presence of phosphoric acid in many alum powders."

Professor H. B. Cornwall, in his "Report of the Dairy Commissioner of New Jersey, 1888," p. 82, gives the results of the examination of a large number of baking powders, but excepting for the "strength," *i.e.*, the yield of carbon dioxide which was estimated quantitatively, the examination was merely of a qualitative nature.

Sulphates, ammonium salts, phosphates, alumina, tartaric acid and tartrates, and potash were tested for, and the results enabled him to classify the powders into—

1. Cream of tartar powders.
2. Acid phosphate of lime powders.
3. Alum and phosphate powders.
4. Alum powders.
5. Unclassed powders.

Professor Cornwall's conclusions agree with those already given at the beginning of this abstract.

We now come to a consideration of the analyses of the United States Department of Agriculture. The samples examined were purchased at retail stores in Washington, D.C.

For classifying the samples, qualitative analyses, similar to those used by Professor Cornwall, were employed.

A detailed description of the quantitative methods employed would take up too much space; suffice it to say that for the carbon dioxide two determinations were always made, one with the addition of acid for determining the *total* amount of carbon dioxide present, the other with the addition of water only for determining the amount of *available* carbon dioxide present, *i.e.*, the carbon dioxide actually liberated when the powder is used for baking purposes.

Other ingredients subjected to quantitative analysis were—

Starch (present as filling).
Phosphoric acid.
Tartaric acid.
Alkalis.
Aluminium.
Calcium.
Sulphuric acid.
Ammonia.
Moisture.

The results of each analysis are given in the first instance as acid and basic radicals in percentage composition. An attempt is then made to combine these into salts showing the constitution of the powder. In the latter case, however, the results arrived at are at best but approximately correct, for the difficulties in the way of arriving at the true constitution of a powder are very great, if not insurmountable. The analyses agree fairly well in a general way with those obtained by Professors Weber and Cornwall. The value of a baking powder with regard to its available carbon dioxide diminishes with age, so that the results obtained cannot strictly be taken as showing the relative values of the powders; but, generally speaking, the tartrate and phosphate powders give higher percentages of carbon dioxide than the alum and alum and phosphate powders. Mr. Crampton says: "Professor Cornwall's average for 20 samples of alum and phosphate powders (no straight powders included) is 8.97 per cent.; for eight samples of tartrate powders, 11.60. Professor Weber's average for 19 samples of alum powders is 7.58 per cent.; for eight samples of tartrate

powders, 11·20 per cent. My average for 20 samples of both alum and alum and phosphate powders is 8 per cent.; for eight samples of tartrate powders, 10·10 per cent. The only straight phosphate powders sold seem to be the various preparations made by the Rumford Chemical Works, and the 'Wheat' powder; at least these are all obtained by any of the investigators. The carbonic acid strength of the former is uniformly good, slightly higher than the tartrate powders; the latter is a peculiar preparation, made up without any filling whatever, and gives a low percentage of carbonic acid, except in one of Professor Cornwall's samples, which seems to have been obtained quite fresh."

A point of importance in connexion with baking powders is the percentage of filling or inert material they contain. The object of the filling is mainly to prevent the active constituents in the powder from reacting on each other during the time the powder is kept. It is possible that too much or too little filling may be present in a powder. In the former case the value of a powder is diminished by the presence of too large a proportion of inert material. In the latter case the powder is liable to rapid deterioration during keeping, so that when used its carbon dioxide value is very low. In the case of bitartrate powders, Mr. Crampton found on an average 14·04 per cent. of filling, 24·57 per cent. being the highest, 5·32 per cent. the lowest quantity; the latter evidently not being sufficient to prevent deterioration. Powders made up with free tartaric acid contained much more filling, namely, 40·05 and 45·63 per cent., possibly on account of the hygroscopic nature of the free acid. 26·41 per cent. was found in a phosphate powder, another contained no filling, evidently to its detriment. The alum and alum and phosphate powders contained large percentages of filling, 40·76 per cent. being the average, 52·29 per cent. the maximum, 31·54 per cent. the minimum.

Probably this high percentage is necessary to prevent deterioration, especially if but a small proportion of the water of crystallisation has been driven off from the alum. Professor Prescott has given it as his opinion that anything over 20 per cent. of filling should be looked upon as dilution.

