

ABSTRACTS AND REVIEWS

I.—Glass-making Materials.

1. The Deterioration of Lime on Keeping. S. A. WOODHEAD (*Analyst*, 1918, 43, 161).—A summary of the author's tests and results is as follows:—

(1) Powdered lime was placed on the floor of a dry shed in such a way as to expose a large surface. Every day during sixty-four days it was turned over with a spade, and re-spread to cover the same floor space. At the end of sixty-four days the percentage of free lime had decreased from 69.1 to 39.5, the loss being equivalent to 43 per cent. of the free lime.

(2) Powdered lime was dumped in a heap outside and exposed to the weather for four months without being touched. Analyses showed the following percentages of free lime:—

At commencement of test	69.1
After four months' exposure:—	
Crust of heap	0.0
Interior of heap	66.9
Average of mixed crust and interior...	60.8

The average deterioration of the sample was equal to 12 per cent. of the free lime. After four months the crust had been changed completely to calcium carbonate.

(3) A sample of lump lime was placed in a bag and left outside protected from rain. In four months the percentage of free lime (mixed sample) decreased from 81.2 to 50.3, equal to a loss of 38 per cent. of the free lime.

(4) A sample of lump lime was dumped outside and exposed to the weather. In four months the free lime (mixed sample) decreased from 81.2 per cent. to 38.8 per cent., equal to a loss of 52 per cent. of the free lime.

From the above results it appears that in order to store lime to the best advantage it should be heaped in a powdered condition.

J. D. C.

2. The Prospects of Founding a Potash Industry in this Country. KENNETH M. CHANCE (*J. Soc. Chem. Ind.*, 1918, 37, 222T).—The author mentioned three industries in which potash may be recovered as a by-product, namely, the blast-furnace industry, the manufacture of cement, and the washing of raw

wool. The recovery of potash in a gas-cleaning plant for a blast furnace had the enormous advantages over all other native sources of supply in that the value of the main product of the plant, namely, the clean gas, was in itself sufficiently great to provide remuneration for the capital outlay involved in erecting and operating the plant, and also the main items of cost (raw material, labour, and fuel) in volatilising potash from an ore in which it is present in insoluble form are reckoned and incurred as items of cost in the original manufacture (that is, of the pig iron).

In the autumn of 1914, the Halberg-Beth plant installed at the works of the North Lincolnshire Iron Co., Ltd., for the purpose of cleaning their blast-furnace gases came into operation. A sample of the dust recovered was found to contain considerable quantities of potash and of cyanide.

An arrangement was made with the British Cyanides Co. at Oldbury for a joint investigation into the possibilities of working up the dust into commercial products. Many working difficulties were encountered, and considerable research was needed both at the blast furnaces and at the Oldbury works. At the furnaces the gases had been water-cooled. Soluble potash salts were thereby carried away and lost. To avoid this, a Green's economiser was installed. (This plant was really too costly for the purpose; one of the greatest difficulties is that there is at present no efficient plant for the dry cleaning of the gases.)

Frequently much of the potash remained associated with the slag. A considerable amount of work was done in ascertaining the effect of the temperature of the furnace on the quantity of potash volatilised. A higher temperature usually meant more potash in the dust, but running the furnaces with periods of higher temperature was not satisfactory.

Whilst carrying out these investigations, it was noted that the amount of volatile chloride in the gas remained constant, and from this it was inferred that the chlorides in the furnace charge were practically constant and were all volatilised. If, then, additional chlorides were artificially fed into the furnace, they should combine with those bases having the most volatile chlorides. Potassium chloride, being the most readily volatilised, should ensure that all the potash was found in the gas as chloride. Salt was therefore added to the furnace in sufficient quantity to volatilise the whole of the potash, and the amount of potash in the gas was thereby increased from about 60 lb. to upwards of 200 lb. per million cubic feet of gas.

The use of salt has been repeated in several blast furnaces in other parts of the country, and in every case the quantity of potash volatilised has been considerably increased. The use of salt appears to have no adverse results on the manufacture of pig iron. Sufficient potash for the founding of an industry can then be obtained.

By the use of suitable quantities of salt coupled with efficient gas-cleaning plants at the blast furnaces, it should be possible to

meet the potash requirements of this country, and at a price which, on a pre-war basis of cost, is less than the lowest figure at which German potassium chloride has ever yet been marketed in this country (namely, £8 per ton).

Arrangements have been made for the manufacture of caustic potash in bulk from the chloride by electrolysis, whilst the salts being produced include potassium carbonate, potassium bicarbonate, potassium ferricyanide, and potassium permanganate.

During a discussion of the paper, the question was raised as to whether calcium chloride (a cheap waste product) might not be found as efficient as salt.

In regard to potash from cement kilns, there was ample evidence to show that by the use of salt in the cement kiln, either in the crystalline form or as sea-water, potash was volatilised. The greatest difficulty was the construction of cheap and efficient plant for extracting the potash from the gas. According to one authority, a combination of electrical precipitation and the collection of the dust in the form of a slurry had been found successful. The gas from a cement kiln had no value beyond its potash contents, and therefore, unless some counter-balancing advantage could be discovered and utilised, the cost of recovering potash must always be greater from a cement kiln than from a blast furnace.

If raw wool received a preliminary washing in cold water, potash may be recovered from it as carbonate in a solution which was contaminated with a small proportion of the natural fats of the wool. If certain physical difficulties of concentration could be overcome there was no doubt that potassium carbonate of great purity could be recovered and the fats rendered of value in the form of gas and oils.

A. M. J.

3. The Alsace Potash Deposits and their Economic Significance in Relation to Terms of Peace. PAUL KESTNER (*J. Soc. Chem. Ind.*, 1918, 37, 291τ).—The paper first points out that Alsace-Lorraine is in reality the key to the industrial and economic supremacy of Germany, as it contains the potash deposit of Alsace and the iron ore deposit of Lorraine. The loss of the latter would render Germany dependent on foreign countries for more than 80 per cent. of her iron ore consumption of 30 million tons per annum.

The author compared the yield per hectare of the principal crops (wheat, rye, oats, barley, potatoes, sugar-beet) of Germany and of France for the year 1913-1914. In each case the yield was greater in Germany, in spite of the fact that the soils of Germany are for the most part ancient sand deserts, whilst the soils of France are most favoured by nature. This is accounted for by the fact that Germany has the potash monopoly, and uses more potash than any other country in agriculture. During the war, by still further increasing the amount of potash used, the Germans have been able to increase their crops and to some extent to discount the blockade.

A summary was also given of the sources from which the world's consumption of potash can be supplied, namely:—

North Germany.—About 1850 potash was discovered in the rock-salt mines of Stassfurt. The workings now extend over a wide area in Brunswick, Hanover, Mecklenburg, and Thuringia. In 1907, thirty-nine companies united into one huge syndicate, the famous Kali Syndikat, which to-day holds practically a potash monopoly. As soon as the Alsace deposits were discovered they came under the control of the Syndicate, and so completed the formidable economic weapon wielded by Germany. With rare exceptions, the salts from the North German basin contain a fairly large proportion of magnesia, and need refining before they can be used even in agriculture.

Galician Deposits.—These beds do not seem to be able to provide even for Austria-Hungary alone, since in 1913 that country imported 21,000 tons of potash from Germany.

Spanish Deposit.—Potash was discovered shortly before the war at Suria in Catalonia, a district where rock-salt mines were already worked. The deposit extends over a considerable area, but is not continuous in the beds as is the case in Alsace; moreover, it appears that the working is rendered difficult because the beds, instead of being horizontal, as in Alsace, are steeply inclined. The deposit comprises both carnallite and sylvinite, the carnallite, which is the more plentiful, containing at least 12 per cent. of K_2O .

United States deposits are not potash mines, but salt lakes situated in the Rockies, in the States of Nebraska, Utah, and California. The reserves are considerable.

Italian deposit at Erythria is of a recent lacustrine formation. The reserves are inconsiderable, but, on the other hand, the deposit is important on account of the richness of the salt, which contains 80 per cent. of KCl .

In *Tunis*, to the south of Gabes, a salt lake of 15,000 hectares has been worked since 1915 primarily for bromine, though also for potash.

In *Chile*, lakes containing deposits of potassium chloride have been found; there is a reserve estimated at 2,000,000 tons, which has a content of from 3 to 12 per cent. of chloride.

There are also deposits in Peru, in Russia, in Morocco, and in the province of Overijssel in Holland which have not hitherto been developed.

There are also natural deposits of potassium nitrate in India and in Chile.

Salt marshes, notably those in the Rhone delta, supply mother liquors from which potassium chloride can be extracted.

Potash may also be recovered from the dust from blast furnaces and cement kilns.

The *Alsace* potash beds are situated in the south of the province, in the plain, bounded on the south by the Jura, on the west by the Vosges, and on the east by the Rhine. Recent borings have shown that secondary beds of the same formation are to be found

beyond the Rhine. The deposits consist of two beds situated below a deposit of rock-salt. The beds are formed for the most part of pure sylvinite, the upper bed having an average content of 35 per cent. of potassium chloride, and the lower one of 30 per cent. The layers are nearly horizontal and are not subject to the infiltration of water. The whole deposit represents more than 300 millions of tons; hence one may reckon that it would suffice for the world's consumption for many years.

The purity of the salt greatly surpasses that of all other known deposits of importance; refining is unnecessary for the salt intended for agriculture. The potash was detected by prospectors looking for coal in 1904; working began in the first shaft in 1910.

The German Potash Syndicate has taken care to limit the working of the Alsace deposit, and only allowed an output of 5 per cent. of the total German output.

A. M. J.

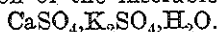
4. Potash (from Lakes) in Nebraska. J. M. LLITERAS (*Chem. and Met. Eng.*, 1918, 19, 633).—It has been proved by the continuous pumping of certain lakes that the potash supply of Western Nebraska is not inexhaustible, as the density of the water falls after a certain length of time. If the lakes, however, are allowed to "rest," the density of the water increases, and in rare cases may attain the original value. Nebraska is now producing about 450 tons of salts daily with an average potash content of 25 per cent. K_2O .

C. M. M.

5. Potash Salts in Hungary. F. VON KONEK-NORWALL (*Chem. Zeit.*, 1918, 42, 365).—Large quantities of alunite are stated to occur in Northern Hungary, from which potassium sulphate may be recovered by roasting at a red heat until all the aluminium sulphate has been decomposed and sulphuric acid fumes are no longer evolved. The residue, in the form of a white powder, consists of potassium sulphate (14—15 per cent.), alumina, and silica, from which with water the potassium sulphate may be separated.

C. M. M.

6. Potassium Salts. (Brit. Pat. No. 111845). F. W. HUBER and F. F. REATH (November 14th, 1917, No. 16741. Convention date, December 2nd, 1916. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—Potassiferous flue dust, such as that obtained by electric separation from the flue gases of cement kilns, is treated with water and the solution separated from the insoluble residue, all the operations being effected at a temperature not lower than about 85° , preferably nearly 100° , so as to avoid the formation of the insoluble double salt



Preferably the quantities are so chosen as to give a solution containing about 4—5 per cent. K_2O .

H. G. C.

7. Sand Washing. (Brit. Pat. No. 111061). J. SOUTHALL June 26th, 1917, No. 9147).—A sand-washer comprises a trough *A* with an undulating bottom, in each section of which is mounted a rotary system of paddles *C* and stirrers *D*, which pass the sand

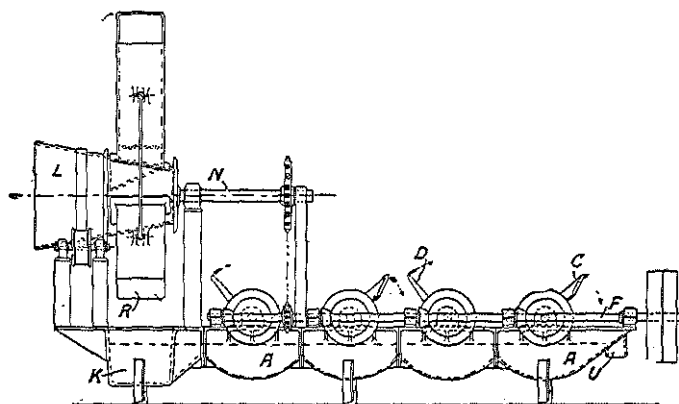
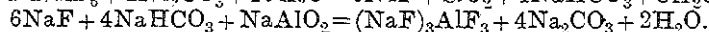
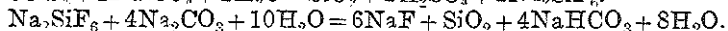
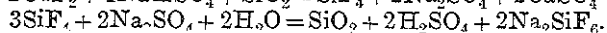
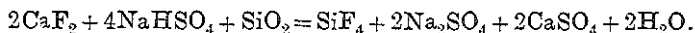


FIG. 1.

through the apparatus towards the discharge end *K* in the opposite direction to a stream of water. At the end *K*, the washed sand is raised by revolving hollow arms *R* to a discharge cone *L*. The dirty water overflows at an outlet *U*. The bearings of the shafts *F*, *N* are arranged above the water-level.

H. G. C.

8. Manufacture of Cryolite from Sodium Bisulphate, Silica, and Fluorspar. (HEM. FABR. GOLDSCHMIEDEN H. BERGIUS & Co., GOLDSCHMIEDEN (Ger. Pat. 307525, 23/1/17).—According to the process described, silicon fluoride, produced by decomposition at red heat of fluorspar and silica by means of sodium bisulphate, is absorbed by solid hydrated sodium sulphate. After separation of sulphuric acid or sodium bisulphate, the sodium silicofluoride is decomposed by fusing it with crystalline sodium carbonate in the proportion of 1 mol. of sodium silicofluoride to 4 mols. of sodium carbonate, with the production of sodium fluoride, sodium bicarbonate, and silica. The silica is filtered off, and cryolite precipitated by addition of sodium aluminate to the solution. The reactions which take place may be represented by the following equations:—



C. M. M.

9. The "Swelling" of Silica. TH. HEBBELER (*Chem.-Zeit.*, 1918, 42, 593).—The author found that if 2 grams of kieselguhr were shaken with water in a 250 c.c. graduated cylinder and then allowed to settle for twenty-four hours, the siliceous sediment occupied a volume of 8 to 18 c.c. If the clear water were then drawn off and replaced by a solution of calcium hydroxide, which in turn was drawn off and a fresh quantity added every day, the volume of the sediment increased gradually until, after fourteen days, it measured 68 to 196 c.c., according to the grade of kieselguhr employed.

This increase in volume was not due to increase in the size of the silica skeletons, but to the separation of calcium hydroxide occluded in the mass. The greater part of the precipitated matter could be removed by extraction with water, and the small portion which was precipitated as carbonate could be removed by water containing carbon dioxide. The volume of the kieselguhr then diminished to that observed originally.

The phenomenon appeared to be purely physical, with no formation of calcium silicate. J. D. C.

II.—Glass : Manufacture and Properties.

10. Barium Carbonate in Glass Manufacture. (*Sprechsaal*, 1905, 38, 55).—The use of barium carbonate in glass manufacture makes the glass more readily fusible, more refracting, and denser. The following batches suitable for pressed glass are quoted:

	I.	II.
Sand	100 kg.	90 kg.
Potash	10	15
Soda	25	13
Barium carbonate.....	25	10
Saltpetre	6	—
Limespar	5	4
Nickel oxide (decoloriser)	—	(2—3) gr.

J. R. C.

11. Yellow Tank Glass. (*Sprechsaal*, 1905, 38, 42).—The following batch is recommended for the production of yellow glass in a tank furnace:

Sand (with 2 per cent. iron oxide content)	100
Chalk, powdered	45
Salt-cake, 96 per cent. powdered	23—29
Coke, finely powdered	1.5
Manganese, powdered	5.5—6

The batch is said to melt in any good tank furnace, whatever the nature of the firing. By raising the manganese content and the

addition of small quantities of iron oxide, the glass can be made darker, until a reddish-brown colour is obtained. J. R. C.

12. The Raw Materials for Plate-glass Works. (*Sprechsaal*, 1904, 37, 454).—The importance of using pure raw materials if it is desired to obtain a good glass is emphasised. With reference to the form in which the alkali is to be added, it is remarked that, when soda is used, the glass melts much easier and more rapidly than when the salt-cake is employed and the attack on the pot is less. The use of salt-cake also necessitates the addition of coke or coal. This must also be pure carbon, and should be finely powdered. The addition of a small quantity of arsenic helps the batch to melt and gives the glass a clear, bright appearance. The two following batches were recommended as giving good clear glasses:

	I.	II.
Sand	100 kg.	100 kg.
Lime	22 „	27 „
Soda	40 „	—
Salt-cake	—	48 „
Coke (powdered)	—	3 „

J. R. C.

13. The Difference between Burning-off and Skimming-off Glass Gall. (*Sprechsaal*, 1904, 37, 1757).—According to the author, the glass gall usually consists of sodium sulphate, which can be got rid of in two ways: either by skimming or addition of carbon to reduce it. The latter method can be carried out by running the furnace with a smoky flame. The effect of the two methods is different, for, in the latter case, the carbon reduces the sodium sulphate to sodium oxide, sulphur dioxide, and carbon dioxide. Thus for every 100 parts of gall there remain in the glass, when it is burnt off, 43 parts of sodium oxide, which would be removed if the gall were skimmed off. The resulting glass has thus a higher alkali content when the second method is adopted.

J. R. C.

14. Gall-bubbles. H. KNOBLAUCH (*Sprechsaal*, 1904, 37, 3).—In the author's view, gall-bubbles are hollow spaces in glass filled with glass-gall, which probably consists of sodium sulphate. They arise, he believes, in the majority of cases, from the furnace temperature being too low. They can, however, be produced, even when the furnace is hot, being then due to lack of carbon. The addition of carbon or the maintenance of a reducing flame will remedy the trouble in this case.

J. R. C.

15. Faulty Bottles. (*Sprechsaal*, 1904, 37, 717, 756, 792).—The errors which may produce faulty bottles are divided into those due to the glass itself, to the annealing, to the workmanship, and to the decoration. In the first group are included such faults as

cords, waves, seeds, and stones. The causes of these faults are enumerated. Bottles well annealed are much more durable than those which are not. Well-annealed bottles will stand a pressure of 30 atmospheres, when similar, unannealed bottles collapse at a pressure of 5 atmospheres. Under this heading is also included the bloom which is often produced in the lehr. It is stated that this can be obviated by keeping the flames away from the glass. Under the heading of errors in workmanship are mentioned those due to the gathering of the incorrect amount of glass and to the bulb on the iron being the wrong shape before the glass is blown in the mould. If the glass is too hot when blown, the bulb may be good and a bad article still produced, as the walls may sink in the mould. A further source of error occurs when the neck of the bottle is made. The neck must be as hot as the additional glass applied or the bottle is liable to crack at this point.

J. R. C.

16. The Lack of Resisting Power of Bottle Glass.
HENINGK-LORENZ (*Sprechsaal*, 1905, 38, 961).—A glass which is recommended as acid resisting to a sufficient degree for ordinary purposes is:

Silica	64.63 per cent.
Alumina	} 7.77 "
Iron	
Lime	16.19 "
Soda	} 9.33 "
Potash	

J. R. C.

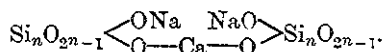
17. Moulds for Hollow Ware. W. GRULL (*Sprechsaal*, 1905, 38, 639).—In view of the cost of iron moulds, such as are usually employed, the author discusses their replacement by wooden ones. The disadvantage of the latter, of course, is that they change shape through burning away. It was found, however, that if "very light" glass is used, about 1,500 articles could be made before the mould had to be discarded. With "fairly heavy" glass and "heavy" glass, the numbers were 800 and 500 respectively. A disadvantage of the iron mould is that, being a good conductor, it quickly chills the glass, with the tendency to produce fine cracks on the surface, whilst it also rusts. To prevent the rust, Bocuze nickel-plated the inside of the mould, and thereby, in addition to eliminating the rust, obtained a polished surface in which to blow the glass. A wooden mould gives a better surface, and this may be advantageous for pressed ware. A mould made from lignite was tested and found to disintegrate as rapidly as a wooden one.

The ideal mould should be made of some substance having a low conductivity, not easily destroyed by the heat of the glass, and capable of producing a velvety surface. The amorphous modifications of coal were suggested for the purpose, namely, graphite,

coke, and charcoal. In this connection, mention was made of an English patent (1869) which endeavoured to substitute a coke mould for an iron one. The coke was bound together with pitch and afterwards with tar, but these binding materials were the cause of failure. The author tried gypsum and kaolin in varying quantities with tar, but was not successful in obtaining a good medium.