Mr. Crampton finally has attempted to make up a domestic baking powder of fair keeping quality, and gives the following formula as answering the purpose well:—

	Oz.
Cream of tartar.....	8
Baking soda.....	4
Corn starch.....	4
	Per Cent.
Total carbon dioxide.....	12·63
Available carbon dioxide.....	10·91

The author's views as to the lines on which legislative regulation of the sale of baking powders should proceed have been given at the commencement of this abstract.

—F. W. T. K.

(B.)—SANITARY CHEMISTRY.

PATENT.

Improvements in the Means of and Apparatus for Treating Refuse. W. Warner, Nottingham. Eng. Pat. 18,719, December 21, 1888. 8d.

THESE improvements have reference to the apparatus commonly known as "Destructors." At the back of the grate is situated a drying hearth on to which the refuse is delivered from a hopper above, placed at the rear end of a reverberatory arch which covers both grate and drying hearth. The construction of the apparatus is such that the main flue for taking off the products of combustion is caused to pass under the drying hearth, which thus receives heat both from above and below. The fire and ash-pit doors are made air-tight so that a forced draught can be used if desired. When employed it is delivered partly below the fire-bars and partly above. The latter current enters the furnace through perforated metal plates so

arranged as to protect the brickwork on each side of the grate, and having air-channels situated behind them. The improvements also have reference to the form of hopper used, the nature of the damper arrangements, and to contrivances for intercepting dust in the flue and facilitating its removal.—A. R. D.

XIX.—PAPER, PASTEBOARD, Etc.

Study of the Quality of Paper. Bull. Soc. d'Encour. pour l'Ind. Nat. 1889, 430—444.

THE increase in the production of paper has led to the introduction of a variety of raw materials in addition to rags, such as hemp, straw, wood-pulp, &c. Of these hemp alone can be considered as an improvement. Attention has been more and more directed to the qualities of paper, its surface, its colour, and at the same time its selling qualities, the result of which is the production of paper of inferior quality, of little strength, and oftentimes destined to a short life. These circumstances have led to the establishment in Germany of a specially appointed laboratory at the Imperial Technical Institute of Charlottenburg, under the direction of Dr. Martens, where papers are systematically examined. The principal points examined are strength, elasticity, nature of sizing, material, thickness, &c.

To determine (1) *the strength*, a number of strips of the paper taken in different directions are tested in a specially constructed machine known as the Gattyg-Reisch machine, and the mean taken. The results are expressed in terms of the length of the paper itself necessary to produce the rupture. This is easily obtained by calculation when the weight of the paper and its breaking strain in grammes are known. The same machine indicates automatically the elasticity or extensibility of the paper.

(2.) *Resistance to Rubbing.*—A sample is taken and rubbed between the hands. With a weak paper minute holes soon make their appearance, the number of rubbings determining the quality.

Papers are classed as follows:—

0. Extremely weak.
1. Somewhat less weak.
2. Less weak.
3. Medium.
4. Moderately strong.
5. Strong.
6. Very strong.
7. Extremely strong.

(3.) *Thickness.*—This is measured by means of a micrometer.

(4.) *Ash.*—Cellulose contains less mineral matter than 1 per cent. Any increase in the amount of ash indicates the addition of mineral matter.

(5.) *Microscopical Examination.*—The sample is moistened with a solution of iodine, and the following colourations are obtained:—1. Fibres coloured yellow, in the case of wood pulp. 2. Fibres of cinnamon colour, hemp, linen, cotton. 3. Fibres, uncoloured, pure cellulose. To prepare the paper for microscopic examination the specimen moistened with iodine solution is placed in a porcelain crucible with a little water, a little soda solution added, and the whole boiled. The liquor is coloured yellow if the paper was sized; after a quarter of an hour's boiling, the residue is washed with water. The pulp is then triturated in a mortar with a little water and a portion placed afterwards on the object glass of the microscope. It is easy under the microscope to distinguish to which of the three groups named the specimen belongs.

(6.) *Examination for Chlorine and Free Acids.*—These bodies are very rarely found in papers. The former is recognised by its action on potassium iodide and starch,

The detection of the latter is a matter of great difficulty. Gertzberg recommends treatment with a solution of Congo-red.

(7.) *Determination of Sizing Material.*—Gelatin is detected by the formation of a cloudiness or precipitate when a solution of tannic acid is added to an infusion of the sample of paper in boiling water. Vegetable size is examined for by warming the paper with alcohol and pouring the solution into water; a precipitate is formed if rosin size be present.

To determine the degree of sizing lines are drawn on the paper with a solution of ferric chloride and the other surface is floated in a solution of tannic acid. Ink is formed with less or greater rapidity, according as the paper is well sized or otherwise.

The percentage of water in a paper is also usually determined.

The following are some of the methods of classification adopted at Charlottenburg:—

CLASSIFICATION ACCORDING TO STRENGTH.

Classes.	1.	2.	3.	4.	5.	6.
a. Mean breaking length in metres.....	6,000	5,000	4,000	3,000	2,000	1,000
b. Mean elasticity percentage extension	4.5	4.0	3.0	2.5	2.0	1.5
c. Resistance to rubbing..	6	6	5	4	3	1

CLASSIFICATION ACCORDING TO COMPOSITION.

1st Class.—Paper composed entirely of cellulose, giving a maximum of 2 per cent. of ash.

2nd Class.—Paper composed of cellulose, straw, but without wood pulp, giving 5 per cent. of ash.

3rd Class.—Paper composed of various substances, but without wood pulp, giving less than 15 per cent. of ash.

4th Class.—Paper composed of various substances, whatever the percentage of ash.

Though many objections have been raised to the above classifications, their value has been shown by the fact that of late years the average quality of paper manufactured in Germany has risen and the intervention of the Government has had a good effect on the industry.

The report concludes with the following notes on the microscopic examination of paper:—

The fibres of plants do not present the same appearance in paper as in the natural state, as the processes which they have undergone, to some extent modify them.

Straw.—The various kinds of straw usually employed are oat, wheat, barley, rye, maize, and, in China, rice. The fibres present but few distinguishing features; they, moreover, resemble those of hemp and linen. On the other hand, it is easy to recognise in a paper the epidermic cells of straw, and even to determine their source. Fig. 1 represents

Fig. 1.

Fig. 2.

Fig. 3.

a cell from rye straw, magnified 250 times; Fig. 2 that from rice, and Fig. 3 that from maize. The latter has been subjected to the action of chromic acid. The following table gives the dimensions of the various kinds of cells:—

	Dimensions of Cells (in Millimetres).	
	Length.	Breadth.
Barley.....	*103—*214	*012—*014
Rye	*086—*345	*010—*016
Wheat.....	*152—*440	*018—*024
Oats.....	*187—*443	*012—*017
Maize	*198—*252	*030—*080

These epidermal cells are always accompanied by vascular cells in the form of spirals and isolated rings (Figs. 4 and 5.)

Fig. 4.

Fig. 6.

Fig. 7.

Fig. 5.

Fig. 8.

Fig. 9.

Wood Fibre.—There are two kinds of wood fibres usually met with in paper, one from the various kinds of pine, showing very characteristic round pitted vessels (Figs. 6 and 7), the other derived from birch and poplar, having equally characteristic, but totally different, markings.

Fibres of Dicotyledonous Plants.—Of these the most important are flax and hemp, and they are very difficult to distinguish from each other. Weisner has lately endeavoured to distinguish them by means of the action of ammonia-copper solution. This solution causes the fibres to swell, and ultimately dissolves away all but the interior canal. The different appearances presented are shown in Fig. 8 (flax) and Fig. 9 (hemp).

Fig. 10.

This reaction cannot be applied to the fibres in paper, as the mechanical treatment they undergo entirely masks their characteristic features.

The action of the beating rod causes the fibres to split up until they present somewhat of the appearance of Fig. 10 or Fig. 11, if it has not been carried on to the same extent. Occasionally transverse markings make their appearance (Fig. 12); these markings never occur in the case of fibres from monocotyledonous plant.

Cotton.—The general microscopical appearance of the cotton fibre is shown in Fig. 13. The spiral appearance,

Fig. 12.

Fig. 11.

however, is sometimes simulated by the flax fibre (Fig. 14), and on the other hand occasionally cotton fibre is met with

Fig. 13.

Fig. 14.

in which it is absent. The ammonia copper reagent causes the cotton fibre to assume the appearance of Fig. 15, the

Fig. 15.

Fig. 16.

interior canal having the appearance of a flat ribband. The action of the roll sometimes causes cotton fibre to assume the appearance of Fig. 16.—E. J. B.