J. R. C.

18. Glass, its Chemical Constitution and Properties. (*Sprechsaal*, 1905, **38**, 482).—In nearly every glass silica is present in combination with two oxides, one of which is monovalent and the other divalent. There are other types, as, for example, phosphate glasses and Peligot's glass without alkali, in which barium oxide and lime are combined with silica; and also there may be more complex glass, as when lead oxide is partly replaced by baryta, giving a tri-basic glass. Dumas held that glass is a real salt, and always alkaline, and that it is always either a definite tri-silicate compound or a mixture of such. This is now doubtful, and it is probable that it is not a simple compound, but an indefinite mixture of definite silicates. Weber has put forward a formula for glass, $xM'_2O, yM''O, 3(x/y^2 + y)SiO_2$. Zulkowski, studying glass from a purely chemical point of view, arrived at the conclusion that a meta-silicate is usually formed, namely, $SiO(OM)_2$. An ortho-silicate can only be produced when alkali is greatly in excess and a very high temperature, higher than the usual glass furnace temperature, is attained. When, on the other hand, silica is in excess, a silicate of the type $Si_nO_{2n-1}(OH)_2$ arises. A practical glass must be di-basic, and Mylius and Förster are of the opinion that it is not a mixture of single silicates, but a double silicate of the form



They hold that a homogeneous glass can only be formed under the following conditions: (1) The mutual proportions of the bases must correspond with the formula $6SiO_2, M''O, M'_2O$. (2) In every series of $M''O$ or M'_2O there must be only one base present (except for Na_2O and K_2O). (3) The more homogeneous a glass is, the more resisting it is.

In practice the first two rules are not adhered to. The presence of poly-meta-silicates corresponding with aluminates is probable, and the same may be said of borates and phosphates. The modern theory of glass is that it is a mixture of silicates, which, when molten, are in a state of mutual solution. When cooling takes place, this condition persists, unless it is so slow that crystals are formed, when devitrification sets in. The crystals so formed have a different composition from the glass. Appert and Henrivaux found that *wollastonite* crystallises out of soda and potash glasses, and *augite* from magnesia- and iron-containing glasses.

J. R. C.

19. Iron in the Furnace Atmosphere as a Source of Colour in Optical Glass. E. W. WASHBURN (*J. Amer. Cer. Soc.*, 1918, 1, 637).—The observation that an optical glass, melted in an electric furnace, yielded a colourless product, whereas the same batch melted in a similar pot, but in a gas-fired furnace, invariably yielded a green glass, led to an investigation of the atmosphere of the furnace as a possible source of contamination with iron.

A silica tube was inserted through the wall of the furnace so that the end of the tube was immediately above the pot of melted glass. At the maximum temperature attained by the furnace, and just previous to stirring, a stream of gas from the interior of the furnace was drawn through a wash-bottle containing sulphuric acid. After a period of two hours the experiment was concluded, the interior of the silica tube washed with some of the acid, and the acid then examined for iron. Distinct positive results were obtained.

The colour of the glass in the pot after several hours' stirring was inferior to that previous to the stirring, this being due, in the author's opinion, to the iron taken up from the furnace atmosphere being thoroughly mixed throughout the glass during the stirring process. The iron present in the atmosphere of the furnace appeared to be in the form of ferric oxide, but whether as vapour or fine dust was not definitely ascertained. Further experiments to measure the vapour pressure of ferric oxide at high temperatures might settle this point. The obvious sources from which the iron might emanate were (1) the iron burners, which were covered with a coating of oxide on the ends in the interior of the furnace, and (2) the iron content of the fire-brick furnace lining. On using clay burners, and coating the interior lining of the furnace with kaolin, a distinct improvement in the quality of the glass was observed. The kaolin lining gradually acquired a red tint, either by the absorption of iron from the fire-clay brick behind it or from iron in the furnace atmosphere.

The author recommends (1) lining the interior of the furnace with a course of kaolin bricks, and (2) water-cooling any metallic iron object necessary in the interior of the furnace. J. H. D.

20. The Identification of "Stones" in Glass. N. L. BOWEN (*J. Amer. Cer. Soc.*, 1918, 1, 594).—"Stones" in glass include all foreign particles of a non-vitreous nature. They may be due to a variety of causes, and are classified according to their origin as (1) pot stones, (2) batch stones, (3) crown drops, and (4) devitrification stones. A proper identification of the type and source of the stones leads to the surest and speediest elimination of them. Chemical analysis is sometimes used, but is unsatisfactory, as the "stones" are frequently very small, and it is impossible to free them entirely from the enclosing glass. Microscopic examination affords a surer and more satisfactory method of investigation, as this renders possible a determination of the refrac-

tive indices and other distinctive optical properties, and is particularly useful in the examination of fine materials intimately intergrown.

"Pot stones" are occasionally comparatively large, but usually quite small. They are always white, even when formed from dark burning clays. They are formed of crystals of *sillimanite* ($\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$) with a little interstitial glass. *Sillimanite* is a universal constituent of "pot stones," and is never found in stones of other origin.

Lack of uniformity in the pot material is a more serious cause of "pot stones" than is the actual solution of the pot material in the glass, since it may give rise to local pitting and the casting of highly resistant stones. If "pot stones" are a frequent source of trouble, the remedy is to be sought for in (1) more careful arching of the pots, (2) varying the batch to render it less corrosive, (3) melting at a lower temperature, and (4) altering the composition of the pot clay.

"Batch stones." The only normal batch constituent liable to remain unassimilated in the glass is the sand. Batch stones therefore usually consist entirely of silica. If the size of the grain be large, there may be a core of unchanged quartz surrounded by a layer of *cristobalite* or *tridymite*. If the grain be small, it may be entirely converted into *tridymite* or *cristobalite*, without any interstitial glass. A batch stone is usually surrounded by an aura of glass of low refractive index, and frequently has a "tail" of similar material. The remedy for batch stones may be (1) to soften the batch, (2) to melt at a higher temperature, (3) to use finer sand, or (4) to pay attention to the more careful mixing of the batch ingredients.

"Crown drops" are caused by the gradual corrosion of the crown bricks by the vapours given off from the batch, and the subsequent falling of drops of fused material, frequently carrying particles of the crown bricks with them, into the glass. In the case of a silica crown, such particles usually consist of rather large crystals of *tridymite*, in contradistinction to the very fine-grained crystals of *cristobalite* usually indicative of batch stones.

"Devitrification stones." When some portion of the glass separates out from the clear metal in the form of crystals, "devitrification" is said to have taken place. This may occur in two forms. The crystals may be large, easily recognisable with the naked eye, and disseminated in a glass otherwise clear, or the crystals may be so small and close together as to give an opaque appearance to the glass as a whole. Both phenomena are essentially the same, although the second type would scarcely be regarded as due to the formation of "stones."

A common form of devitrification is that in which spherulites are formed in the glass. These appear to be entirely crystalline, but are really composed of crystal fibres radiating from a core, the interstitial fibres being filled with glass. If the crystals are silica, this is usually in the form of *tridymite*, and the interstitial

glass has a higher refractive index than the glass surrounding the spherulite. *Wollastonite* (calcium silicate) also frequently separates from the glass in the form of spherulites. These consist of prismatic fibres of *wollastonite* with interstitial glass containing minute crystals of *cristobalite*. From special batches, barium silicate (BaSi_2O_6) or lead silicate (PbSiO_3) may separate.

The separation of these "devitrification stones" usually means that the material of which they are formed is in excess in the batch. If it is not possible to reduce the amount, owing to the corresponding effect on the properties of the glass, recourse must be had to variation in the heat treatment in order to reduce the quantity of such stones to a minimum. The optical properties of the crystals usually found in glass are summarised briefly as follows:—*Sillimanite* (Al_2SiO_5): refractive indices, $\gamma=1.681$ and $\alpha=1.660$. The refraction is higher than that of all glasses except the very heavy lead glasses. Other refractive indices are:—*Quartz*, 1.553 and 1.544; *tridymite*, 1.469—1.473; *cristobalite*, 1.484—1.487; *barium disilicate*, 1.617—1.598; *wollastonite*, 1.633—1.620.

J. H. D.

21. The Condition of Arsenic in Glass and its Role in Glass-Making. E. T. ALLEN and E. G. ZIES (*J. Amer. Cer. Soc.*, 1918, 1, 787).—The authors have investigated the amount and character of the arsenic retained in optical and plate glasses, and find that the major part exists in the pentavalent state, but that a portion exists in the trivalent state. The amount of arsenic present in the glass as As_2O_3 and As_2O_5 , respectively, was determined, and the amount that should be present was calculated from the batch mixture on the assumption that only moisture, CO_2 , and oxygen (from KNO_3) were lost.

The results showed that in the case of four glasses in which the batch contained nitre, the loss of arsenic varied from 11 to 21 per cent., and of the arsenic retained in the glass about 86 per cent. in three cases and more than 90 per cent. in the fourth case was in the pentavalent condition. In the case in which the batch did not contain nitre, 33 per cent. of the arsenic was lost in the furnace, and the amount of As_2O_5 found in the glass was twice that of the As_2O_3 .

The authors favour the opinion that the arsenic is oxidised to the pentavalent condition at the lower temperatures, and the product is dissociated at high temperatures, As_2O_3 , the oxygen escaping, and thus assisting in the fining of the glass. J. H. D.

22. Selenium and the Nature of the Decolorising Process. G. RAUTER (*Sprechsaal*, 1904, 37, 598).—The principle of all decolorisers is that when added to the batch they produce a bluish-violet colour, which is complementary to that due to iron. As a result, the glass appears to be decolorised, but is actually coloured a faint grey. A decoloriser is the more effective the weaker this grey tint is. Cobalt oxide and nickel oxide can be used, exceed-

ingly little of them being required to counteract the yellowish-brown iron colour. The action of manganese is uncertain; this is because it performs a double function. It oxidises the iron to give a yellow colour and then neutralises it. Selenium, on the other hand, is a strong reducing agent, and can be used to colour a glass red. It would thus be thought that the action of the selenium would be to reduce the iron to a lower oxide and then superpose its red on the green thus produced. However, the glass is usually green, as the usual furnace atmosphere is reducing; therefore an investigation of the properties of selenium was undertaken with the view of elucidating its action. The conclusion was drawn that glass is coloured red by selenium on account of numerous reflections at the surfaces of minute selenium particles which are in suspension in the glass. If only a small amount of selenium is added, the red is not strong, but there are still many reflections. The green light from an iron-containing molecule is not reflected and does not emerge from the glass, which is thus decolorised.

J. R. C.

23. Decolorising Media and their Action. (*Sprechsaal*, 1905, 38, 1331).—On account of the high melting point of nickel oxide, its action takes place at the end of the melt. Special care must be taken to get it pure, as it may contain cobalt. The quantity required is given as 2—5 grams of nickel oxide to 100 kg. of sand.

Cobalt oxide must be used with care, as a very little too much will colour the glass blue. In ordinary circumstances, half a gram is enough for every 100 kg. of sand in the batch.

Manganese dioxide gives a different colour when used with a potash batch from that obtained with a soda batch. Much more is required to decolorise an ordinary glass than with nickel or cobalt oxides, 250 to 300 grams being necessary for every 100 kg. of sand. Glass decolorised by manganese turns violet with prolonged exposure to sunlight.

As a rule, about 220 grams of antimony oxide will be enough for 100 kg. of sand in the batch. It is not recommended, however, as it is liable to attack the pot. The uncertainty about the action of selenium, which may colour the glass red, militates against its use. Arsenic is of more value as a means of clearing the glass than as a decoloriser.

J. R. C.

24. Strengthened Glass (Brit. Pat. No. 111539). S. GOLD-REICH, C. A. MCKERROW, and SPLINTERLESS ANTI-MIST GLASS SYNDICATE (December 2nd, 1916, No. 17346).—In the manufacture of strengthened glass comprising two sheets of glass and an interposed sheet of celluloid, the celluloid is treated, not with a solvent of celluloid, but with a softener thereof, such as industrial spirit, and is caused to adhere to the glass by the simultaneous action of heat and pressure. Specification 1790/10 is referred to.

H. G. C.

25. Strength Tests of Plain and Protective Sheet Glass.

T. L. SOREY (*J. Amer. Cer. Soc.*, 1918, 1, 801).—A study of the effect of a thin coating of celluloid on the mechanical properties of sheet glass.

The tests imposed were of three types, namely, (1) firing tests, (2) impact tests, and (3) cross-bend tests.

For the firing tests, bullets were fired from a regulation rifle at a distance of 50 feet. For the impact tests the sheets were supported in a frame, and struck by a $1\frac{1}{4}$ lb. steel ball at the end of a stiff wire arm, 24 inches long, forming a pendulum. The latter was allowed to swing through 5° , then 10° , and so on, the angle of swing being increased until the plate fractured.

For the cross-bend tests, strips of glass 12 in. \times 2 in. were placed upon supports 10 in. apart, and increasing pressure applied to the middle of the strip until fracture occurred.

The results of the tests showed that:—

(1) In both impact and cross-bend tests, blown window glass is stronger than plate glass.

(2) Whilst the energy of impact necessary to produce fracture increased with the thickness of the glass, the amount of cracking occurring at the time of initial fracture also increased.

(3) The force of the blow required to crack a piece of glass is not materially increased by the celluloid coating, but the shattered glass remains in place.

(4) In the cross-bend tests, the protective glass is about 15 per cent. weaker than plain glass when the celluloid-coated side is in compression, but about 40 per cent. stronger when the celluloid-coated side is in tension.

J. H. D.

26. The Effect of certain Impurities in causing Milkiness in Optical Glass.

C. N. FENNER and J. B. FERGUSON (*J. Amer. Cer. Soc.*, 1918, 1, 468).—In the manufacture of optical glass by the Bausch and Lomb Optical Company, a matter which gave considerable difficulty for a time was the occasional production of pots of milky or opalescent glass. A light flint which had a PbO content of about 33.5 per cent. and the refractive index of which was about 1.572 was the type of glass in which the phenomenon most frequently occurred. The evidence indicated that the source of the trouble lay in the sulphate and chloride content of the Russian potash which replaced the German product.

Certain considerations rather obscured matters

(1) There seemed no direct connection between the amount of sulphate or chloride in the potash and the tendency of the glass to become milky.

(2) Experimental melts were made in small pots, and various amounts of sulphate and chloride were added to the batches, and again there seemed no relation between milkiness and the amount of sulphate or chloride added.

(3) During a laboratory study of the ternary system CaO-MgO-SiO_2 , a similar milkiness had been obtained, and it had been

possible to detect multitudes of minute crystals of SiO_2 with the microscope.

More trustworthy methods of temperature control were installed, and it was found that the formation of the pots of milky glass ceased when the pots were held at 1400° or a little higher for a period of about thirty-six hours. Later, when it seemed desirable to cut down the length of time the pots remained in the furnace, pots of milky glass again began to appear, although potash containing only 0.3 per cent. SO_3 as a maximum was used in the batch. The trouble was reduced when the length of time of stirring was increased.

Apparently the elimination of the last traces of SO_3 and Cl from a glass is favoured by a high temperature and prolonged time, and also by agitation of the melt which accompanies stirring.

If a glass which was milky or was likely to become milky was heated to 1100 — 1150° , the milkiess disappeared, but glass so treated developed numerous bubbles. Analysis showed that a very milky glass contained 0.14 per cent. SO_3 . After being cleared up by heat treatment, the same glass contained 0.06 per cent. of SO_3 . It is doubtful whether the minute particles to which the milkiess is due are themselves composed of sulphates or chlorides; it is more probable that sulphate or chloride impurities behave as catalytic agents, causing the separation of clouds of minute crystals of crystobalite. With the best microscopic magnification, it is barely possible to discern discrete particles of foreign matter, as they are so minute as to be of similar order of magnitude to the wave-length of light. The bluish colour of opalescence shows that they produce a scattering of light rays. The devitrifying effect of sulphate and chloride must also vary with the composition of the glass, for an analysis of a glass for searchlight mirrors manufactured in England gave 0.74 per cent. of SO_3 , and it showed no tendency to devitrify.

The Russian potash could also be employed without detriment in the manufacture of a light crown glass. A. M. J.

27. The Effect of certain Impurities in causing Milkiess in Optical Glass. F. GELSTHARP (*J. Amer. Cer. Soc.*, 1918, 1, 559).—A criticism of the paper by Fenner and Ferguson. The Pittsburgh Plate Glass Co. had been very successful in producing several types of optical glass. In early work, an occasional pot of milky glass was obtained, the glasses in which the opalescence was produced being a boro-silicate crown (refractive index 1.522) and a dense flint (refractive index 1.616). Impure potassium carbonate was not the cause of the opalescence, as pure nitrate was used to supply the necessary potash.

The optical glass referred to by Fenner and Ferguson and the two mentioned above have a high molecular content of silica, and therefore approach supersaturated solutions. In the author's view, if for some reason the alkali content is lower than intended, milkiess may easily result. Thus,

(1) KCl and K_2SO_4 in Russian potash may be responsible for the deficiency of K_2O in glass.

(2) Variable composition of Russian potash would mean variable alkali.

(3) A considerable amount of alkali volatilises, and the amount varies with furnace conditions.

Further experiment was therefore necessary before accepting the statement that SO_3 and Cl in some optical glasses will cause milkiness. It is probable that the presence of salts in solution in glasses which contain a high proportion of silica (approaching a super-saturated solution) will tend to cause such glasses to turn milky more readily on slow heating or cooling, although the writer had never found that the presence of SO_3 , Cl , or F in soda-lime glass (in amounts up to 0.6 per cent. of each) caused opalescence to the slightest extent so long as the ratio of alkali to silica was below the limit at which opalescence occurs when SO_3 , Cl , or F were absent.

A. M. J.

28. The Effect of certain Impurities in causing Milkiness in Optical Glass. C. N. FENNER and J. S. FERGUSON (*J. Amer. Cer. Soc.*, 1918, 1, 561).—A reply to the criticisms of Gelstharp. The authors consider there is no likelihood of the calculated alkali in their glasses being low. As there was no reason to suppose that the K_2O content of K_2SO_4 in a lead-alkali-silica mixture was more volatile than the K_2O of K_2CO_3 , the equivalent K_2CO_3 for the K_2SO_4 of the potash was calculated, and that amount used; also, as KCl is volatile, it was considered safest to assume that it all escaped, and additional potash was allowed for this. The authors hesitate to believe that glasses are in such a critical region that the addition of a little silica will throw them into a supersaturated condition. A set of laboratory experiments gave evidence on this. A glass which became milky on reheating was used as the basis for the experiments. Several chunks of the glass were placed in a platinum crucible and heated for about an hour at 950 – 1000° . The glass was cooled and broken out. It appeared very milky throughout. Another sample of the same glass was ground to pass 80 mesh, and heated for about two and a-half hours at 1400 – 1500° .

The glass when cooled quickly was perfectly clear. To determine whether milkiness could be developed, it was reheated for two and a-half hours at 900 – 1000° . It was then removed and cooled; a thin film of white, devitrified material formed on the surface, but the bulk of the glass was perfectly clear.

Another sample of the glass was ground to pass 80 mesh, mixed thoroughly with 2 per cent. of finely ground quartz, and heated for nearly two hours at 1400 – 1500° . After cooling, it was reheated at 1018 – 1042° for about three hours. The surface devitrification was a little greater than in the second experiment, but the material underneath was free from milkiness.

From the experiments, it is inferred that the original sample

contained some ingredient which assisted the excess silica to crystallise out; when the glass was heated to 1500° approximately, this ingredient was volatilised. The result can scarcely be attributed to a change in alkali, for volatilisation would lead to a decrease rather than an increase.

The authors therefore agree that a final proof has not been obtained, but evidence points strongly to the fact that traces of SO_2 and Cl produce opalescence.

[The conclusions of Fenner and Ferguson in Abs. 24 and 26 agree closely with those previously obtained by J. D. Cauwood and W. E. S. Turner (this JOURNAL, 1917, 1, 187), who studied the effect of small quantities of sulphate and chloride, the influence of temperature and of reheating.] A. M. J.

29. Optical Glass Melting. E. ZSCHIMMER (*Sprechsaal*, 1904, 37, 1041, 1081).—One of the principal difficulties in the production of optical glass is the elimination of "cords." Cordy metal can arise in many ways. If the batch is not well mixed it will be produced; the solution of the pot walls in the metal is a very frequent cause; and the evaporation of the more volatile constituents, giving rise to a variation in constitution, also has this effect. Photographs of "cords" are given, one showing the cords proceeding from the pot walls.

Usually the glass is melted for about thirty hours and cooled down very slowly, this taking from four to five days. In this process the glass breaks into pieces, which are then put into shallow, rectangular moulds and heated to the softening point, when they sink and fill the moulds. The slabs thus obtained are cooled very slowly to prevent any strain arising.

It is pointed out that small bubbles in the glass do not affect its optical performance, but only its appearance. J. R. C.

30. Glass Making Processes. N. L. BOWEN (*Optician*, 1918, 56, 193).—The article dealt generally with factors tending to produce non-homogeneity. According to the author, the more fusible portions of the batch liquefy and filter downward through the grains of the more refractory material. The sand was found usually to be the last material to dissolve, the grains tending to rise in the liquid, thus making the upper parts more siliceous and of lower density. Diffusion lessened this continuous density gradient in time, and appropriate stirring eliminated it. The action could be interrupted and observed at an intermediate stage; sand grains were then found suspended in the liquid, and, pointing down from each grain, a tail of glass of lower refractive index than the surrounding glass, thus affording a proof of the explanation. There were two other factors making for inhomogeneity—solution of the pot and the volatilisation of certain ingredients—but their effect was not regarded as so important as that of the sinking of the heavy liquid and the rising of the sand grains. J. R. C.

31. Scientific Glassware. MORRIS W. TRAVERS (*J. Soc. Chem. Ind.*, 1918, 37, 235).—The author explained how, persuaded by Mr. D. H. Baird, he decided to tackle the problem of manufacturing light hollow glassware which prior to the war was mostly obtained from enemy countries. Difficulties encountered throughout the manufacture are dealt with.

A large number of samples of glass were first analysed, noting the kind of article for which each sample was suitable, and testing the qualities and working properties of the glass.

A small oil-fired furnace, capable of founding about 1 cwt. of glass, was first erected, batches based on the analyses made were melted, and from these melts tube and hollow articles were made and their qualities tested.

From these experiments it was found that a soda-potash-lime-alumina glass equal to the best German lamp-working glass, and a resistance glass similar to the "Jena" resistance glass, but modified in a manner calculated to remove the objection that it gave up zinc to acids, could be manufactured.

Oil-firing, though applicable to tank furnaces, did not seem suitable for pot furnaces, so other furnaces heated by gas from coke in a producer were installed. Two Hermansen recuperative furnaces had also been installed in a new glass-house.

Experience in the matter of pot-setting had led the author to blame the glass manufacturer rather than the pot-maker for many of the mishaps to pots. He described the method of pre-heating pots now successfully followed in his own works.*

The author pointed out that investigations on the composition of glasses had so far only supplied us with the bare minimum of necessary information, and much correlated work by the chemist, glass manufacturer, and practical glass-blower was still necessary. There was scope also for a considerable amount of research on the mixing of batch and in connection with the mixing of batch and cullet. Observations had led to the conclusion that considerable advantage may be gained from the grinding of the cullet and mixing it with the batch.

In the author's view, the formation of "cords" in glass was well worth attention. Those which had their origin in ill-digested particles of clay, of scale from the pot, or from the material of the batch might be ruled out of investigation. The glass-maker would say that such cords were due to "lack of heat," which was true in the sense that if the pot were hot enough during the found even fairly large particles of clay will completely dissolve. Sometimes during the working of a pot of metal the glass "goes cordy" and remained cordy, but sometimes became clear again in a truly remarkable manner. This was possibly a surface phenomenon, and worthy of the attention of those who had made a study of colloids.

It would be of benefit to both consumer and manufacturer if it were possible to standardise chemical and bacteriological glass

* See this JOURNAL, T., 1918, 2, 170 and 270.

ware; at present, owing to the variety of goods to be manufactured and the comparatively small demand for them, the introduction of automatic and semi-automatic machinery was not practical politics. The author suggested that a 500 c.c. beaker should be about 0.8 mm. thick and a 1000 c.c. beaker 1.0 to 1.2 mm. thick. The articles must, of course, be evenly blown.

Moulds used for the blowing of graduated flasks had often been noticed to shrink. Brass moulds are recommended.

Annealing presented many difficulties. In the case of scientific glassware, enormous bulk for small weight had to be dealt with, and as the goods must pass very slowly through the hot part of the lehr, unusually large lehr accommodation was required.

The lehrs used by the author were heated by means of producer-gas. The gas entered a space below the bed of the lehr, which was formed of a brick arch, and then passed up ports at the side. Secondary air entered through slides at the front and met the gas at the bottom of the ports, and the length of the flame issuing from the ports, and consequently the temperature of the lehr, could be increased or reduced by closing or opening the air slides. The temperature could be regulated to within 10° .

The fall of temperature along the lehr was regulated by taking away the hot gases into a flue through openings which were closed by dampers. Resistance glass could be removed from the lehr at 300° .

Beakers and similar pieces of apparatus had to be cracked off, flanged, and lipped. Badly annealed goods cracked off so as to leave jagged edges, so that efficiency of production depended upon efficient annealing.

Problems of the graduating shop were touched upon, and the author, who pointed out that scientific literature included very few papers dealing with the accuracy of volumetric measurement, and that a great deal of work might well be done with a view to improve the ordinary dividing machine. A simple method was described for accurately determining volumes. A rod of pure nickel was bored and the hole rounded at the bottom. The end of the rod was then carefully ground until the capacity, determined by filling the vessel so formed with mercury and pressing a polished glass plate over the top, was exactly the volume required.

In calibrating an instrument like a burette, the glass tube was filled with water, allowed to drain to the zero level, and the height of the meniscus marked. The required volume of mercury was then poured into the burette from the nickel measure, and the sides of the tubes, being wet, the water meniscus rose by an amount equal to that which it would fall if the same quantity of water were allowed to flow from the apparatus.

Grinding, polishing, stoppering, and similar operations which in this country were usually performed by highly skilled workmen using very crude tools, demanded the attention of the engineer.

A. M. J.

32. Some Aspects of the Scientific Glassware Industry.

F. W. BRANSON (*J. Soc. Chem. Ind.*, 1918, **37**, 337r).—In a previous communication (*J. Soc. Chem. Ind.*, 1915, **34**, 471; this JOURNAL, 1917, Abs., p. 15) the author gave analytical data on the composition of practically all the types of important chemical glassware imported prior to the declaration of war. His preference for chemical glassware was a zinc-alumina boro-silicate glass.

A Jena glass beaker obtained direct shortly before the declaration of war had the following composition:— SiO_2 64.66, Al_2O_3 6.74, ZnO 10.12, CaO 0.08, MgO 0.13, K_2O nil, Na_2O 7.21, B_2O_3 11.14, Fe_2O_3 0.10.

Numerous analyses and experimental meltings of the author indicated that with about 6.5 per cent. of Al_2O_3 , 7.5—8.5 per cent. of ZnO , and about 7 per cent. of B_2O_3 a good glass was obtained which with perfect annealing was equal to all reasonable requirements for scientific work provided the silica and alkali were present in the best proportions. If the amount of ZnO were reduced, lime appeared to be the best substitute.

A proportion of about 6 per cent. of Al_2O_3 gave increased strength to the glass and diminished the action of the melted glass on the pots.

A zinc-aluminium boro-silicate obtained by the use of a good formula was not expensive to make, and did not devitrify. It had good working properties, and was therefore a favourite with workmen owing to its good plasticity over a wide range of temperature. It made excellent glass tubing for the manufacture of glass apparatus and ampoules.

In addition to the above, a considerable quantity of aluminium boro-silicate and other types of scientific glassware of excellent quality were being made by other firms. (For analyses of British glasses, see *J. Soc. Glass Tech.*, 1917, **1**, 196).

A great aid to the industry would, in the author's view, be the standardisation of hollow scientific glassware, such as beakers and flasks, as to shape, contents, and weight.

The author strongly emphasised the importance of good annealing. A careful determination of the exact temperature for annealing, without deformation, a glass which approximated in composition to the general formula given above was 580°. The articles were tested by means of a Hilger's strain-viewer.

Reference was made to the work of Twyman (*J. Soc. Glass Tech.*, 1917, **1**, 61), and of English and Turner (*J. Soc. Glass Tech.*, 1918, **2**, 90), on annealing.

The question of increasing the resistance of glass by re-annealing was raised. Dr. W. E. S. Turner stated that experiments carried out in his laboratory did not reveal any difference in resistant power due to re-annealing, whilst he further pointed out that experiments carried out at the National Physical Laboratory failed to bring to light any difference between the ordinary annealed and the re-annealed (with flue gases containing sulphur dioxide) Jena ware.

A. M. J.

33. Chemical Glassware. P. H. WALKER (*J. Amer. Chem. Soc.*, 1905, 27, 865).—An abstract of this paper has already appeared under Transactions, 1917, 1, 165. V. D.

34. The Use of Quartz Glass in Chemistry. M. BERTHELOT (*Compt. rend.*, 1905, 140, 817).—The author found quartz glass very useful in the study of reactions at very high temperatures. It is easily worked in the oxy-hydrogen, or, better still, in the oxy-acetylene, flame, and uniform tubes can be obtained which will resist a pressure of three atmospheres up to the softening point, 1400°.

Acids do not attack these tubes, and they can be cooled by plunging them into cold water whilst at a red heat. V. D.

35. The Permeability of Quartz Glass. M. BERTHELOT (*Compt. rend.*, 1905, 140, 821).—Quartz glass vessels had previously been shown to be permeable by hydrogen and helium (Villard, *Compt. rend.*, 1904, 138, 1033, and Jacquerod and Perrot, *ibid.*, 1904, 139, 789), but the author has carried the investigation still further, observing the exchange which takes place between the gases enclosed in the vessels and the atmosphere.

On heating carbon in a quartz glass tube maintained at a temperature of 1300—1325° for half an hour, it was found that the tube contained nitrogen and carbon monoxide, showing that the elements of the atmosphere had entered the tube by endosmose. Similarly, when 4 c.c. of oxygen were enclosed in a tube and heated at 1300° for one hour, 3 c.c. of nitrogen were found in the tube on cooling.

The hydrocarbons naphthalene and methane were heated in a similar way, and at the end of an hour nitrogen was found to have entered the tube, which also contained some carbon and a little hydrogen. Thus, at the high temperature of the experiment these compounds were split up into their elements, the hydrogen escaping into the air through the walls of the vessel, and the elements of the atmosphere entering, showing that quartz glass behaves like animal membranes, allowing gases to pass through it by a process of osmosis. V. D.

36. The Permeability of Quartz Glass Tubes. M. BERTHELOT (*Compt. rend.*, 1905, 140, 1159).—Tubes of quartz glass were found permeable by hydrogen at high temperatures, the transpiration being very rapid at a temperature of 1300°. At the ordinary temperature, such transpiration was not evident even after many days' exposure, and not appreciable, if it existed at all, at 600—800°.

The passage of hydrochloric acid gas through the walls of a quartz glass tube was not noticeable below a temperature of 1400°, while that of carbon dioxide was only slight at 1300°.

The transpiration of nitrogen was not sensible at 800°, was slight at 1000°, but was appreciable at 1300—1400°, though even at this temperature it was much less rapid than that of hydrogen at the same temperature.

Oxygen permeated the tubes much more rapidly than nitrogen, but not so rapidly as hydrogen. Using air as the enclosed gas, and introducing a quantity of known volume under normal temperature and pressure, the tube was sealed and heated at a temperature of 1400° for an hour. The pressure of the hot gas caused the softened quartz to swell, but when the contained gas was reduced to normal conditions its volume was less than the original volume, and the percentage of oxygen was 17.7, whereas the air originally contained 20.8 per cent. of oxygen.

Under these conditions, then, approximately one-sixth of the initial volume of nitrogen and one-third of the initial volume of oxygen had passed from the tube, this ratio being very similar to that in which the gases of the atmosphere dissolve in water.

V. D.

37. The Permeability of Glass Vessels. M. BERTHELOT (*Compt. rend.*, 1905, 140, 1286).—A vessel of glass or silica softens at a high temperature, and the walls acquire properties resembling those of a colloidal solid, such as caoutchouc. Gases enclosed in the vessel diffuse through its walls, and the gases of the surrounding atmosphere pass inwards.

When the glass or silica is heated to its softening point, the walls of the vessel are thinned by internal pressure, and this permeability is then most evident. As soon as the temperature is lowered below the softening point, the transition ceases.

The author has carried out his investigations using tubes of different kinds of glass, viz.: (1) ordinary white glass, softening at 550° and becoming plastic at 650° , and (2) Jena glass, softening at 750° . The tubes contained hydrogen, oxygen, and carbon monoxide, and in all cases the experiments proved that in the neighbourhood of the softening temperature the transition of the gases took place according to the laws of diffusion through permeable membranes, the gas diffusing out and air diffusing in.

V. D.

38. The Filming of Glass. (*Trans. Optical Soc.*, 1918, 19, 184).—An abstract of a discussion held by the British Optical Instruments Manufacturers' Association. Generally speaking, glasses showing the greatest affinity for water gave the most trouble. The chemical constitution of the lubricants used in optical instruments appeared to have an important bearing on the subject. A high degree of potash was requisite, as small pits, scratches, etc., on the surface tend to act in the same way as dust particles, namely, as nuclei around which film was deposited. It was suggested that investigations should be carried out in order to find a more suitable lubricant, one that was free from unsaturated compounds, for use in optical instruments. It was also suggested that better ventilation should be provided between the different chambers of an instrument, and that such instruments should be so designed as to permit of easy access to the glass surfaces for the purpose of cleaning.

The results of tests on seventeen samples of glass were presented. The tests were: (1) The alkalinity of a freshly-broken surface which has been weathered for seven days in an atmosphere at 180°, saturated with water vapour, the number of mg. of iodeosin precipitated on 1 sq. m. of surface being taken as a measure of the weathered alkalinity. (2) The glass was subjected for thirty hours to the action of clean air at 80°, saturated with water vapour, and the deposit on, or corrosion of, the surface was examined microscopically. The glasses were classed as: (i) unaffected or only slightly affected; (ii) decidedly affected; (iii) very seriously affected. In the following table + indicates that the glass was rather more, and — that it was rather less, affected than the standard for the class:—

Sample.	Maker.	Type.	Melting.	N _p .	v.	Results of test.	
						1	2
0	Schott & Gen	H.F.	O5916	1.6241	35.7	37	2
1	Chance	B.S.C.	3401	1.5078	64.0	24	2—
2	Schott & Gen	B.S.C.	—	1.5188	60.4	36	2+
		Spectacle					
3	—	Crown	—	—	—	43	2+
4	Schott & Gen	B.L.F.	—	1.555	48.2	60	2+
5	Graillot	B.L.F.	1056	1.559	50.6	12	1+
6	Chance	B.L.F.	3684	1.5503	51.8	28	2
7	Chance	H.C.	3504	1.5163	60.5	26	2
8	Chance	M.B.C.	3359	1.574	57.7	6	1+
9	Schott & Gen	B.S.C.	O7302	1.5765	64.0	6	2
10	—	Plate	—	—	—	28	3
11	Chance	L.F.	1044	1.5791	40.5	17	1
12	Mantois	L.F.	9040	1.574	42.7	13	2
13	Chance	H.F.	3867	1.6211	36.2	12	3 1
14	Chance	H.F.	3621	1.6223	36.1	11	2
15	Chance	Soft C.	3532	1.5138	56.9	52	3
16	Graillot	E.D.F.	1126	1.652	33.6	11	1+

J. R. C.

39. On the Compressibility of Solids. J. Y. BUCHANAN (*Proc. Roy. Soc.*, 1904, 73, 296).—The method used to determine the compressibility of several metals was that used in 1880 for investigations on glass. The method was briefly described. The linear compressibility was measured, and the cubic compressibility obtained from this. In addition to the evaluation of the desired quantity for five metals, determinations were also made with English flint glass, density 2.968, and German tubing glass, density 2.494. The linear compressibility, that is, the decrease in unit length, per atmosphere pressure, multiplied by 10⁶, was, for the former, 1.02, and for the latter 0.846. The compositions of the glasses were not given.

J. R. C.

40. Resistance to Compression of Glass and Quartz. G. BERNDT (*Verh. d. D. Phys. Gesell.*, 1917, 19, 314; abs. from *Deutsch. Mech. Zeit.*, 1918, 114).—The machine referred to in

Abs. 84 was used for the purpose of ascertaining the resistance to compression of mirror glass and quartz. The test-pieces, which were cubes of 5, 8, 10, and 15 mm. edge, were compressed between plane, hard, polished steel plates. A new plate was used for every test, so that the surface was always accurately plane and there was no tangential strain. The following results were obtained, the pressures being expressed in kg./cm.²:—

Length of cube edge.	Mean value of pressure for several tests.	Highest value.
5 mm.	12,000	13,000
8 "	10,300	10,400
10 "	9,000	10,000
15 "	8,700	8,800

The surfaces in contact with the steel were polished; the other faces sometimes polished, sometimes finely ground. Experiment showed that the condition of these surfaces was immaterial; nevertheless, in the later tests all were polished. The pressure was gradually applied until the cube burst. Slight inequalities of the compressed surfaces caused the cube to split prematurely. The values obtained in these cases were disregarded. The pressure producing fracture was found to be independent of the time when this was varied from a few seconds to five minutes. Periods of from one-half to one minute were usually employed.

One cube with a 5 mm. edge exhibited an interesting behaviour when compressed. It was subjected to a pressure of 3,000 kg. without breaking, and when the pressure was released it was seen that a cylinder had been cut out of the cube. It appears that the effective area of pressure is a circle, and it was found that cylinders 5 mm. high and 5 mm. in diameter withstood the same pressures as the cubes of 5 mm. edge.

Glasses for these tests must be homogeneous and perfectly annealed. To illustrate the effect of imperfect annealing, the borosilicate crown 516/640 of the Sendlinger Optical Works was used. Two specimens were employed, one very notably strained and the other very well annealed. The test-pieces were cylinders of 5 mm. diameter, and the following results were obtained:—

	Load.	Mean value.	Max. value.
Strongly strained.	Continually increasing	15,000	18,400
	Increasing by steps	15,300	17,500
Annealed.	Continually increasing	14,200	16,900
	Increasing by steps	12,500	15,100

When quartz was tested, the steel plates were compressed, on account of its hardness. The cylinders split very often, but the values of the crushing strength arrived at were:—

	Parallel to the optical axis.	Perpendicular thereto.
Mean	25,000	22,800
Maximum	28,000	27,400

41. The Annealing of Glass. (*Proc. Tokyo Phys. Soc.*, 1918; *J. Ind. Eng. Chem.*, 1919, 11, 244).—If a newly drawn glass fibre is heated slowly in an electric furnace and its length observed, it is found first to increase as the temperature rises, and then at a temperature about 400° it begins to contract, whilst at 500° it becomes elastic; also, if a short cylinder of glass between crossed Nicols is heated, the interference rings show little change until 400° is reached. Then they widen and disappear at about 500° . (See also this JOURNAL, 1918, 2, 90.)

When glass is slowly heated or cooled, the temperature curve shows that over the plastic range there is absorption or liberation of heat, proving that some change of state of a constituent of the glass takes place at that temperature. The first two effects vary with the nature of the glass, and are not exhibited by annealed specimens, but the third effect is found in both annealed and un-annealed glass. S. E.

42. Antimony Oxide as an Opacifier in Cast Iron Enamels. J. B. SHAW (*J. Amer. Cer. Soc.*, 1918, 1, 502).—According to the author, antimony oxide is equivalent to tin oxide, pound for pound, as an opacifying agent, and whilst tin oxide is dear, antimony compounds are fairly cheap; hence, the use of the latter in enamels for ironware is worth considering as a commercial proposition.

To obtain some idea of the value of antimony oxide in the above connection, experimental melts were made, the work being carried out in three stages:—(1) 500 gram batches, in a laboratory furnace; (2) 75 lb. batches, which were melted and applied to commercial wares; (3) 2000 lb. batches, melted and applied to commercial wares on a works scale.

Knowing the efficiency of cryolite as a flux and opacifier in enamels, trials were made with a view to determine the possibility of using it in conjunction with antimony oxide.

Forty-four batch compositions of melts are given in the paper. From the experiments, it was concluded that whilst good colours were easily obtained, it would not be possible to utilise the fluxing power of cryolite to advantage, as the range of composition of enamels suitable for the iron was so small. Another series of enamels was tried, using felspar, borax, soda-ash, nitre, barium carbonate, zinc oxide, and antimony oxide, but no lime or cryolite. Such enamels all failed, retaining the consistency of soap-suds even after intense heating.

A third series, containing fluorspar in addition to the materials mentioned above, was found to give the best results.

The control of crazing and shivering is stated to be best accomplished by varying the silica content. The fusibility was similar to that of ordinary tin enamels, and the opacity quite as good.

It was found that the following conditions require emphasis:—

(1) Only the purest white antimony oxide must be used, other-

wise the colour of the enamel is liable to be similar to that of the oxide itself.

(2) Excessive smelting will produce a bluish-green colour in any antimony enamel containing fluorspar and a low percentage of lead. The fluorspar should therefore not exceed more than 5 per cent. of the raw batch.

(3) Thoroughly oxidising conditions (plenty of nitre) must be maintained at all times during the melting of antimony enamels. Reduction causes the development of a green colour.

(4) Manganese dioxide (up to 0.4 per cent.) may be used to mask the bluish-green colour of the fluorspar-antimony compound.

An ivory-green colour results from the use of low fluorspar or insufficient smelting, or both. The addition of 1 per cent. of lead oxide will sometimes convert a useless, leadless antimony enamel into one having a pleasing cream colour. A high lead content is not, however, permissible with antimony, because the combination produces a yellow colour.