Manufacture of Paper in Japan. M. Martens. Bull. Soc. d'Encour. pour l'Ind. Nat. 1889, 495—498.

The German Consul at Gioko-Osaka lately sent over a collection of samples of papers made in Japan, which have been examined at the Institute at Charlottenburg according to the methods in use there. The results are given in the following table:—

Name.	Composition.	Ash.	Weight of Square Metre.	Breaking Length.	Extensibility.
		Per Cent.	Grms.	Kilometres.	Per Cent.
Gampi.....	Gampi.....	1.2	12.6	7.2	2.9
Kodsu.....	Kodsu.....	2.3	22.1	4.25	3.9
Mitsumata	Mitsumata	1.4	15.4	4.08	2.8
Kopigampi	Gampi.....	2.4	8.2	7.05	2.1
Ussuyossi.....	{ $\frac{1}{2}$ Gampi	1.5	10.0	7.12	2.2
	{ $\frac{1}{2}$ Mitsumata.....				
Usu nedzumi	0.8 Gampi	4.3	23.1	7.73	3.2
Programi	0.2 Silk.....				
Hiro Suki.....	Kodsu	1.9	7.6	8.16	2.6
Murnasaki.....					
Srogami	Gampi.....	1.8	37.8	10.8	3.3
Atsu Hinkirigami	Gampi.....	1.8	23.9	10.7	3.1
Usu Hinkirigami	Gampi.....	2.2	81.9	10.5	4.3
Fu Hiyoshi.....					

By "breaking length" is meant the length of a band of paper suspended vertically, the lower end being free, which the fixed end will support before breaking.

It is remarkable that with European papers the breaking length varies from one to six kilometres, whereas with the Japanese papers it rises to as high as 10.8 kilometres.

The principal materials used for making paper in Japan are: 1. *Wickstronia canescens*; 2. *Edgeworthia pagrifera*; 3. *Broussonetia papyrifera*. Their common names in Japan are Gampi, Mitsumata and Kodsu. Efforts have been made to acclimatise these plants in Europe, but without success. Nearly all the paper is made in Japan by hand labour, the

methods being handed down in families. The methods are very simple. The bark is removed from the tree and allowed to soak for some days to loosen the outer coating. This is removed and the pure bast fibre is allowed to bleach in the sun. It is then boiled in lime water or in a lye made from the ashes of the plants themselves, well washed in water and then beaten into pulp with sticks. The frame on which the paper is made is of thin strips of bamboo and silk. The paper is sized with boiled rice or some similar starchy material.—E. J. B.

PATENTS.

Improvements in Treating or Cleansing Paper-making Materials and other Fibrous Materials and Fabrics.
R. Hamilton, Edinburgh, and I. C. Hamilton, Linlithgow.
Eng. Pat. 1433, January 26, 1889. 11d.

THE inventors assist the action of caustic soda in the preparation of paper pulp from rags, esparto, &c., by the addition of the soda or potash salts of certain sulphonic acids obtained by treating olefines with sulphuric acid.—E. J. B.

Improvements in the Manufacture and Bleaching of Wood and other Pulps and in Apparatus for that Purpose.
C. Ramsey, Leeds. Eng. Pat. 1834, February 1, 1889. 8d.

THE inventor boils wood chips with lime water in a vomiting boiler. When sufficiently acted upon he treats with a solution of hypochlorite of magnesia at 3° B. for eight hours, the circulation of the liquid being maintained by means of steam. The pulp so obtained is then bleached in a separate vessel with another solution of hypochlorite of magnesia. The solutions are prepared by adding solution of sulphate of magnesia to one of bleaching powder.—E. J. B.

XX.—FINE CHEMICALS, ALKALOIDS, ESSENCES AND EXTRACTS.

On the So-called Double Cyanide of Zinc and Mercury.
W. R. Dunstan. Pharm. J. February 15, 1890, 653.

SIR JOSEPH LISTER has recently drawn attention to the valuable antiseptic properties possessed by a material which is described in many chemical treatises as a double cyanide of zinc and mercury prepared by precipitating a solution of the cyanide of mercury and potassium with a solution of zinc sulphate (Lancet, November 9, 1889, and January 4, 1890).

During the manufacture of this substance several facts were observed which seemed to throw doubt on the statement that it is constituted of a chemical compound of the two cyanides.