(5) Cryolite is unsatisfactory as a flux or opacifier in antimony enamels, but small quantities (up to 3 per cent.) will aid in producing a good colour, and that without introducing any troublesome element.

(6) Extreme care in proportioning the raw materials, very careful and thorough mixing, and proper melting will insure the successful use of antimony oxide.

A. M. J.

43. A Glass of Low Resistivity. C. E. S. PHILLIPS (*Brit. Assoc. Reports*, 1906, Sect. A).—When sodium silicate and borax were fused together in the following proportions, a glass was obtained which conducted electricity fairly well: sodium silicate, 32 parts; calcined borax, 8 parts.

By the addition of 1.25 parts of Powell's flint glass, the stability was increased, and the surface improved without decreasing the conductivity. This glass was found suitable for use in cases of electrostatic instruments. It could be cast into plates, but was not otherwise very workable, due to its low fusion point. It took a fine polish, had a density of 2.490, and was somewhat harder than the ordinary soda glass of commerce.

No fluorescence was shown by this glass under cathode radiation, and while it was transparent to X-rays, it was opaque to ultra-violet light. Its specific resistance was of the order of 10^9 ohms at 20° , and its electrical conductivity about 500 times that of any glass made previously. In the form of a powder it could be fused on to copper, adhering without cracking.

V. D.

44. Phosphorescence caused by the β - and γ -Rays of Radium. G. T. BEILBY (*Proc. Roy. Soc.*, 1904, 74, 511).—The author noted that a piece of potash glass exposed to the rays showed a feeble fluorescence. After it was removed from the radiation, the place where the rays had entered the surface was found to be coloured brown. The patch phosphoresced feebly. Six weeks

afterwards there was no phosphorescence until the glass was heated to 100°, when it gave a faint, green glow. On heating to 200°, the brown patch disappeared.

A lens of colourless flint glass phosphoresced feebly while under the influence of the radium, but not when removed therefrom, and exhibited no revived phosphorescence when heated to 200°. This heating caused a brown coloration, which had resulted from the action of the rays, to disappear. J. R. C.

45. On the Coloration of Glass by Natural Solar and other Radiations. W. CROOKES (*Proc. Roy. Soc.*, 1904, 74, 524).

—The paper described the coloration of two pieces of transparent glass sent to the author from South America. They were taken from rubbish heaps, where they had been exposed to the action of the sun for a long time at a high altitude. The specimens were coloured an intense purple. It appears probable that the coloration was due to the presence of manganese in the glass, this being affected by the solar rays of short wave-length which would be present at an altitude of 4,000 metres, but not at sea-level, owing to atmospheric absorption. The colour disappeared when the glass was re-heated to the softening point, but could be reproduced, in a short time, by exposure to the β - and γ -rays of radium. Examination showed that the coloration was not superficial, but had penetrated throughout the mass. J. R. C.

46. The Action of Ultra-violet Light on Glass. F. FISCHER (*Physikal. Zeitsch.*, 1905, 6, 216).

—Eight specimens of glass were exposed to the action of light of short wave-length, and it was found that four of them were coloured, namely, ordinary Thuringian glass, two kinds of Thuringian "apparatus" glass, and Jena normal thermometer glass. The following remained uncoloured: Jena "telescope" glass, Jena Durax glass, German lead glass, and English lead glass. Analysis showed that the first four contained manganese and the others did not. The colours disappeared when the glasses were heated to the softening point and cooled. The explanations given by Crookes (this vol., Abstract No. 45) apply equally to these observations. J. R. C.

47. The Fluorescence produced by Radio-tellurium in Glass, Mica, and Quartz. H. GREINACHER (*Physikal. Zeitsch.*, 1906, 7, 225).

—The glass walls of a vacuum tube, in which was a copper plate covered with radio-tellurium, were observed to fluoresce most in the neighbourhood of the plate. Investigation of the fluorescence produced in plates of glass and mica and in a quartz lens by this substance showed that the effect is greatest at the surface, and is probably due to the easily absorbed α -rays. J. R. C.

48. The Observation and the Determination of the Magnitude of Ultra-microscopic Particles, with particular application to Gold Ruby Glass. H. SIEDENTOPF and R. ZSIGMONDY (*Ann. Physik*, 1903, 10, 1).

—All ruby glass, no matter

what the colouring agent, is at first optically clear. The colour appears when the glass is re-heated, or when it is very slowly cooled in the pot, and is caused by the separation of finely divided metal particles. Hitherto, there had been no determinations of the size or other properties of these particles. It had only been assumed that, as they were not microscopically visible, their magnitude must be less than half a wave-length of light. The authors described a method whereby the particles may be observed, the method being applied to gold ruby glass.

The paper is divided into three sections. In the first, the apparatus was described. A small volume of the glass was laterally illuminated by concentrated sunlight, and the diffraction discs caused by the ultra-microscopic particles examined in a direction perpendicular to the illuminating beam. The description is very complete, and details are given of the order in which the various adjustments should be made to obtain the best results. The condition of polarisation of the diffracted light was discussed. The limit to the size of the particles which can be observed by this method is theoretically considered, and a limiting value of 6×10^{-6} cm. is derived.

In the second section, the determination of the size of the particles is described. The particles in a definite volume were counted, and their size calculated from the specific weight of the gold and the total mass of the metal found by analysis. It was assumed that the particles were cubical in shape.

The sources of error of the method, which are numerous, were exhaustively discussed, and their influence on the final result considered. A method, which can be accomplished quickly, for the approximate determination of the size from the distance between the particles was briefly described. It was shown that a conclusion as to the size could be drawn also from the brightness of the diffraction discs formed by the particles.

In section three, the relation between the colour and the particle size was considered. It was pointed out that the treatment of the glass affected the colour and the size of the particles. It was noticed that streaks were of a slightly different composition from the rest of the glass, and so the condition of the gold particles was different; there was also a difference in colour. The colour of the glasses examined, their appearance in polarised and unpolarised light, the gold content, and the probable size of the particles were summarised in two tables. The colour could not be connected with the particle size. It was shown that gold particles must exist which have some colouring action, but are smaller than can be observed by the method described.

J. R. C.

49. Colours in Metal Glasses and in Metallic Films.

J. C. M. GARNETT (*Phil. Trans.*, 1904, A, 203, 385; 1906, A, 205, 237).—The phenomena which these papers seek to explain were observed by Siedentopf and Zsigmondy (Abstract, No. 48). The author showed that the particles observed by Siedentopf and

Zsigmondy in gold ruby glass are spherical in shape when the diameters are less than 10^{-5} cm. An investigation into the optical properties of a medium containing such metal spherules shows that every such medium has a definite colour by transmitted light, depending on the optical constants of the metal, the quantity of it in unit volume, and the refractive index of the medium, but not on the size or distance apart of the spherules. Their presence accounted for the optical properties of gold ruby glass, and it was proved that the irregularities in the effects of colour and polarisation sometimes exhibited by gold glasses were due either to the excessive distance apart of the particles or their excessive size (greater than 10^{-5} cm.). The method of inquiry adopted enabled one to predict, from a knowledge of the metal present in metallic form in a glass, what colour that glass would be. For example, if the metal were gold, a glass the refractive index of which for the D-line is 1.56 will transmit more red than yellow, a silver glass will transmit more yellow than red, and a "potassium-sodium" glass more blue than yellow. A very slight separation of sodium or potassium would give a very strong blue or violet coloration. It seemed to the author probable that the violet coloration of X-ray soda-glass bulbs was due to this separation,* as it was found that the red colour could be produced in colourless gold glass by exposure to β -rays. A piece of this glass placed in a tube containing radium emanation exhibited an unmistakable ruby tint within two days.

In the second part of this paper the colours of metallic films were discussed. It was mentioned in an appendix that large particles of gold (diameter greater than $0.1\ \mu$) in a glass would, by removing the red and yellow light by reflection, give the glass a blue colour by transmitted light and a brown turbidity by reflected light.

In the second paper, the consideration of the structure of metal glasses was resumed. Curves were given representing the absorption by specimens of gold ruby glass, silver stained glass, and copper ruby glass. A comparison of these curves with the graphs for gold spheres and molecules in glass led the author to the conclusion that the colour of gold ruby glass was primarily due to the presence of the small spheres. The irregular blue and purple colours sometimes exhibited were explained by the presence of coagulations of the spheres. The close similarity between the observed absorptions of yellow glass produced by staining with silver and the calculated absorptions by a diffusion of silver spheres in glass indicated that the stained region must contain such spheres. Their presence also accounted for the blue reflection from the internal face of the stained layer. A comparison of the observed and calculated absorptions of copper ruby glass showed that, in this case also, the colour was due to small metallic spheres. On the other hand, the metals which coloured some other glasses cannot be present in metallic form; for example, cobalt in this

* Colour possibly due to manganese in the glass. See Abs. 45.—Ed.

condition would give a reddish-brown colour by transmitted light, not the deep blue of cobalt glass.

The colours in metallic films and in metallic solutions were further discussed in this paper.

J. R. C.

50. The Physical Basis of Colour-Technology. M. LUCKIESH (*J. Franklin Inst.*, 1917, July, 1).—The chief methods of analysing colour are by means of the spectrophotometer, the monochromatic colorimeter, and the trichromatic colorimeter. The first of these provides data of greater physical usefulness than the others, and the paper dealt with results chiefly obtained in this manner. Three classes of coloured media were discussed, namely, pigments, dyes, and coloured glasses. Coloured glasses were more nearly related to dyes than to pigments. A given concentration of colouring material in a glass apparently obeyed the same law relating to thickness and transmission factor for a given wavelength as a dye solution. It was not established, however, that the introduction of various amounts of the colouring material resulted in corresponding concentration; the uncertain conditions of melting made this point difficult to decide. The physics of the process by which glasses are coloured by means of metallic compounds was not wholly clear. It was considered that metals colour glass in two ways, one by being in a state of true solution in the glass, and in the other by being in a colloidal state. In this connection, reference was made to the work of Garnett and of Siedentopf and Zsigmondy (this vol., Abstrs. No. 49 and 48).

Spectral analyses of a number of pigments and dyes were tabulated, reflection factors being given in the former case and transmission factors in the latter. To simplify the study of coloured media, especially dyes and coloured glasses, laws have been formulated by theory and confirmed by experiment. Lambert's law, that all layers of equal thickness of a medium absorb equal fractions of the incident radiant energy, was well established, but there appeared to be some doubt as to the validity, especially in the case of "colloidal" glasses, of Beer's law, that the absorption is the same function of the concentration of a dispersing absorbing substance as of the thickness of a single substance. Assuming the truth of these laws, the spectral analyses of coloured solutions and glasses, of any thickness and concentration, could be obtained from two determinations of spectral character. This method had been found practicable in the development of coloured glass and in the study of many problems arising in colour technology. It was usually applied graphically, and examples were given illustrating the uses of the scheme in practice. In the development of coloured glasses there were sometimes chemical considerations which alter the predictions based on computation, but the procedure formed a working basis.

The spectral analyses of some fundamental coloured glasses were presented, and also the results of some simple combinations. Selenium, copper, and gold were the colouring agents for red

glasses. No single element isolated spectral yellow, but carbon, sulphur, uranium, and silver produced yellow glasses of varying colour. Iron, chromium, and copper imparted green and bluish-green colours to glass when introduced under proper chemical conditions. Cobalt, which was most commonly used for blue glass, transmitted also a deep red band. If a cobalt-blue were combined with a copper bluish-green, the latter absorbed the red, and an excellent blue glass was obtained. Nickel and manganese produced a purple colour, but the latter was not an efficient purple, as its absorption band was not sharp. The author considered that, in such cases as street-lighting glassware, it would be better to eliminate the manganese and to endure the unneutralised green hue of the iron, on account of the reduction of the transmission factor consequent on the introduction of the manganese. This reduction was accentuated after the glass had been exposed for some time to intense sunlight or arc radiation, when the originally clear glass might be coloured to a deep purple.

In developing a coloured glass for a specific purpose, various factors were to be considered, such as the illuminant to be used and the result to be obtained. From these, an ideal spectral transmission curve was determined, and by means of the spectral analyses of different coloured glasses, bearing in mind the chemical considerations if a mixture were finally necessary, various combinations could be made with the aid of the graphical method.

J. R. C.

51. The Influence of Temperature on the Absorption of Light in Isotropic Bodies. R. A. HOUSTON (*Ann. Physik*, 1906, 21, 535).—The effect of temperature on the absorption bands of seven glasses and seven dye solutions was investigated with a spectroscope and a spectrophotometer. The glasses were coloured by didymium, uranium, gold, copper, and cobalt, and there was a "potash manganese" glass. If d is the ratio of the intensity of the light after transmission to the original intensity and l is the thickness of the glass, then the quantity $nk = -\lambda \log d / 4\pi l \log e$ is called the "absorption index" of the medium for light of wavelength λ . This quantity was tabulated for various wave-lengths for all the glasses, both at the ordinary temperature and at a temperature in the neighbourhood of 300°C, and curves were given which represent the variation graphically.

Didymium glass exhibited ten narrow absorption bands in the visible spectrum. On heating, some of these bands coalesced, and this was believed to be due to one set being produced by praseodymium and the other by neodymium, the one group increasing in intensity and the other decreasing until the border line is indistinguishable. Uranium glass was found to have two absorption bands, both of which were noticeably weakened when the temperature was raised. The effect of heating was most pronounced in these two cases, but there was some change in all. The author held that there was no displacement of absorption bands with rise

in temperature, only an alteration in the distribution and magnitude of the absorption.

The theory of absorption was discussed along the lines originated by Drude. The results obtained with two gold ruby glasses were the only ones which agreed at all well with the theoretical formula, and the theory was extended by the introduction of the idea of the reciprocal action of the electrons in an attempt to reconcile it with the other results.

The effect of pressure on the absorption was experimentally investigated, but the apparatus was not sufficiently sensitive to indicate the effect.

J. R. C.

52. The Measurement of Absorption in Tinted Glasses.

L. W. PHILLIPS (*Trans. Optical Soc.*, 1904—5, 43).—Observations were made on a number of blue and green glasses, using the Simmance-Abady flicker photometer. The composition of the glasses was not recorded.

J. R. C.

53. Silicate Specific Heats. W. P. WHITE (*Amer. J. Sci.*,

1919, 47, 1).—This paper extends in scope and accuracy some work previously published. The charges of silica or silicate tested were heated in electric or steam heaters, with particular care to secure both constant and uniform temperatures, and were dropped into the calorimeters by an automatic arrangement, which secured uniformity and quickness. A large number of precautions against error were employed, and these were described in detail. The mean specific heats for eight intervals, ranging from the interval 0° to 100° to that of 0° to 1400°, were determined for nine substances, namely, cristobalite, anorthite, andesine, albite, microcline, wollastonite, diopside, magnesium silicate amphibole, and magnesium silicate pyroxene.

For quartz and silica glass, the values of the interval specific heats to 100°, 300°, and 500° satisfy the expressions:

$$\begin{array}{llll} \text{Quartz} & \dots & \dots & 0.1685 + 0.000194\theta - 0.00000011\theta^2 \\ \text{Silica glass} & \dots & \dots & 0.1670 + 0.000189\theta - 0.000000125\theta^2 \end{array}$$

The mean atomic heats at different temperatures were calculated by a method which was explained, and the results tabulated, for fourteen temperatures from 0° to 1300°. A useful comparison of these results with previous work was given.

In a lengthy section, devoted to the conclusions to be drawn from the experiments, attention was directed to the variations of the atomic heat, which should be a universal constant according to the kinetic theory. A comparison was also made between the specific heats of the substances as glasses and in the crystalline form. Every crystalline substance was also examined in the form of glass. The specific heat of the glass was usually little, if any, greater than that of the crystal. The exceptions to this rule occurred in the glasses containing sodium or potassium, and might be connected with the fact that these substances tend to impart

Interval Specific Heats.

	0—100°	0—300°	0—500°	0—700°	0—900°	0—1100°	0—1300°	0—1400°
Quartz	0.1869	0.2169	0.2380	0.2543	0.2596	0.2641	—	—
Pseudo-wollastonite	0.1844	0.2045	0.2170	0.2258	0.2324	0.2379	0.2426	0.2449
Cristobalite	0.1883	0.2333	0.2426	0.2508	0.2569	0.2625	0.2662	0.2680
Anorthite.....	0.1902	0.2143	0.2297	0.2399	0.2481	0.2551	0.2629	0.2674
Andesine	0.1925	—	0.2330	0.2441	0.2524	—	—	—
Albite	0.1948	0.2203	0.2363	0.2474	0.2561	0.2630	—	—
Microline	0.1870	0.2108	0.2202	0.2371	0.2450	0.2511	(0—1160°)	(0—1250°)
Wollastonite	—	—	—	0.2274	0.2344	0.2401	0.2416	—
Diopside	0.1924	0.2163	0.2314	0.2421	0.2500	0.2563	—	0.2603
Magnesium silicate amphibole	0.2033	0.2298	0.2461	0.2576	0.2661	0.2730	—	—
Magnesium silicate pyroxene	0.2039	0.2309	0.2484	—	—	—	—	—

Glasses.

	0—100°	0—300°	0—500°	0—700°	0—900°	0—1100°
Silica	0.1845	0.2124	0.2302	0.2423	0.2512	—
Anorthite.....	0.1885	0.2152	0.2305	0.2405	—	—
Andesine	0.1934	0.2211	—	0.2484	0.2615	—
Albite	0.1977	0.2238	0.2410	—	0.2640	—
Microline	0.1919	0.2163	0.2321	0.2431	0.2515	0.2598
Wollastonite	0.1852	0.2078	0.2203	0.2355	—	—
Diopside	0.1938	0.2189	0.2333	0.2439	—	—
Magnesium silicate.....	0.2040	0.2302	0.2474	0.2598	—	—

exceptionally high expansion coefficients to glasses in which they occur. Several of the glasses showed a decided increase in specific heat at some fairly elevated temperature, and it seemed probable that this increase would have appeared in other glasses if they had been tested at higher temperatures.

In quartz, below the α - β -inversion at 575° , the heat absorption was much less than corresponds with the abnormal expansion, and the author considered that quartz, and probably other forms of silica, exhibit what appear to be two kinds of inversion, due to different mechanisms. This question was exhaustively discussed by him.

J. R. C.

54. Temperature-Viscosity Relations in the Ternary System Lime-Alumina-Silica. A. L. FIELD and P. H. ROYSTER (*U.S. Bureau of Mines*, Tech. Paper, 189, 1918).—The authors confined themselves to that range of composition encountered in iron blast-furnace slags. Synthetic melts were made and their viscosities measured at temperatures ranging from the melting point to an upper limit of 1600° , an electric furnace being used and the temperatures measured by a Holborn-Kurlbaum optical pyrometer. The viscosity was estimated by rotating the graphite crucible containing the melt and determining the torque on a steel ribbon used to suspend a graphite rod in the axis of the crucible. In the binary system calcium metasilicate-*gehlenite* ($\text{Ca}_2\text{Al}_2\text{SiO}_7$), a maximum viscosity at temperatures between 1350° and 1600° was shown by a mixture of about 30 per cent. of *gehlenite* and 70 per cent. of calcium metasilicate, and a minimum viscosity by the eutectic mixture. At the saturation temperature and at 50° and 100° superheat, respectively, the binary eutectic exhibited maximum viscosity when compared with contiguous mixtures. Viscosity-temperature measurements were made of mixtures representing seven quintuple points of the ternary system. Two of these mixtures (CaO 47.2, Al_2O_3 11.8, SiO_2 41, and CaO 49.5, Al_2O_3 43.7, SiO_2 6.8) did not obey the usual rule of possessing a viscosity-temperature curve continuous at the melting point, so that crystallisation of these mixtures should proceed without difficulty. Viscosity measurements were made of compositions lying on the boundary curves between the fields of calcium metasilicate and *anorthite*, calcium metasilicate and *gehlenite*, *gehlenite* and *anorthite*, and calcium orthosilicate and *gehlenite* at temperatures of 1400° , 1500° , and 1600° . Each of the viscosity-composition curves terminated at a quintuple point representing a eutectic, and included between these two ternary eutectics the binary eutectic between those two compounds the stability of which yielded its limits. In the boundary curve between calcium orthosilicate and *gehlenite* there were also two quintuple points where *gehlenite* α - and β -calcium orthosilicate are in equilibrium with their melt. The viscosities of the mixtures corresponding with these two points were much higher than for any composition lying in this part of the system; this appears to be due to the existence of the molecular

aggregate identified with β -calcium orthosilicate. In each of these boundary curves the viscosity increased from a minimum at a binary eutectic to a maximum at a quintuple point. It was found that the viscosity surfaces were not of a simple nature at any given temperature, and their form depended greatly on the temperature. The investigation of what occurred in manufacturing processes involving molten silicates was still further complicated by the fact that even an approach to equilibrium is seldom obtained.