It is stated on the authority of Rammelsberg, in Gmelin's "Handbook," that when the soluble double cyanide of mercury and potassium, $\text{HgK}_2(\text{CN})_4$, is decomposed with a solution of zinc sulphate, or when the soluble double cyanide of zinc and potassium, $\text{ZnK}_2(\text{CN})_4$, is decomposed with a solution of mercuric chloride, an insoluble double cyanide of mercury and zinc is precipitated, the composition of which is probably represented by the formula—

the chemical changes being expressed by the equations—

It is this substance, freed from soluble salts by washing with cold water, that has been prepared for Sir Joseph Lister. It was observed that in washing the precipitate with cold water large quantities of mercuric cyanide are dissolved from it, only a relatively small proportion, varying from one-fourth to one-fifth of the calculated quantity, remaining in the precipitate. In the absence of knowledge as to the cause of this action, and as to the nature of the precipitate, the manufacture of the substance becomes an entirely empirical operation.

The methods which suggested themselves were—

1. The precipitation of a solution of mercury potassium cyanide with a solution of zinc sulphate—

2. The decomposition of a solution of zinc potassium cyanide with a solution of mercuric chloride—

3. The decomposition of a solution containing a formula-weight of mercury potassium cyanide and a formula-weight of zinc potassium cyanide with just sufficient dilute sulphuric or acetic acid to convert the whole of the potassium present into potassium salt; the cyanides of zinc and mercury would thus be precipitated together:—

4. The simultaneous dissolution of equivalent quantities of freshly precipitated mercuric oxide and freshly precipitated zinc carbonate in strong aqueous hydrocyanic acid—

Having prepared the pure reagents the four above-mentioned processes were successfully put into operation for the purpose of ascertaining whether mercuric cyanide will unite with zinc cyanide in any proportion.

Method 1.—This method is substantially the same as that by which the substance used by Sir Joseph Lister has been prepared. Sir Joseph Lister informed the author that the process adopted has been as follows: Cyanide of mercury, 24 oz.; cyanide of potassium (about 95 per cent.), 12 oz. 171 grains; zinc sulphate, 27 oz. 159 grains. The potassium cyanide and the mercuric cyanide are dissolved in 4 pints of cold water, and the liquid is precipitated by the addition of the zinc sulphate dissolved in 12 pints of cold water. These quantities are calculated from the equation given above. The precipitate is collected and washed with two successive quarts of water (see also "Lancet," January 4, 1890).

The substance prepared in this manner is a nearly white powder. The composition of a specimen furnished by Sir Joseph Lister was ascertained by analysis. By washing with cold water, until nothing further is removed, the amount of soluble mercuric salt is determined. The mercury, zinc, and cyanogen were determined by known reliable methods.

The results of the analysis were—

	Per Cent.
Total mercuric cyanide	17.77
Mercuric salt removed by cold water	2.86
Zinc cyanide	67.85

There were also present about 10 per cent. of zinc hydrate, or more probably hydroxy-cyanide, originating partly from the alkali contained in the potassium cyanide, and partly, no doubt, from the decomposition of zinc cyanide.

The supposed double cyanide of zinc and mercury, $\text{ZnHg}(\text{CN})_4$, would contain 68.6 per cent. of mercuric cyanide; the substance analysed contained less than one-fourth of this quantity, the remainder having been dissolved by the water present during precipitation and by that used in washing the precipitate.

The substance was now prepared by the same method, but more water was added to the solutions before precipitation. The precipitate was washed until quite free from soluble mercuric salt and dried over caustic soda in a vacuum desiccator, to avoid any possible decomposition by heat. The results of the analysis of this specimen were—

	Per Cent.
Total mercuric cyanide	6.77
Mercuric salt removed by cold water	None.
Zinc cyanide, including hydroxy-salt	93.3

The quantity of water present during precipitation is thus shown to exercise an important influence on the composition of the precipitate. A large quantity of water leads to the retention of much less mercuric salt in a form in which it is not dissolved by water. The amount of mercuric cyanide in this specimen is only about one-tenth of that contained in the compound $\text{HgZn}(\text{CN})_4$.

Method 2.—Seven grms. of the double cyanide of zinc and potassium were dissolved in water and precipitated by the addition of a solution containing 7.7 grms. of mercuric chloride. The entire quantity of water present was rather less than in the preceding experiment. The precipitate