C. M. M.

55. Slag Control in the Iron Blast Furnace by means of Slag Viscosity Tables. A. L. FEILD (*Chem. and Met. Eng.*, 1918, 19, 294).—The author showed in the form of a curve the diminution of slag viscosity with increase of temperature, by means of which curve it could be demonstrated that a minor change in percentage of one of the principal constituents—lime, alumina, and silica—might cause a great change in the temperature-viscosity relations. A gradual increase in the amount of lime, instead of producing a gradual change in viscosity, produced maxima and minima. Changes in percentages of minor constituents of a slag, such as oxides of magnesium, manganese, iron, etc., did not appreciably affect temperature-viscosity relations if the percentage of magnesia, the most important minor constituent, did not exceed 8 per cent. The temperature relations of a slag were said to be most suitable with a viscosity ranging from 10 in the furnace to a viscosity of 4 where the slag leaves the furnace. In controlling the slag between these limits, it was shown that the calculations of slag analyses must be made on a basis of 100 per cent. of lime, alumina, and silica. Lime must be accurately determined by analysis, and not by difference, as slag properties were particularly susceptible to slight differences in the lime content. C. M. M.

56. Some Mixed Crystals of Calcium Ferrite and Aluminate. EDWARD D. CAMPBELL (*J. Ind. Eng. Chem.*, 1919, 11, 116).—In this investigation the author hoped to redetermine the existence or non-existence of a calcium ferrite of the empirical formula $5\text{CaO} \cdot 3\text{Fe}_2\text{O}_3$, and to obtain some experimental evidence as to what is formed when a mixture of calcium oxide, ferric oxide, and alumina was melted and then cooled at a rate slow enough to permit the material to be nearly in equilibrium during the entire cooling period.

The investigation led to the following conclusions:—

(1) That dicalcic ferrite and monocalcic ferrite are the only definite compounds of CaO and Fe_2O_3 .

(2) That pure tricalcic aluminate may be recovered by crystallisation from a solution of CaO in $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ as a solvent, provided the concentration of CaO at the beginning of the crystallisation is less than that which would be required to form tricalcic aluminate with all the Al_2O_3 present.

(3) That if a solution with the empirical formula $8\text{CaO} \cdot 3\text{Fe}_2\text{O}_3$,

containing both Fe_2O_3 and Al_2O_3 in the molecular proportion of 2 to 6, be slowly cooled, mixed crystals with Fe_2O_3 and Al_2O_3 in the ratio 1 to 7 crystallise out until the Fe_2O_3 - Al_2O_3 ratio in the solution has been increased to 3 to 5.

(4) That when the Fe_2O_3 - Al_2O_3 ratio has been increased until it has become 3 to 5, mixed crystals of this latter ratio crystallise out, producing a further increase in the Fe_2O_3 - Al_2O_3 ratio until at about 1370° it has become 4 to 4.

(5) That the aluminates in which part of the Al_2O_3 is replaced by Fe_2O_3 are capable of holding in solid solution less calcium oxide than the pure aluminates.

The experiments described suggested a possible explanation of the general formation of many minerals which apparently consist of mixed crystals formed in a slowly cooling magma.

C. M. M.

57. The System Lime-Alumina-Silica; (and its Relation to Blast-furnace Slags and Portland Cement). B. NEUMANN (*Stahl u. Eisen*, 1918, **38**, 953; from *J. Soc. Chem. Ind.*, 1918, **37**, 770A).—The author reviewed the present state of knowledge in regard to the ternary system CaO - Al_2O_3 - SiO_2 .

Portland cements made from pure materials and burned at a sufficiently high temperature would consist solely of $3\text{CaO}, \text{SiO}_2$, $3\text{CaO}, \text{Al}_2\text{O}_3$, and $2\text{CaO}, \text{SiO}_2$.

The natural impurities resulted in free lime or free $5\text{CaO}, 3\text{Al}_2\text{O}_3$ being present in commercial cements, together with small quantities of magnesia, iron oxide, etc.

The following summary of the compounds formed in the production of Portland cement was given:—

Cement.	Percentage composition of raw materials.	Burning temp.	Constituents in finished cement.
Chemically pure cement.	$\left\{ \begin{array}{l} \text{CaO} = 68.4 \\ \text{Al}_2\text{O}_3 = 8.0 \\ \text{SiO}_2 = 23.6 \end{array} \right.$	1650°	$2\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{Al}_2\text{O}_3$
White cement.	$\left\{ \begin{array}{l} \text{CaO} = 6.62 \\ \text{Al}_2\text{O}_3 = 6.4 \\ \text{SiO}_2 = 25.0 \\ \text{MgO}, \text{Fe}_2\text{O}_3, \text{Na}_2\text{O}, \text{K}_2\text{O} \end{array} \right. = 2.4$	1525°	$2\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{Al}_2\text{O}_3$ Trace CaO
Commercial (grey) cement.	$\left\{ \begin{array}{l} \text{CaO} = 63.2 \\ \text{Al}_2\text{O}_3 = 7.7 \\ \text{SiO}_2 = 22.4 \\ \text{MgO}, \text{Fe}_2\text{O}_3, \text{Na}_2\text{O}, \text{K}_2\text{O}, \text{SiO}_2 \end{array} \right. = 6.7$	1425°	$2\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{SiO}_2$ $3\text{CaO}, \text{Al}_2\text{O}_3$ Trace CaO $\text{CaO}, 3\text{Al}_2\text{O}_3$ and ferrite

If the clinker was insufficiently burned, there would be a deficiency of $3\text{CaO}, \text{SiO}_2$.

The temperature of formation of tricalcium silicate was about 1700° ; calcium aluminate appeared to act as a flux, allowing the $3\text{CaO}, \text{SiO}_2$ to form at a lower temperature.

A. M. J.

58. Hydrothermal Formation of Minerals (Silicates).

W. J. MÜLLER and J. KOENIGSBERGER (*Zeitsch. anorg. Chem.*, 1918, 104, 1).—Investigations have been made as to the products formed when mixtures containing K_2O , Al_2O_3 , SiO_2 , and water are heated together under pressure for varying times at temperatures from 100–440° in the presence or absence of carbon dioxide. The results obtained in the presence of carbon dioxide agree better with the observed order of succession of minerals in clefts and cavities in nature than those in the absence of carbon dioxide. Below 360°, *potassium felspar* is not formed. In the presence of carbon dioxide, only quartz is stable at 310°, but at higher temperatures aluminosilicates begin to appear. In the absence of carbon dioxide, *zeolites* are formed at 100°, but apparently their limit of stability is reached below 300°. However, the opinion is expressed that in no case was a true equilibrium obtained in the experiments below 400°. Besides the minerals already mentioned, *leucite*, *potassium nepheline*, and *pectolite* were identified among the products.

C. M. M.

III.—Lampworked and General Scientific Apparatus

59. A Special Stopcock for Dropping Liquids arranged for Equalising the Pressure Above and Below the Outlet of the Stopcock. H. L. FISHER (*J. Ind. Eng. Chem.*, 1918, 10, 1014).—When dropping liquids into a vessel in which the pressure is either above or below the atmospheric, it is usual to connect the top of the reservoir to the container by means of an external tube. In this new apparatus connection is made by means of an annular groove in the key of the stopcock, so that no matter which position the key occupies, there is always communication between the atmosphere in the lower flask and the atmosphere in the upper reservoir (Fig. 2). The outer arm of the stopcock is extended until it opens above the liquid in the container. The liquid, passing downwards, enters at an aperture in the lower part of this extended arm, and is delivered through a small glass tube sealed in at this opening. Below the barrel of the stopcock the two tubes continue to run concentrically, the outer, or air-communicating, tube ending a little above the end of the inner, or liquid, tube.

S. E.

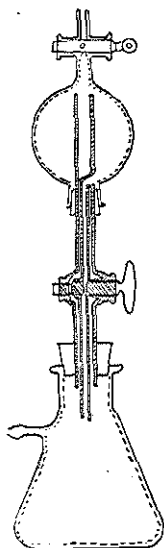


Fig. 2.

60. Absorption Pipettes. E. VAN ALATINE (*J. Ind. Eng. Chem.*, 1919, 11, 51).—When using the Parr carbon apparatus, it seems desirable to have an absorption bulb which is effective and rapid, but which does not contain glass beads or rods. The apparatus, as shown in Fig. 3, has been designed to meet this need, and is of a size suitable for absorbing up to 100 c.c. of carbon dioxide from 100 to 200 c.c. of air. If absorption from a smaller volume of air is made, a pipette with smaller bulbs, *A* and *B*, and a smaller capillary at *E* should be used. If absorption from a larger volume of air is to be made, then *A*, *C*, and *D* should be larger, but *B* should not be changed.

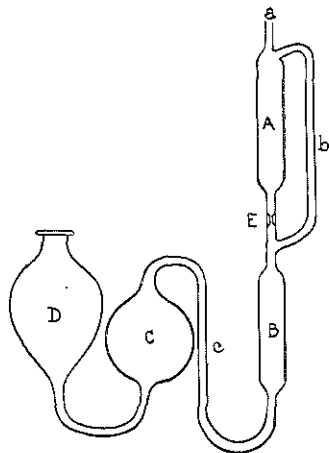


FIG. 3.

When the gas enters at *A*, it quickly forces the liquid from the tube *b* and the bulb *B*, through the tube *c*, into the bulb *C*. Such gas as still remains to be forced into the pipette must pass through the bulb *B*, the sides of which are kept wet by the liquid dripping slowly through the capillary *E*. By the time that *A* is half emptied, all the gas has been forced out of the Parr apparatus. When the bulb *A* has completely been emptied through the capillary *E*, some of the gas will have passed from *B* to *A* through the tube *b*, but most of it will have been trapped in the bulb *C* by the falling liquid filling the bend in the tube *c*. As this gas is drawn back to the Parr apparatus, it must bubble through this liquid in the bend of *c*.

Although it is not necessary to shake the pipette, absorption is, according to the author, as rapid as it is in a bead-filled apparatus.

S. E.

61. New Reflux Condenser. J. J. BANJA (*J. Ind. Eng. Chem.*, 1919, 11, 52).—In a common type of reflux condenser, the hot vapours enter at the colder end of the cooling chamber, and, on condensing, block up the exit tube until the increasing weight of liquid forces its way down the tube and spurts back into the receiver. To overcome these undesirable features, the hot vapour is led by a side-tube, 2 (Fig. 4), to the top of the condenser and into the top end.

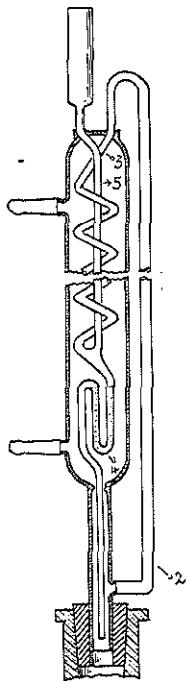


FIG. 4.

of the condensing coil, 3. The condensed liquid flows through the trap 4 back to the receiver in a steady stream. Any tendency to disturb the balance of the liquid in the trap finds an outlet through the central tube 5. The flow of the cooling water in a direction opposite to that of the condensed liquid diminishes the strain put on the glass.

S. E.

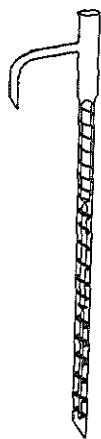


FIG. 5.

62. The Limits of Separation by Fractional Distillation. A New Still-head. S. F. DUTTON (*J. Soc. Chem. Ind.*, 1919, **38**, 451).—The new still-head consists of two glass tubes, one inside the other, the inner one having its ends sealed up, and the annulus between the two tubes containing a spiral of wire. The condensed liquid seals the wire spiral to the two tubes, and thus causes the ascending vapours to pass along a long spiral track. Since the volume of liquid returning to the flask is much greater at the bottom of the still than it is at the top, it is advisable to have the wire wound on cores of decreasing diameters, as shown in Fig. 5, using thicker wires as the width of the annular space increases.

With such a still-head, it is claimed that almost perfect separation of such liquids as benzene, toluene, and xylene from their mixtures can be obtained.

S. E.

63. Apparatus for the Continuous Testing of Gases, with Special Reference to Acid or Alkaline Constituents.

C. A. KING (*J. Soc. Chem. Ind.*, 1919, **38**, 33r).—A current of the gas to be tested is passed upwards through a small absorption chamber provided with projections inwards from the wall (Fig. 6). The washing and indicating solution is dropped steadily into a U-tube, which is connected to the upper end of the absorption chamber. The solution drains away from the lower end of the absorption chamber through another U-tube, in which any change of colour of the solution can be noted.

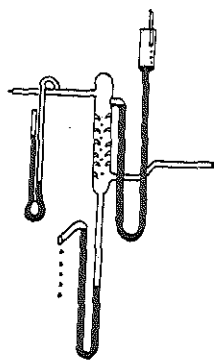


FIG. 6.

When a supply of gas is being tested for ammonia, the indicator used is a solution of methyl-red with just sufficient acid added to develop the true red colour. If ammonia is present, it changes to yellow, the change

being readily observed even in artificial light.

S. E.

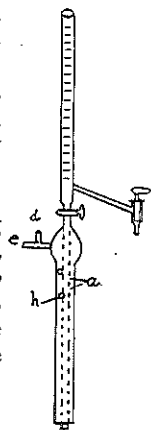
64. Glass-cutting Tool. H. H. PARKER (*J. Amer. Chem. Soc.*, 1918, **40**, 195).—A description is given of an instrument which resembles in appearance a gas-heated soldering bit. The object of

the instrument is to replace the heated end of a file, which is often used to lead cracks in glass. The paper contains three illustrations of the apparatus, and photographs of work carried out with it.

J. D. C.

65. An Improved Automatic Burette. G. J. HOUGH (*J. Ind. Eng. Chem.*, 1919, 11, 229).—The burette illustrated in Fig. 7 was devised for use with bottles containing stock solutions. Its advantages are that it requires no bracket to support it, and that it can be quickly removed and cleaned ready for use with another solution.

The base of the burette consists of a glass tube, *a*, passing to the bottom of the bottle containing the solution. This is surrounded by a wider tube, which passes through the rubber stopper fitted into the neck of the bottle. To the side-tube, *c*, is attached a pressure bulb, and *d* is closed up by the thumb while pumping air into the reservoir. The hole, *h*, in the outer jacket, which should be above the level of the liquid, serves to equalise the pressure in the reservoir.



S. E. FIG. 7.

66. On the Lags of Thermometers with Spherical and Cylindrical Bulbs in a Medium whose Temperature is Changing at a Constant Rate. A. R. McLEOD (*Phil. Mag.*, 1919, [vi], 217, 134).—The lag of a thermometer situated in a medium the temperature of which is changing is of practical interest in the case of ascending aeroplanes and balloons. The medium in this case is the atmosphere, but application might also be made to the case where the variable temperature of any other medium is to be determined by a thermometer as a function of the time. Expressions are given for the steady values of the lags for spherical and cylindrical bulbs when the surface conductivity is finite, and for the lags at any instant when the surface conductivity is infinite. In a uniform temperature gradient, the lag varies almost inversely as the conductivity of the fluid filling the thermometer. Numerical results are given for mercury and alcohol in spherical and cylindrical bulbs. These calculated results show that for spherical bulbs of mercury and alcohol giving the same volume expansion the lags are about the same. With the same thermometric substance the lag is less for cylinders 10 cm. long than for spheres giving the same volume expansion, and it is less for a cylinder of alcohol than it is for a cylinder of mercury.

S. E.

IV.—Decorated Glass.

67. Production of Metallic Decorative Coatings on Glass. (*Chem.-Zeit.*, 1903, 27, 1138).—It is stated to be impossible to obtain a non-transmitting, and therefore perfectly reflecting, film by the ordinary staining process. If, however, the glass is covered with the metallic oxide and heated alternately in a reducing and oxidising atmosphere three or four times, such a film is produced. This film is so bound to the glass that it is only attacked by aqua regia.
J. R. C.

68. Coloration Method. B. D. AVIS (U.S. PATENT 1277172, 1918; from *J. Soc. Chem. Ind.*, 1919, 38, 22A).—The method described is an improvement in the process described in the U.S. patent 933522. The surface to be coated is covered with an ammoniacal solution of dimercuric ammonium nitrate or an alkaline alcoholic solution of a double mercury alkali salt, and the double salt is precipitated by evaporation of the ammonia or alcohol. It is stated that glass, porcelain, metal, wood, paper, etc., can be coloured by this method. The transparency of glass is not destroyed by the coloration.
S. E.

V.—Optics and Optical Instruments.

69. The Optical Properties of Vitreous Silica. J. W. GIFFORD and W. A. SHENSTONE (*Proc. Roy. Soc.*, 1904, 73, 201).—The composition of vitreous silica is not liable to variations such as occur in two meltings of the same glass; it is not attacked by most reagents, and the supply is not limited like that of fluorite. It can be regarded, therefore, as a standard glass. A prism of this substance was prepared by the authors from one melting, and also a compound prism was made by a workman from four different melts. This last prism was found to be perfectly homogeneous, differing in this way from a prism made from four pieces of optical glass from the same melt. The refractive indices of the silica for wave-lengths ranging from 7950 to 1850 Å.U. were tabulated. For the D-line the value is 1.4584772. The dispersion, v , is 67.920, as compared with 95.493 for fluorite and 70.048 for quartz.
J. R. C.

70. Tools for Grinding Glass of Refractive Index 1.523. W. J. DRUIFF (*Optician*, 1918, 55, 177).—The radii of curvature, r , of lens-grinding tools are evaluated by the formula $r = M/D(\mu - 1)$, where M is 1 metre, D the dioptric power, and μ the refractive index. The values of r for powers ranging from 0.12 to 2,800 were set out both in millimetres and inches.
J. R. C.

71. The Field of a Prism. A. WHITWELL and T. CHAUNDY (*Optician*, 1918, 56, 93, 143, 209).—A continuation of a series of articles on the behaviour of prisms (*cp.* Vol. II, Abstr. No. 100). The question of the field delimited by the various prisms was considered. In the first section the real and "ghost" images produced by rays parallel to the base of a right-angled isosceles prism were discussed, and subsequently the more general case of rays which are not so parallel. The consideration of oblique rays introduces the possibility of total internal reflections at the triangular faces, as well as at the rectangular ones, so the "equivalent prism" system was extended to include these reflections. The overlapping of the true and ghost images was treated briefly in the third section, and the manner in which any ray of a ghost image could be prevented from emerging. The latter was done by the insertion of stops of convenient size at suitable positions. J. R. C.

72. A Method of Testing Right-angled Prisms. S. D. CHALMERS and H. S. RYLAND (*Trans. Optical Soc.*, 1904—5, 34).—A beam of light is allowed to fall on the hypotenuse of the prism, part being internally reflected by one of the faces including the angle and part by the other. If the right angle be perfect, the two parts will return parallel to each other and to their original direction. The authors gave practical details of this test, and stated that an error of less than two seconds is recognisable. The same principle could also be used for testing plane parallel surfaces. J. R. C.

73. Some Uses of Cylindrical Lens Systems, including Rotation of Images. G. J. BURCH (*Proc. Roy. Soc.*, 1904, 73, 281).—Stokes showed that when two lenses are placed in contact with their axes of curvature at right angles, the combination acts as a spherical lens, and the formula $\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$ holds for it. If the lenses are not in contact, however, there is only one pair of conjugate points at which a real object will give a real image. Such a system may be employed for comparing by photography curves plotted to different scales, or for increasing or diminishing the ordinates of a curve the scale of which is unsuitable. The appearances presented by the cylindrical telescope and cylindrical microscope are also described. In these cases, the axes of curvature of the lenses are parallel. The telescope is particularly useful in that it can be used to rotate an image formed by polarised light without affecting the polarisation of the light. J. R. C.

74. A Chart for finding the Number of Lenses in, and Size of a Block. H. LEE (*Trans. Optical Soc.*, 1918, 19, 165).—Formulae for finding the number of lenses in a block have been given. The practical cases are those in which there are one or three lenses in the centre. Charts are constructed for these two cases, so that, given the diameter of the lenses and the radius of

curvature, the number of lenses which may be placed on a block of given radius, or, alternatively, the radius of the block required to contain a number of lenses, can be determined immediately. The charts are easily understood.

J. R. C.

75. Charts for assisting in the Selection of suitable Glasses for Cemented Doublets. T. SMITH (*Trans. Optical Soc.*, 1918, 19, 169).—The charts described in this paper are intended to serve as a guide to a computer in selecting a pair of glasses for any purpose. Objectives of the type considered can be calculated from expressions for the first order aberrations when thicknesses are neglected. The aberrations of such thin lenses are determined by three quantities, which depend on the relative powers of the two component lenses and on their refractive indices. To enable a two-dimensional diagram to be drawn, one of these quantities must be fixed, and since many lens combinations include a dense flint of refractive index about 1.62, one chart has this as the fixed quantity. The refractive index of the other glass is taken as abscissa, and the ordinate is the logarithm of the ratio of the powers. This chart is used in conjunction with a second, which has the same abscissa and the logarithm of v as the ordinate. By substituting for this second chart another diagram in which the ordinates are changed, any required amount of chromatic aberration may be introduced without affecting the spherical corrections. By the use of such charts, much time can be saved in calculating simple cemented objectives, since it is possible to ascertain beforehand that the glasses selected will be the most suitable of those that are available. After the selection has been made, the proper curvatures for the surfaces of the new lens will then be found in the usual way.

J. R. C.

76. The Prevention of Film in enclosed Optical Instruments. H. S. RYLAND (*Trans. Optical Soc.*, 1918, 19, 178).—In every type of enclosed optical instrument, instances of "film" will be found. The following precautions when taken have been ascertained to eliminate film: (1) No japan or bitumen-black to be used on interior surfaces. (2) No pitch or beeswax to be used within the case. (3) All interior surfaces must be thoroughly cleaned and freed from animal matter, such as finger-marks. In the case of aluminium or other porous metals, heat treatment is necessary after machining to remove all traces of grease. (4) The lenses and prisms after ordinary cleaning must be dipped in hot running water with a pair of tweezers, and wiped dry with clean linen. (5) After washing the linen used for cleaning purposes, it must be well rinsed in running hot water until all trace of soap has gone. (6) Dust must be removed with a clean camel-hair brush and not by blowing. (7) The linen used for cleaning must be used in such a way that no part of it which has been touched by the fingers is brought into contact with the glass surface. (8) All surfaces must be well polished.

In the discussion which followed the paper, J. W. French laid stress on the necessity for the efficient desiccation of optical instruments and scrupulous cleanliness in all optical work. C. Beck stated that there is evidence to show that film does not appear inside optical instruments except in the presence of moisture; for example, it is not met with inside submarine periscopes, which are filled with absolutely dry air and hermetically sealed. J. R. C.

77. Astigmatism: Interchangeability of Planes of Stop and Object. T. CHAUNDY (*Trans. Optical Soc.*, 1918, 20, 11).—A beam of light from a source near the axis of the system is supposed to pass through a co-axial optical system. The beam is restricted to be of small angle by an axial stop. The paper dealt with the astigmatism of the image and with the conditions under which an interchange of the planes of the source and the stop leave the astigmatism unaffected. The problem was analytically discussed by a method of line co-ordinates which supposes that the co-ordinates of a typical ray after emergence from the instrument are expressed as functions of the co-ordinates of the ray before incidence. The condition of interchangeability was derived, and the case in which the incident beam is parallel received special consideration. J. R. C.

78. Stray Light in Optical Instruments. L. C. MARTIN (*Optician*, 1918, 55, 239).—The presence of this unwanted light is not very easily recognised in an ordinary examination of the instrument, but the author described an arrangement which easily reveals its presence. A black disc, 2 feet in diameter, is pasted on a piece of tissue paper, 6 feet square, which is placed in front of a window. If the disc is examined by the instrument to be tested, no light should be transmitted through the eyepiece. Some stray light is introduced by double reflections at air-glass surfaces, and the author advocates the cementing of components, where possible. Another source of stray light is the ring of dirt sometimes left round the edges of the objective. This scattered light could be eliminated by internally stopping down the objective. The performances of an English prism binocular, a Zeiss binocular, and a Galilean binocular were compared by means of photographs. In the Zeiss instrument, reflected light from the walls of the tube had been controlled by the provision of a series of diaphragms mounted in the tube, so that no reflected light could reach the eye.

J. R. C.

79. Micrometer Microscopes. A. W. GRAY (*Optician*, 1918, 55, 217, 227, 242, 253).—The first article dealt with some errors affecting measuring microscopes. The most important corrections are necessitated by the deviations from the nominal value of a division and other constructional errors. Temperature changes may cause variations in magnification by thermal expansion of the screw, or the microscope lenses, or by altering the refractivity of

the media traversed by the light. Serious errors may also be caused by failure to focus accurately. Another possible source of trouble may long evade detection. Any holes in the surfaces of the thrust bearings may harbour minute grains of dust, which in time work between the rubbing surfaces and produce more or less periodic irregularities. When high accuracy is demanded, the screw errors should be investigated periodically.

Methods of applying corrections to a group of micrometers were considered in the second article. For this purpose, the author has developed a method which requires little expenditure of labour after the microscopes have once been calibrated. It is a simplification of that employed by the International Bureau of Weights and Measures in measuring the national prototype meters. The method was described and an example given.

The third and fourth sections were devoted to a description of the determination of the corrections of micrometer microscopes. The method employed is a graphical one, and is very sensitive.

J. R. C.

80. The Examination of a Microscope Objective. K. STREHL (*Zeitsch. Instrumentenkunde*, 1905, 25, 3).—The author treats of the wave surface transmitted by the objective, and the effects of spherical and chromatic aberration are discussed. The paper is too mathematical to be abstracted.

J. R. C.

81. A New Construction for Bodies of Binoculars. (*Optician*, 1919, 56, 247).—A detailed description of a method of manufacture of the bodies of binocular or monocular glasses. Hitherto these have been made, usually, by casting aluminium, but by the new method any suitable sheet metal can be used.

J. R. C.

82. Aeronautical Sighting and Range Finding Apparatus. (*Optician*, 1919, 56, 226).—The instrument described furnishes the means for determining the distances and positions of terrestrial objects from aeroplanes during flight, and by it also the speed of the machine relative to the ground can be accurately ascertained. Numerous diagrams are given to illustrate the principles set out.

J. R. C.

83. Improvements in Range Finders. (*Optician*, 1919, 56, 216).—A description of a range-finder more especially adapted for the use of anti-aircraft guns. It is assumed that the height of an enemy aircraft has already been given by some other station, and the function of the instrument is to determine the angular elevation. The article is diagrammatically illustrated.

J. R. C.

84. Testing of Materials at the Optical Institute of C. P. Goerz. G. BERNDT (*Deutsch. Mech. Zeit.*, 1918, 99, 109, 121).—In the first section, after dwelling on the advantages of having instruments for testing the raw materials used in the con-

struction of scientific instruments, the author discusses the form of the elasticity curve for metals after the limit of elasticity has been reached and Hooke's law has ceased to be valid. All the machines described subsequently are specially intended for testing metals, but where the tests are applicable they can be used for the examination of glass also. A hydraulic machine for tension and compression fracture tests, a torsion machine, a Brinell press, and an arrangement for testing resistance to fracture when struck are described. The first three are of the usual type, and the last consists essentially of a weighted pendulum, the weight, at the bottom of its swing, hitting a plate of the material under test. The surfaces resulting from the fracture of metals are illustrated and discussed.

J. R. C.

85. The Optical Determination of Stresses in Aeroplane Spars. A. R. Low (*Engineering*, 1919, 107, 234).—A scale model of a standard pattern of aeroplane spar was made, using xylonite for the spars and steel for the struts and wires. The spars were loaded, and the stresses in them determined by using crossed Nicols. The numerical values of the stresses were obtained by loading a simple tension test-piece until the same colour was observed as with the loaded spar. The discrepancies between the observed and calculated values were often considerable, especially at high loads.

S. E.

VI.—Illumination and Illuminating Ware.

86. The Use of Inert Gases in Electric Incandescent Lamps (Brit. Pat. No. 112264). SIEMENS & HALSKE AKT.-GES., Nov. 22nd, 1917, No. 17211. Convention date, Dec. 29th, 1916. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—A carbon-filament lamp is filled with an inert rare gas, such as argon, practically free from traces of nitrogen or other harmful gas. Other inert substances, such as mercury vapour, may be present. Increased life and efficiency are obtained. H. G. C.

87. Thorium Pyrophosphate (Brit. Pat. No. 112380). WELSBACH CO., GLOUCESTER, NEW JERSEY, U.S.A. ([Assignees of M. A. Goltz, Winona, Minnesota, U.S.A.], June 14th, 1917, No. 8550. Convention date, Feb. 28th, 1917).—The product obtained by decomposing monazite sand with sulphuric acid is heated to a sufficient degree to convert some or all of the free phosphoric acid into pyrophosphoric acid. On treating the mass with water, a precipitate of thorium pyrophosphate is obtained. H. G. C.

88. A New Illuminator for Microscopes. ALEXANDER SILVERMAN (*J. Ind. Eng. Chem.*, 1918, 10, 1013).—In this new illuminator three iris-like fingers fasten a circular lampholder to the objective of the microscope. The lamp used is a 9 volt, 0.7 ampere unit with a blue or daylight glass. Experiments show that the heat given off by such a lamp is insufficient to cause any harmful effect on the objective, even although it be left running continuously for some considerable time. A shutter may at times prove desirable to cut off the light from one-half of the circular source. To answer this purpose, a dull black disc which is attached to the holder may be brought over so as to cover up half of the lamp. Details are sometimes visible when so illuminated, but are quite obscured when the whole lamp is bare. S. E.

89. Street Lighting Developments at Oxford. (*Electrician*, 1919, 82, 109).—The holophane refractor lantern which has recently been installed in Oxford streets consists of two distinct prismatic pieces fitting closely inside each other, and thus modifying the natural distribution of the light. Although made up of prismatic elements, the interior and exterior of the lantern are quite smooth, and thus admit of easy cleaning. These lamps give a fairly uniform distribution of light, and also eliminate glare owing to the diffusion of the light on passing through the refracting surfaces. S. E.

90. Influence of Quality of Gas and Other Factors on the Efficiency of Gas-mantle Lamps. R. S. McBRIDE, W. A. DUNKLEY, E. C. CRITTENDEN, and A. H. TAYLOR (*U.S. Bureau of Standards*, Tech. Paper 110, 1918).—The paper is a report of a part of a general investigation to determine the relative usefulness of gases of different heating values for mantle lighting, cooking, water heating, etc.

Experiments were carried out with various types of upright and inverted incandescent mantle burners, and the gases employed in the investigation comprised carburetted water-gas of about 665 B.Th.U. and 565 B.Th.U. per cub. ft., coal-gas of about 565 B.Th.U. per cub. ft., some specially enriched gases of higher calorific value, and natural gas of calorific value 1120 B.Th.U. per cub. ft. The chief conclusions drawn were:—(1) The inverted burners show no difference in efficiency with lean water-gas with either adjustment; (2) upright burners have a higher efficiency with lean water-gas than with town gas, both at maximum efficiency adjustment and at maximum candle-powder adjustment; (3) the upright burners similarly show a distinct advantage in the use of the benzol-enriched gas as compared with ordinary town gas; (4) with all types of burners there is a small advantage gained by the use of water-gas rather than of coal-gas of the same heating value, except in some cases at very low pressures.

Experiments involving alterations of gas quality led to the conclusion that if a lamp is adjusted for maximum candle-power, an

increase in the heat value of the gas supplied produces a decrease of efficiency, and *vice versa*. It was concluded that the usefulness of a uniform quality of coal-gas of 550 to 575 B.Th.U. per cub. ft. increased or decreased with a corresponding change in the calorific value of the gas.

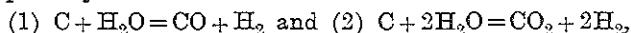
C. M. M.

VII. Fuels, Refractories, and Furnaces.

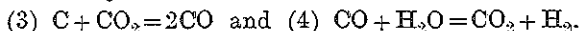
91. Methane. W. MALISOFF and G. EGLOFF (*J. Phys. Chem.* 1918, 22, 529).—This paper contains a summary from all sources of the investigations which have been carried out on methane. It is pointed out that the consumption of natural gas in America in 1917 reached the figure of 900,000,000 cub. ft., this gas averaging 78.2 per cent. of methane.

C. M. M.

92. Theory of Water-gas Formation. Gwosdz (*Zeitsch. angew. Chem.*, 1918, 31, 137).—The author made investigations to ascertain the parts played in water-gas formation by the supposed primary reactions:—



and the secondary reactions:—



Superheated steam was passed over various forms of heated carbon, and the composition of the issuing gases was determined. The speed of the current of steam varied, and the temperatures also varied from 855° down to 560°. It was found that natural forms of carbon containing ash in appreciable quantities behaved in a very different way from purified carbon almost free from ash. Thus with gas coke (8.5 per cent. ash) and wood charcoal (1.4 per cent. ash), a considerable proportion of carbon dioxide was always formed (up to 29 per cent.). On the other hand, lamp carbon (0.1 per cent. ash) at temperatures down to 600° gave mixtures closely resembling water-gas as manufactured. Even at 560° the mixture obtained was:—CO₂, 8.6 per cent.; CO, 39.5 per cent.; H₂, 40.0 per cent.; residue, 11.9 per cent. It was concluded that reaction (2) cannot be primary, because reaction (3) is known to be too sluggish to account for the formation of the high percentage of carbon monoxide found at these low temperatures. Further, that reaction (1) is the primary reaction of water-gas formation, and that the carbon monoxide formed reacts with the excess of steam, tending to establish the water-gas equilibrium, and that this reaction is catalytically influenced by the finely divided ash in the carbon.

C. M. M.

93. Carbonisation of Lignites. E. STANSFIELD and R. E. GILMORE (*Trans. Roy. Soc. Canada*, 1917-18, 11, 85).—Laboratory tests were carried out on a sample of lignite having a gross calorific value 4260 calories, moisture 31.8 per cent., ash 5.2 per cent., volatile matter 28.9 per cent., fixed carbon 34.1 per cent. The calorific value of the dried lignite was 6260 calories.

Five sets of carbonisation experiments on the material as received were carried out. (1) Ordinary carbonisation between 200° and 700°. The loss of volatile matter was slight up to 300°, increased rapidly up to 600°, and was practically constant by 700°. The calorific power of the residue increased to a maximum (7530 calories) at 550–600°, and then decreased. (2) With slow carbonisation similar results were obtained, except that for any given final temperature the loss of volatile matter was less than with more rapid carbonisation. (3) With vacuum carbonisation (25 mm.), the volatile matter given off was greater than at ordinary pressures, the calorific value of the residue was practically the same up to 350°, but above that temperature it was less (for example, 7365 calories at 600°). (4) With carbonisation in the presence of steam, up to about 450°, results were obtained similar to those in the previous tests, but above that temperature the results varied. It was concluded that 450° is the maximum temperature for satisfactory carbonisation in the presence of steam. In this series the calorific value of the residue was in all cases slightly lower than in the vacuum series. (5) Carbonisation under pressure gave results closely resembling those of the vacuum series, but the calorific values of the residues were higher than in any other series, the maximum being 7640 calories at 550°.

It was concluded that a temperature about 600° is the most suitable for carbonisation.

J. D. C.

94. Fuel-economisers. (Brit. Pat. No. 111393). W. SHARP (February 5th, 1917, No. 1790).—Irregularly-shaped porous refractory blocks with roughened surfaces, for use in combination with coal or coke in open fireplaces, are made of fire-clay or common clay together with slaked lime and sand, to which are added coarse sawdust or crushed coke, the whole being intimately mixed, rendered plastic by the addition of water, moulded, and cut into the required shapes, air-dried, and burnt in an open fireplace.

H. G. C.

95. The Manufacture of Refractory Materials for Glass Works Construction. R. H. MINTON (*Trans. Amer. Cer. Soc.*, 1906, 8, 353).—In the author's view, the main essentials for a good tank block are high refractoriness, resistance to the fluxing action of lime, salt-cake, etc., used in making the glass, resistance to the wearing action of the moving glass, and non-conductivity. Extreme fineness of grain of the clay is to be avoided, as this causes fluxing at lower temperatures than with coarser grain.

Again, coarse grains insure greater resistance to heat, but decrease the resistance to erosion. The block must be well burned to reduce shrinkage; it must be dense to resist fluxing and wearing action, but not so dense as to induce cracking. These requirements are conflicting, and experience must decide the correct proportions in which to mix the materials required. The processes of manufacture of the blocks were described.

J. R. C.

96. The Calculation of the "Rational Analysis" of Clays.

HENRY S. WASHINGTON (*J. Amer. Cer. Soc.*, 1918, 1, 405).—By far the greater number of clays of any notable commercial value contain the four minerals kaolin, quartz, feldspar, and mica. As each of these influences the "burning" and other properties of a clay and of the finished products, it is of importance to be able to estimate the relative amounts of each present in any given clay, so that the proper mixtures may be made or the proper temperature and other conditions may be controlled.

The "rational" analysis aims at the estimation of the amounts of the different minerals that are present in a clay, and seeks to attain its object by treatment of the clay with various strong reagents, particularly hydrochloric and sulphuric acids and alkali hydroxides. Following Mellor, the essential features of the "rational" analysis are: digestion of the clay with hot concentrated sulphuric acid and subsequent washing, alternatively with alkali and hydrochloric acid, to remove the "clay substance." This may be preceded by treatment with hot alkali to remove soluble silica, or with dilute hydrochloric acid to remove the carbonates, and it may be followed by evaporation of the residue with hydrofluoric acid to remove quartz and other silica, and determination of alumina, which is used as a basis for the calculation of the feldspar present. Factors that will seriously influence the results are: the chemical composition of the mineral treated, the size of the grain, the concentration of the reagent, the length of time during which the material is treated, the temperature at which the mixture is treated, and whether this is attained suddenly or gradually or is uniform or varied during treatment. One can only consider, then, that the methods of "rational" analysis can furnish little but approximate and uncertain, and probably more or less erroneous and misleading, information. It would seem better, therefore, to call such an analysis "modal," as it aims at determining the "mode" or universal composition.

In contrast with the uncertainties of the "rational" analysis, the "ultimate," or what is better called the "chemical," analysis can be carried out with ease and great accuracy and its results stated in terms of the constituent oxides, may, the author believes, be readily reduced to mineralogical terms by a simple process of calculation that will yield information as to the mineral composition of a clay far more accurate and certain than the information furnished by the usual "rational" analysis, even when the latter is properly executed and the calculations are correctly made.

The paper suggests a simple and expeditious method of calculating the mineral composition of a mixture of silicates from the chemical analysis, and describes a modification adapted to the mineralogical characters of clays. Stated briefly, the principle consists in utilising our knowledge of the various molecules which the constituent oxides are capable of forming, and in considering the minerals present in the rock or clay as made up of such molecules, the actual minerals into which the molecules combine being dependent on the conditions and being in accordance with our knowledge of the occurrence of minerals in rocks.

The chemical ("ultimate") composition of a clay is expressed as made up of silica (SiO_2), alumina (Al_2O_3), ferric oxide (Fe_2O_3), magnesia (MgO), lime (CaO), potash (K_2O), soda (Na_2O), water (H_2O), with sometimes small, but possibly notable, amounts of titanium dioxide (TiO_2) and carbon dioxide (CO_2), and very small and negligible amounts of other constituents. In mineralogical or "modal" composition ("rational"), all clays are essentially mixtures of kaolin ($\text{Al}_2\text{O}_3, 2\text{SiO}_2, 2\text{H}_2\text{O}$), and, expressed below by the symbol Kl, quartz=Q, and the feldspars, orthoclase=Or ($\text{K}_2\text{O}, \text{Al}_2\text{O}_3, 6\text{SiO}_2$), albite=Ab ($\text{Na}_2\text{O}, \text{Al}_2\text{O}_3, 6\text{SiO}_2$), and anorthite=An ($\text{CaO}, \text{Al}_2\text{O}_3, 2\text{SiO}_2$), and, in some clays, small amounts of muscovite=Mn ($\text{K}_2\text{O}, 2\text{H}_2\text{O}, 3\text{Al}_2\text{O}_3, 6\text{SiO}_2$). The problem is to express the chemical composition of a clay in the terms of the minerals kaolinite, quartz, and the three feldspars.

From the analysis of a mineral, the formula is found by reducing the constituents to molecules and finding the ratios of these. Suppose that the composition by chemical analysis is:—

	Percentage composition.	Molecular composition.
SiO_2	63.36	1.056
Al_2O_3	23.76	0.233
Fe_2O_3	0.52	0.003
CaO	0.69	0.012
Na_2O	0.97	0.016
K_2O	1.63	0.017
H_2O	9.07	0.504

Here (assuming the absence of calcite) the lime (CaO) forms part of residual anorthite ($\text{CaO}, \text{Al}_2\text{O}_3, 2\text{SiO}_2$), or possibly one of the calcic zeolites, which contain hydrated anorthite molecules. The soda (Na_2O) forms part of residual albite ($\text{Na}_2\text{O}, \text{Al}_2\text{O}_3, 6\text{SiO}_2$), or possibly may form part of sodic zeolite, in which hydrated albite or nephelite molecules are present, the difference in silica content of which is of negligible moment. The ferric oxide may be assumed to be present as limonite ($\text{Fe}_2\text{O}_3, \text{H}_2\text{O}$), the most common of the hydrated ferric oxides. The calculation is briefly done thus: After calculating the orthoclase, albite, and anorthite, the remaining alumina serves as a basis for calculating the kaolinite; the ferric oxide is the basis for calculating limonite; the silica remaining from the orthoclase, albite, anorthite, and kaolinite is

the quartz, and the water remaining from the kaolinite and limonite is moisture. The calculation is represented thus:—

Orthoclase	=	556×0.017	=	9.45	per cent.
Albite	=	524×0.016	=	8.33	"
Anorthite	=	278×0.012	=	3.34	"
Kaolinite	=	258×0.188^1	=	48.50	"
Limonite	=	178×0.003	=	0.53	"
Quartz	=	60×0.458^2	=	27.48	"
Moisture	=	18×0.125^3	=	2.25	"
				<hr/>	
				99.88	

$$^1 0.188 = 0.233 - (0.017 + 0.016 + 0.012).$$

$$^2 0.458 = 1.056 - [(6 \times 0.017) + (6 \times 0.016) + (2 \times 0.012) + (2 \times 0.188)].$$

$$^3 0.125 = 0.504 - [(2 \times 0.188) + 0.003].$$

If carbon dioxide is found, it is assumed to be present in calcite; an equivalent amount of CaO is allotted to the CO₂ for calcite, the calcite is then reckoned by multiplying the molecular number of CO₂ by 100, and the rest of the lime is calculated to anorthite, as above.

Magnesia (MgO) may be assumed to be present in chlorite, a complex mineral, or rather mineral group, into which biotite usually enters; but it is best treated on the assumption that it enters serpentine (3MgO, 2SiO₂, 2H₂O), the unit of calculation being one-third of the molecular number of the MgO present. Any error involved will be quite negligible.

Muscovite may be present, though in small amount. Its composition may be considered as a mixture of orthoclase, alumina, and water, so that the percentage amount in a clay cannot be calculated from a chemical analysis alone if orthoclase and kaolinite are present also. However, as orthoclase and muscovite have about the same fluxing effect, it will serve all practical purposes to calculate the potash of any muscovite present as orthoclase and the alumina as kaolinite, some of the excess silica being taken for this. It is obvious that the separate determination of potash and soda is necessary for the proper calculation of the felspars.

A table of "rational" and "chemical" analyses of clays is appended, which shows that these two modes of analysis do not generally agree; indeed, some of them are hopelessly incongruous, and, in the author's opinion, the so-called "rational" analysis is quite untrustworthy.

C. M. M.

97. The Porosity and Volume Changes of Clay Fire-brick at Furnace Temperatures. GEORGE A. LOOMIS (*J. Amer. Cer. Soc.*, 1918, 1, 384).—Failure to classify clay fire-bricks satisfactorily has, in the author's view, been due in part to the fact that clay refractories are used under such a variety of conditions. It is generally conceded, however, that refractoriness is a primary requisite of a fire-brick for general use. The other properties, such as ability to resist abrasion or the penetration of slags, may be said to be of secondary importance.

Of the several tests of refractoriness, the three which have been used the most are: the chemical analysis, which gives a theoretical indication of refractoriness, the direct determination of the so-called "softening point," and the determination by an actual "load test" of the ability of a fire-brick to resist deformation under loads at high temperatures. Another test, which has not been used very extensively in the case of fire-bricks, is the determination of the porosity and volume changes on heating the bricks to different temperatures. A decrease in porosity and volume indicates the progress toward vitrification. Over-firing is then indicated by an increase in porosity and by an increase in volume as the vesicular structure accompanying over-firing is developed. The value of this test is all the more evident when it is realised that the degree of vitrification, as shown by the changes in porosity, also represents the amount of softening which must necessarily take place in the process of vitrification. Marked softening of the mass of the brick means decreased resistance to deformation.

A study of the data obtained shows some interesting relationships between the porosity and volume changes and the results of the load tests. In nearly all cases of brick which successfully withstood the load test—showing a deformation of not more than 5.55 per cent.—there was comparatively little volume change by either expansion or contraction up to 1425°, whilst a considerable number of the bricks which failed in the load test showed very appreciable volume changes. Similarly, the porosity decrease in the case of bricks which passed the load test is not large, whilst many of those which failed show considerable decrease in porosity at some point below 1425°. In many cases, over-burning of the brick of poorer grade is distinctly evident from the volume and porosity changes. The sudden and more or less pronounced expansion at the lower temperatures of firing, in the case of some of the bricks, is certain evidence of over-burning, which was confirmed by the results in the load tests. An abrupt increase in porosity at the same or at a slightly higher temperature is usually noted in such cases. Invariably, such bricks failed in the load test. Bricks which showed either marked volume change or a considerable decrease in porosity also failed to withstand the load test. It would seem, then, that the volume and porosity changes of clay fire-bricks might serve in some measure as a criterion of their ability to withstand load at high temperatures.

C. M. M.

98. The Tensile Strength of Raw Clays. H. RIES (*Trans. Amer. Cer. Soc.*, 1904, 6, 79).—During the air shrinkage of a clay, the particles draw together into a close mass, and this air-dried body is hard enough to suggest that the grains must be tightly packed, if not interlocked. Equal sized grains are not capable of becoming packed into a dense, tight mass, but variation in grain size permits the pore space to be filled in. The tensile strengths of five clays, of different mechanical compositions, were determined.

Diameter of grains in mm.	Percentages of each grain size.				
	Clay 1.	Clay 2.	Clay 3.	Clay 4.	Clay 5.
0.005—0.0001	87.96	30.645	22.00	44.00	59.00
0.01—0.005	6.95	14.21	5.66	7.11	11.00
0.25—0.01	3.00	5.585	26.55	24.35	14.70
0.5—0.25	1.00	6.400	11.45	7.80	3.50
1.0—0.5	—	42.95	33.44	16.35	11.40

Tensile Strengths in lb. per square inch.

Clay No. ...	1	2	3	4	5
	20	105	289	297	453

From this table it appears that an excessive amount of small clay particles or a large percentage of sand grains (1.0—0.5 mm.) weakens the strength of the air-dried clay.

J. R. C.

99. The Measurement of Plasticity and Textile Strength.

E. C. STOVER and J. LINDLEY (*Trans. Amer. Cer. Soc.*, 1905, 7, 397).—The apparatus used for determining plasticity consisted of a hollow brass tube 2 inches in diameter and 12 inches long, made conical at one end, and provided with a screw cap $\frac{3}{8}$ inch in diameter, to which brass collars with various sized holes could be secured. The clay to be tested was made into a roll and placed in the cylinder beneath a plunger, which was forced down until the clay was squeezed slowly through the hole in the bottom disc. A cord of clay thus hung down, finally breaking under its own weight. The more plastic the clay the greater the weight required to break the cord. The method gave uniform results.

In the tensile stress test the cross-breaking strain was measured, a cylinder being prepared, 3 inches long and ends 1 square inch in area, and the couple required to break it ascertained.

J. R. C.

100. The Occurrence of High-grade American Clays and the Possibilities of their Further Development.

H. RIES (*J. Amer. Cer. Soc.*, 1918, 1, 446).—Before the Great War, clays from Central Europe, used in the manufacture of glass pots, graphite crucibles, enamels, etc., and the china and ball clays of England, were imported by the United States. Investigations, partly urged by war necessity, had, however, shown that the United States could supply satisfactory refractory clays of high bonding strength, suitable for fire-bricks, glass-pots, crucibles, etc., and that it has a considerable reserve of kaolins. A single clay may not have all the desired properties, but judicious blending of two or more clays may often yield a mixture having the desired properties. The high-grade clays were mostly located in the eastern half of the United States, whilst some clays of value occurred in the west; they had not been drawn upon by factories. Detailed results were promised in a bulletin of the United States Geological Survey.

A. M. J.

101. The Nature of the Air Content of Pugged Clays.

H. SPURRIER (*J. Amer. Cer. Soc.*, 1918, 1, 585).—The author described a simple apparatus devised to secure any desired amount of the gas occluded in clay, and consisting of a large glass funnel inverted and equipped with a tube of 30 mm. internal diameter and suitably drawn out at both ends. The upper end is bent and capable of being connected to ordinary gas-collecting tubes. The funnel is immersed in water contained in a large iron bath; air is expelled from the tube, which then fills up with water. In an actual test, samples of pugged clays are slipped under the funnel, when the air contained in them rises into the tube and is collected, the clay being added until a sufficient quantity of gas is collected.

The following represents the composition of a sample of collected gas:—

Carbon dioxide	3.85 per cent.
Oxygen	13.46 "
Carbon monoxide	1.92 "
Nitrogen	80.77 "

100.00 per cent.

The chemical changes in the gas are connected with the physical changes which take place during the ageing and weathering of clays. It is suggested that some study of the changes of chemical composition of the gases would throw light upon the question of the plasticity of the clay.

A. M. J.

102. The Moulding of Clay Goods. (Brit. Pat. No. 111762).

B. J. ALLEN (February 15th, 1917, No. 2252).—Articles of clay, plumbago, silica, or the like are made by deposition from suspensions by electric endosmose on plaster or other porous moulds. The substance is mixed with liquid, with the addition of acid or alkali, and introduced into the mould. One metal electrode plate *B* is attached to the outside of the mould *A*, and the other electrode, *D*, is placed inside, the polarities being determined by the character of the substance. By reversing the current for a period or periods, or by varying the pressure, the porosity of the deposit may be increased. Deposits of varying thickness may be produced

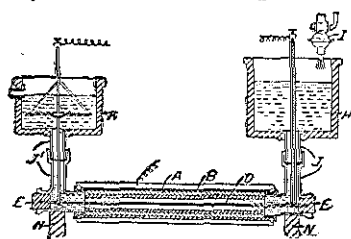


Fig. 8.

by placing plates of opposite polarities against different parts of the outside of the mould and operating as described in Specification 110649. Reversal of the current may also be employed for detaching the deposit from the mould. Superfluous liquid may be siphoned off and the residual moisture absorbed by the mould or extracted by a vacuum jacket, as described in Specification

110649. The apparatus shown is for making silica tubes. A suspension flows from a pipe, *I*, and vessel, *H*, through porcelain,

etc., tubes, *J*, to the mould, which is supported by insulators, *N*. Water escapes by pipes *J*¹ and a vessel *K*. Electric conductors pass through the vessels *H*, *K* to the interior electrode, *D*, which is held by non-conducting plugs, *E*. An apparatus for making Woulff's bottles, retorts, and stills has the absorbent mould enclosed in a vacuum chamber; the separated liquid is removed from the interior of the mould through perforated inner electrodes.

H. G. C.

103. The Moulding of Clay Goods. (Brit. Pat. No. 111775). B. J. ALLEN (March 3rd, 1917, No. 3160).—Articles of clay, plumbago, silica, alumina, etc., are made by deposition from suspensions on metal moulds by electric endosmose. The suspension may be acid or alkaline, and may be poured into a type-metal mould (*a*) within which are hung one or more brass or other plates, or perforated tubes (*c*), forming the opposite electrode. Clear liquid may be siphoned off by tubes (*d*) from within the internal electrodes. These tubes may pass through charging funnels (*f*), being protected by insulation (*g*), and may be provided with terminals. The density of the deposit increases with the electric pressure. Reversal of the current facilitates removal of the completed article. The mould shown is for the production of Woulff's bottles. Crucibles, cores, tubes, muffles, basins, flasks, etc., also may be made.

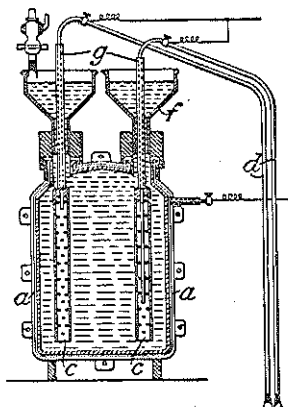


FIG. 9.

H. G. C.

104. Heat Conductivity of Refractory Clays. H. A. WHEELER (*Trans. Amer. Cer. Soc.*, 1904, 6, 119).—Experimental determinations were made of the heat conductivities of a number of clays. The method employed was to maintain one side of a slab of the clay at a constant high temperature, periodically noting the temperature of the other side. Data were thus obtained from which inferences could be drawn respecting the effect of various factors, namely, thickness, specific gravity, porosity, grog, and shape. The rate of heat conductivity varies inversely as the thickness. The effects of variation of specific gravity and porosity appeared to be small, and could not be estimated. The data indicated that an increase in the amount of grog decreases the heat conductivity, whilst a convex shape given to the test-piece increases the thermal gradient.

J. R. C.

105. The Action of Grog in Ceramic Bodies. S. GEIJSEBEK (*Trans. Amer. Cer. Soc.*, 1905, 7, 133).—The shrinkage and porosities of a number of clays with varying percentages of grog were

determined. It was found that the size of the grain of the grog had no effect on the shrinkage or porosity, provided the percentage of grog remained the same. An increase in the percentage of grog did not give rise to a proportional decrease in shrinkage nor a proportional increase in porosity. The first 10 per cent. addition of grog to a clay reduced the shrinkage and increased the porosity far in excess of any subsequent increase of the percentage of grog, and the effect of an increase of the percentage was less the higher this percentage.

In a discussion on the paper, many members stated that they found the shrinkage with fine grog to be a little more than with coarse. Others confirmed the author's statement. J. R. C.

106. Composition of Refractory Silica Bricks. J. S. McDOWELL (*Eng. and Min. J.*, 1918, 105, 954).—A completely inverted brick should contain about 87 per cent. of tridymite and 13 per cent. of silicates. Apparently sixteen or seventeen burnings, or one continuous burning for a month, would be needed to reach this composition, so that the cost is prohibitive. So far as permanent expansion is concerned, there is little advantage in more than one burning, and, for practical purposes, none after the third burning. The author considers Wernicke and Wildschrey's statement that ordinary quartzites do not produce good silica bricks to be too sweeping, yet he confirms their general conclusion that the finer grained quartzites with a cement of amorphous silica are the most suitable for making bricks. He also confirms their statement that the selection of rock of the proper texture offers greater possibilities for the production of the best (*tridymite*) bricks than any alteration in the process of manufacture. A coarse texture brick spalls less than one composed of fine grains, but insufficient grinding may induce other defects. As there are often wide variations in the textures of quartzites of the same geological location, the averages of a sufficiently large number of grain-size measurements should be taken.

C. M. M.

107. Silica Refractories. D. W. Ross (*J. Amer. Cer. Soc.*, 1918, 1, 477).—Silica bricks are made from quartzites of early geologic age, the most suitable ones ranging from the slightly porous to the highly metamorphosed, impervious rocks having tightly interlocking grains. If a thin section of a highly metamorphosed rock be viewed under the microscope, the interstitial impurities appear as sharply defined lines, whilst in slightly metamorphosed rocks the interstitial material appears as translucent, cloudy areas. Those quartzites which are crushed largely by a breaking through of the original grains are apt to yield silica brick of lower porosity than those in which the breaking is largely through the interstitial material between the built-up grains or those in which the original grains break free from the interstitial material.

Innovations in the methods of manufacture may be advisable in

special cases in order to obtain greater uniformity of product. One such innovation is to control the grinding so that the percentages of the various sized particles in the mixture will remain constant at all times, and then to machine-mould the brick at a pressure of approximately 1,500 lb. per square inch in order to obtain a brick of smooth finish and of uniform size.

The porosity of a finished silica brick depends primarily upon the porosity of the unburned mixture. The heating of bricks which contain large percentages of unchanged quartz to temperatures above 1350° causes undue expansion, resulting in a more porous product. If, however, the temperature of the kiln be kept at 1250° to 1350° until a large percentage of the quartz has been transformed, and then slowly proceeding to higher temperatures, the bricks should have both a low porosity and a low specific gravity.

The specific gravity of a silica brick, as determined by the wet, dry, and suspended weight method, gives a means of judging the degree to which the original quartz has been transformed, but to obtain a comprehensive idea of the qualities of any silica brick, the chemical composition, porosity, cold cross-breaking strength, softening temperature, behaviour under load, and appearance in thin section under the microscope should also be determined.

A. M. J.

108. The Partial Purification of Zirconium Oxide. A. J. PHILLIPS (*J. Amer. Cer. Soc.*, 1918, 1, 791).—The problem investigated was to reduce the iron oxide content of crude zirconia to less than 0.1 per cent. without removing silica, alumina, and titanium oxide.

The crude material was ground to a fineness such that 75 per cent. passed a 100-mesh sieve.

Fusion with various fluxes, for example, Na_2SO_4 , NaCl , NaF , fluorspar, and borax gave unsatisfactory results, as also did treatment with hydrochloric acid gas. The most successful results were obtained by mixing the zirconia with 4 per cent. of carbon, moulding the mass into small balls, and heating these in a current of chlorine gas in a vertical up-draught furnace.

The author concludes that an injection of low-pressure steam along with the chlorine would probably yield the most satisfactory results. It was found that the size of the balls was relatively unimportant, balls of $\frac{1}{4}$ inch and 1 inch diameter being chlorinated at the same rate and equally completely. The iron is volatilised as ferric chloride, the residue remaining in two samples treated being 0.04 per cent. and 0.03 per cent. respectively. The loss of zirconia through chlorination was about 5 per cent. in one case and 0.5 per cent. in the other.

J. H. D.

109. Production of Highly Refractory Ware from Non-argillaceous Materials, particularly Zirconia. H. ARNOLD (*Chem.-Zeit.*, 1918, 42, 413, 426, 439).—Pure zirconia melts at

about 2600° , has a coefficient of expansion of 8.4×10^{-7} , is highly insensitive to sudden changes in temperature, readily dissolves other oxides, and has an electrical conductivity of 0.0008 at 1200° , which is increased to 0.00255 recip. ohm by adding 1 mol. of Al_2O_3 to 9 mols. of ZrO_2 , to 0.0075 at 1000° if the alumina is replaced by CeO_2 , and to 0.0358 at 1287° if replaced by Fe_2O_3 . The author finds that the use of any fluid in pressing zirconia ware is detrimental, and recommends pressing the cold zirconia dry at 300 atm. on the hot material at 50 atm. A mixture of raw and highly calcined zirconia should be used, and as soon as the articles are dry they may be burned in an electric furnace at 2000 — 2300° , only about one hour being required for crucibles 2 in. high and $1\frac{1}{8}$ in. diam. The addition of a small percentage of alumina or clay is advantageous, but magnesia and silica make the ware too porous. Articles made of zirconia may be cast in plaster moulds, using a slip composed of graded zirconia and colloidal zirconia solution, the latter being prepared by repeatedly evaporating zirconium nitrate with twenty times its weight of water. The author measured the speed of translation of the particles of colloidal zirconia solution, and found that the speed is seriously affected by electrolytes in the zirconia. The plasticity of zirconia slip and the ease with which it leaves the mould are related to its electrical properties. The proportion of water in the slip must be regulated according to the rate at which it is to be absorbed by the mould. Non-porous moulds may be used if they have a low coefficient of expansion and are lined with wax or other readily fusible or soluble material, which may be removed before the article. Ware with walls only a fraction of a mm. thick may be cast in this manner. Zirconia ware should be supported on discs of carbon or zirconia and burned in an electric resistance furnace at 2000° ; if burned at a higher temperature, its porosity is increased by the volatilisation of a further part of the impurities. Vessels of clay or other refractory materials may be lined or coated externally with zirconia, but such a method of protection has only a limited applicability. Hitherto, zirconia ware has not been glazed satisfactorily; a glaze composed of felspar 222.4, alumina 40.8, zirconia 147.6, magnesite 50.4, and quartz 69.6 parts burned on the ware at 1900 — 2000° is fairly satisfactory and does not craze, but is rather matt and liable to blister. There is a strong tendency for the zirconia to combine with glazes melting at a lower temperature, although when the product is sufficiently refractory they may be used.

C. M. M.

110. Furnace Linings. (Brit. Pat. No. 111007). I. HALL, Jan. 31st, 1917, No. 1558).—Crucible and like furnaces are lined and relined by means of a core, the bottom part of which is enlarged and adapted to form a combustion chamber. The core is placed in position in the furnace and packed round with refractory material. The larger part may be separated from the rest of the core and made in segments to facilitate withdrawal. The tangential inlet or

inlets into the combustion chamber may be formed by separate cores inserted from the exterior to fit apertures in the main core, and they may also be made collapsible like the lower part of the main core.

H. G. C.

111. Refractory Substances for Furnace Linings. (Brit. Pat. No. 111853). H. A. KENNEDY, *Pennsylvania, U.S.A., Clearfield*, (November 26th, 1917, No. 17454. Convention date, November 28th, 1916. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—A refractory material for furnace linings, etc., is made by clinkering, at a temperature higher than that employed in the manufacture of Portland cement, a finely divided and intimate mixture containing approximately 78–92 parts of CaO and MgO, 2–13 parts of SiO₂, and alumina or iron oxide, or both. To a certain extent, alumina and iron oxide may be replaced by silica or, in their place, basic slag, blast-furnace slag, bauxite, chrome iron ore, etc., may be employed. Magnesium limestone or dolomite is preferred as the source of CaO and MgO. The limestone may be first calcined and hydrated, and the materials may be mixed wet or dry. The heating is preferably effected in a rotary kiln by means of a powdered fuel flame, the kiln being inclined less or rotated more slowly than a cement kiln, so that the period of burning will be greater. The product is finally cooled in a cooling cylinder, and is then ready for use. H. G. C.

112. The Firing of Refractory Materials. (Brit. Pat. No. 111355). A. REYNOLDS (December 4th, 1916, No. 17397).—In the manufacture of refractory bricks, etc., coherence is imparted to the article by subjecting the working surface or surfaces, after the usual burning, to a temperature sufficiently high to produce incipient fusion. Bricks are bedded in the floor of a furnace with the working surface uppermost, and the spaces between them are filled with a ramming of highly refractory material, such as chromite, plumbago, or ground carbon and tar, for example, fine coke and tar. For ladle nozzles, the articles are mounted in the end of a revolving furnace to prevent falling off of the incipiently fused portions. Fig. 10 shows a furnace (a) mounted on rollers (b) and lined with plumbago pieces, f, g, h, i, backed by spongy fire-brick (e) or other bad conductor. The nozzle (k) is mounted in the piece (g) on a fire-clay bedding (l). Stoppers for ladles are treated by mounting the article in a rod and revolving it within a horizontal passage in the fur-

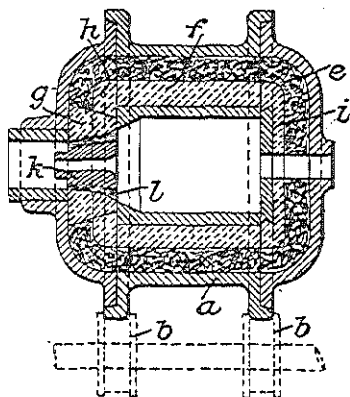


FIG. 10.

nace hearth, such passage being of slightly larger diameter than the article and communicating through slotted holes with the

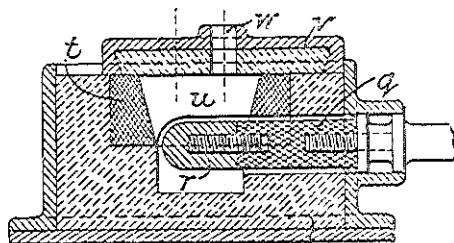


FIG. 11.

furnaces above and the atmosphere below, so that, as the article is revolved, its surface is subjected alternately to heating and cooling. Fig. 11 shows a suitable furnace lined with fire-brick (s) in which there is a stoppered cavity containing a block (t) of plumbago, etc., provided with a slot (u), above which is a sliding cover (v) provided with a suitable burner opening (w). The stopper (r) is mounted on a refractory rod (q) in a cavity communicating with the atmosphere through lateral passages.

H. G. C.

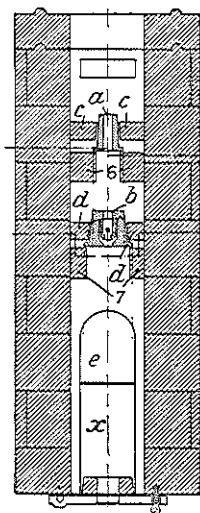


FIG. 12.

113. Nozzles for Coke Ovens. (Brit. Pat. No. 111053). D. BAGLEY, May 31st, 1917, No. 7800).—Comprises modifications in the nozzles which supply gas and air to the flues of coke ovens and like furnaces with vertical or horizontal series of flues. As shown in connection with a vertical-flued coke oven, gas is supplied through a tapering conduit (e) (Fig. 12) and passes to each heating flue through two nozzles, the lower of which (b) serves to regulate the quantity of gas supplied.

H. G. C.

114. Heat Insulation and Lagging Materials. J. S. F. GARD (*Chem. Trade J.*, 1919, 64, 47).—Magnesia was found to be the most efficient lagging material for boilers, steam-pipes, and engines. In the form of "magnesia covering," which is the most suitable form, it is composed of hydrated magnesium carbonate, 85 per cent., and asbestos fibre, 15 per cent.; it

has a density of 12–15 lb. per cub. ft., and will retain 85–87 per cent. of the heat which would escape from an uncovered pipe. Silicate cotton or slag wool is an efficient lagging material, but when subjected to vibration is reduced to half its original volume. Furnace settings are chiefly lagged with very light, porous silica bricks having a honeycomb structure and a density of 30–35 lb. per cub. ft. (compared with 112–125 lb. for common bricks and 137–150 lb. for firebricks). The graph representing the ratio of heat loss to thickness of covering of magnesia is almost hyper-

bolic, so that complete insulation is impossible. For a temperature of 400° F. (204.5° C.), covering more than 1½ in. thick is of little additional value. Above 400° F. a thickness of 2 in. is necessary. Where an acid-resisting lagging is required, magnesia covered with an acid-resisting coating was found to be best.

C. M. M.

115. Regenerative Coke Ovens. (Brit Pat. No. 111801). D. BAGLEY (May 18th, 1917, No. 7138).—A regenerative oven with vertical heating flues has regenerators above and below each coking chamber extending along the length thereof, which operate alternately to heat the air supplied for combustion in the heating

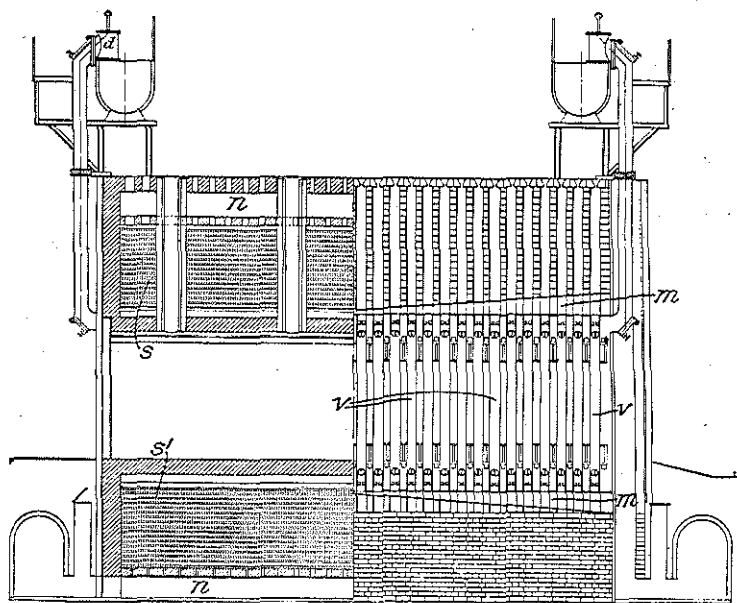


FIG. 13.

flues according to the direction of combustion therein, whether upwards or downwards. Gas is supplied to the heating flues (*v*) either from below or from above through conduits (*m*), being delivered through removable nozzles (Fig. 13). Air is admitted to the lower regenerator (*s*) through a conduit (*n*) with openings into the regenerator, which increase in diameter from the admission end of the conduit, and is supplied to the heating flues near the bottom thereof through channels in the walls having outlet ports at two levels. Similar air-supply conduits and channels are provided for the upper regenerator (*s*) for use when downward combustion is being effected. Suitable reversing valves are provided. With

upward combustion, the waste gases pass into the upper regenerators, either through the channels which supply air for downward combustion, or directly from the tops of the heating flues, in the latter case entering the upper regenerators at the top and passing downwards therein. The air may pass to the upper regenerators through passages in the arches of the coking chambers.

H. G. C.

116. Heat Balance on a Producer-gas Fired Chamber Kiln. R. K. HURSH (*J. Amer. Cer. Soc.*, 1918, 1, 567)—The data are based on tests made at the plant of the Baker Clay Company at Grand Ledge, Michigan, in the summer of 1917.

The equipment tested consisted of a kiln of sixteen chambers, each having a capacity of fifty to fifty-five thousand standard-sized bricks, and three 6-feet, water-sealed gas-producers of the pressure type.

Coal was weighed separately for each producer, and an average sample was reserved for analysis. Ashes were removed from the pits every other day, and a sample taken for analysis.

The steam pressure at the blowers of the producers was taken at hourly intervals, and the diameter of the orifice in the blower measured.

From the average pressure and the area of the orifice, the steam consumption was calculated by means of the Grashof formula. Samples of hot producer-gas were collected through a glass-lined sampling tube inserted in the gas main a short distance from the header. (No attempt was made to determine the soot and tar.) The temperature of the producer-gas was measured at the point of sampling by means of a base metal thermocouple. The temperature and humidity of the atmospheric air were determined by means of wet- and dry-bulb hygrometer readings. Temperatures in the tops of the kiln chambers were measured by means of a platinum-platinum-rhodium thermocouple inserted through the crown holes. Flue-gas samples were taken from the main draught flue near the point of delivery from the kiln. The temperature was measured at the same point with a silver-constantan thermocouple.

The test covered the period of firing one chamber forty-four hours from the time the fires were started in it until its finish and the beginning of firing in the next chamber.

The following calculations were recorded:—

A. For the Producer.

- (1) Volume of producer gas (4.73 cb. m. per 1 kg. of coal).
- (2) Volume of dry air used (3.79 cb. m. at *N.T.P.* per kg. of coal).
- (3) Moisture entering producer with the air (0.039 kg. per kg. of coal).
- (4) Steam used in producers, calculated from the Grashof formula, $M = 0.0165 F p^{0.75}$, where M = lb. steam flowing per sec., F = area of orifice in sq. in., p = absolute pressure of steam in lb.

per sq. in. (0.284 lb. of steam per lb. of coal, or kg. of steam per kg. of coal).

The moisture entering the producers from the moisture and combustion of hydrogen in the coal was $0.0258 + 0.039 \times 9 = 0.377$ kg. per kg. of coal. The total moisture entering the producers from all sources was therefore $0.039 + 0.284 + 0.377 = 0.700$ kg. per kg. of coal fired.

(5) Free moisture in producer gas = difference between total moisture and the moisture equivalent of the free and combined hydrogen in the gas (0.263 kg. of free moisture in gas per kg. of coal fired).

(6) Calorific value of producer-gas from analysis (5095 Cals. per kg. of coal fired).

(7) Sensible heat of producer-gas. The average temperature of the producer-gas was 575° , and the average specific heats were obtained from the formulæ of Langen (991 Cals. per kg. of coal fired).

Total heat content of hot producer-gas = $5095 + 991 = 6086$ Cals. per kg. of coal.

(8) Heat supplied to producers.

Heat content of dry air (av. temp. 17.5°) = $4.9 \times 0.241 \times 17.5 = 20.8$ Cals. per kg. coal.

Heat content of moisture = $4.9 \times 0.00801 \times 604 = 23.7$ Cals. per kg. of coal.

Heat content of steam (assuming it to be saturated at average pressure) = $0.284 \times 644 = 183$ Cals. per kg. of coal.

The calorific value of the coal was 7108 .

\therefore Total heat supplied to producers = $7108 + 23.7 + 20.8 + 183 = 7335$ Cals. per kg. of coal.

\therefore Hot gas efficiency = $6086 / 7335 = 82.97$ per cent.

(9) The heat lost in unburned carbon in the ashes was 50 Cals. per kg. of coal.

(10) The heat losses due to conduction, radiation, etc., were determined by difference, and amounted to 1199 Cals. per kg. of coal.

This gives the heat balance of the gas-producers, which when tabulated is as follows:—

Heat in producer-gas calorific value plus sensible heat, 82.97 per cent.

Loss due to conduction, radiation, etc., 10.35 per cent.

Loss due to unburned carbon in ashes, 0.68 per cent.

B. For the Kiln.

(1) Volume of flue-gas and air used in kiln.

(2) Sensible heat of flue-gas.

(3) Heat used for burning the ware.

The heat value of the hot producer-gas, the heat in the atmospheric air supplied to the kiln, and the heat from the combustion of carbon in the clay constituted the heat input for the kiln. If

this be 100 per cent., it was found that the heat required to raise the temperature of the clay and drive off water was 51.49 per cent. The losses due to sensible heat of flue-gas was 38.21 per cent., and losses due to conduction, radiation, etc., was 10.30 per cent.

Considering the kiln and producers as a unit, the total heat input from the coal used, air supplied to producers and kiln, and steam supplied to producers and carbon in the clay was 76,318,000 Cals. Of this amount, 43.59 per cent. went to the burning of the ware, 32.35 per cent. to the flue-gas, 8.72 per cent. to heat losses from the kiln, 14.72 per cent. to heat losses from the producers, and 0.62 per cent. loss was due to unburned carbon in the ashes.

A. M. J.

VIII.—Chemical Analysis.

117. Methods of Glass Analysis with Special Reference to Boric Oxide and the Two Oxides of Arsenic. E. T. ALLEN and E. G. ZIES (*J. Amer. Cer. Soc.*, 1918, 1, 739).—After a critical study of the determination of arsenic in glass in trivalent and pentavalent form, the authors describe the following as the best method:—

(a) *Total Arsenic*.—Fuse up 1 gram of glass with 3 grams of Na_2CO_3 and 0.1 gram of KNO_3 . Decompose the cake with 10 c.c. of 1:1 sulphuric acid (not hydrochloric acid, as this would volatilise some of the arsenic). Evaporate until white fumes appear, and continue the heating until the silica becomes dense. Cool the solution, add hot water, boil until any insoluble sulphates settle satisfactorily, and filter by suction. Add a small crystal of KI to the filtrate, heat, and precipitate the arsenic with H_2S in a flask. Stopper up the flask and allow to stand overnight. Filter off the As_2S_3 , and wash with warm dilute H_2SO_4 . Dissolve this precipitate with strong ammonia, and if any remains insoluble digest this with ammonia and ammonium carbonate, adding the soluble portion to the main arsenic solution. To this add about 5 c.c. of 3 per cent. hydrogen peroxide, and boil for some time on a hot plate until all the arsenic is oxidised and the excess of H_2O_2 decomposed. When the bulk is reduced to 10–15 c.c., acidify with about 7 c.c. of 1:1-sulphuric acid, and continue boiling for fifteen minutes. Transfer the solution to an Erlenmeyer flask, make up to 100 c.c. with hot water, add a small crystal of KI, insert a two-bulb trap in the neck of the flask, and boil until the free iodine has all been expelled and the bulk of the solution reduced to about 40 c.c. (It may be necessary to add more water and repeat the evaporation to 40 c.c. in order to drive off the whole of the iodine.) Dilute quickly with cold water to 75–100 c.c., and cool rapidly. Neutralise the bulk of the solution with a saturated solution of K_2CO_3 , completing the neutralisation with solid sodium

bicarbonate. Then add starch paste and titrate with a standard iodine solution containing 1.1 grams of I per litre.

In fourteen pairs of duplicate determinations the maximum variation was found to be 0.3 mg. and the mean variation 0.1 mg., using 1 gram of glass for each determination.

(b) *Separation of Tervalent and Pentavalent Arsenic.*—The sample is treated with HF and H_2SO_4 in a platinum crucible or small dish, the vessel being brought to a final maximum temperature of 200° . All the arsenious oxide is volatilised as trifluoride and all the arsenic oxide retained in the residue, in which it is determined by the Gooch and Browning method as above. The arsenic trioxide is determined by difference.

To verify the presence of trivalent arsenic, the authors distilled off the arsenic trifluoride as above, passed the gas into water, and determined the arsenic in solution. Positive results were obtained of the same order as the amounts found by difference.

Ferrous and ferric iron, and the small amounts of chloride usually found in glass, do not affect the determination.

Determination of Boric Oxide.—After testing the various methods used for the determination of boric acid, the authors conclude that Wherry's method, and its modification by Taylor and Sullivan, cannot be recommended for general use as a method of high accuracy, and state that their experience shows Chapin's method to be superior to all others, at any rate for the determination of boric oxide in glasses. The method is as follows:—

Fuse the powdered silicate with Na_2CO_3 , take up the melt with 1:1-HCl, and volatilise the liberated boric acid as methyl borate by distillation with methyl alcohol in presence of granular $CaCl_2$. Treat the distillate with $N/2$ - or $N/5$ -NaOH (according to the amount of boric acid present), and distil off the methyl alcohol. Treat the alkaline borate with HCl and heat under proper conditions to expel CO_2 . Finally, neutralise the excess of HCl with NaOH, using paranitrophenol as indicator, add mannite, and titrate the boric acid with standard NaOH, using phenolphthalein as indicator.

The authors confirm Chapin's statement that the method is trustworthy in presence of fluorides and oxides of zinc and arsenic (if in small quantity), and a blank determination indicated that no appreciable amount of boric acid was derived from the glass parts of the apparatus. (Probably this result would be different if fluorides were present.) A constant error was found to be due to traces of boric acid in the reagents used, and it is advisable to avoid excess of reagents as far as possible.

Commercial wood alcohol was not found to answer for the determination of boric acid. Impurities in the alcohol cause the sharpness of the end-point of the titrations to be obscured, and the results are only satisfactory when the methyl alcohol used is pure. If the substance contains large quantities of As_2O_3 , the boric acid determination becomes inaccurate or impossible unless the As_2O_3 is first oxidised to As_2O_5 in an alkaline solution.

Determination of Iron in Optical Glasses.—The method advocated is as follows:—

The sample should be pulverised in agate, and not steel. Decompose 2 to 3 grams of the glass with 3 c.c. of 1:1-sulphuric acid and 5 c.c. of hydrofluoric acid, cool, transfer residue to a beaker with water, and boil well. Filter and wash. (This precipitate may contain as much as 50 per cent. of the total iron.) Remove the arsenic and lead by precipitation with H_2S . If zinc is present, neutralise the solution with Na_2CO_3 , and add 0.3 to 0.5 excess of 50 per cent. formic acid before passing in H_2S . In a solution of this acidity, zinc sulphide is precipitated in a denser form than from alkaline solutions. The filtrate from the zinc sulphide is boiled to expel H_2S , and the iron precipitated by boiling with ammonia and hydrogen peroxide.

The insoluble sulphates are treated with hot ammoniacal ammonium acetate to remove lead sulphate, and the residue fused with potassium bisulphate. The iron is extracted by hot dilute H_2SO_4 and precipitated as above. The two iron precipitates are filtered and washed together, dissolved after fusion with bisulphate, and any trace of platinum in solution removed by H_2S , the excess gas being finally expelled from the solution by boiling in a current of pure CO_2 . The cold solution is titrated with standard permanganate, which is best standardised by sodium oxalate. A careful blank test on the materials is essential.

Determination of Zinc.—After removal of lead and barium as sulphates, arsenic and zinc may be precipitated together in a formic acid solution. The zinc sulphide is dissolved out by hot 1:1-hydrochloric acid, and the zinc determined by (a) adding a slight excess of sulphuric acid, evaporating to dryness, and weighing as sulphate, (b) precipitating the zinc as carbonate and weighing as oxide, or (c) expelling the HCl by boiling with H_2SO_4 , precipitating the zinc, and redissolving in excess of NaOH , acidifying the solution with acetic acid, and depositing the zinc electrolytically on a copper-coated platinum electrode.

Determination of Lead and Barium occurring together.—The authors state that they found it impossible to separate lead and barium sulphates satisfactorily with ammonium acetate, as some of the barium sulphate was invariably dissolved. They recommend determining lead and barium together as sulphates, and then determining the barium in a separate sample after removal of the lead, arsenic, iron, alumina, etc. It is pointed out that the barium sulphate always occludes some soluble sulphates, and the results are therefore slightly high.

If a direct determination of the lead is required, the glass is fused with sodium carbonate at the lowest possible temperature, the silica removed in the usual way, and the lead precipitated as sulphide, which is oxidised to sulphate by careful evaporation with nitric and sulphuric acids.

Separation of Aluminium from Barium and Calcium.—If an alkaline earth is present, the alumina precipitate with ammonia

should always be reprecipitated. One of the authors prefers to precipitate the alumina by ammonium sulphide the first time, by making the filtrate from the zinc and arsenic slightly ammoniacal, and allowing the solution to stand overnight. In any case, *every filtrate* from the alumina should be evaporated to a small bulk and refiltered to arrest any alumina which may have passed again into solution.

Analysis of Borate Glasses.—After the solution has been evaporated for the second time to remove silica, cool the dish, add 25 c.c. of methyl alcohol, and evaporate to dryness. Repeat the evaporation with methyl alcohol to ensure the complete volatilisation of the boric acid as methyl borate.

In the determination of alkalis by Lawrence Smith's method, it is recommended that the mixed chlorides of alkalis and ammonium should be evaporated with 10 c.c. of methyl alcohol, keeping the dish covered.

Some data are given on the subject of gases in glass, an example showing 6.55 c.c. of gas obtained from 6.57 grams of powdered glass, the gas having the following percentage composition:—oxygen, 64.2; carbon dioxide, 24.2; carbon monoxide, 3.5; hydrogen, 3.9; nitrogen, 4.1.

J. H. D.

118. A Study of the Sources of Error incident to the Lindo-Gladding Method for Determining Potash. T. E. KEITT and H. E. SHIVER (*J. Ind. Eng. Chem.*, 1918, 10, 994).—The authors' work proves that there are two sources of error in the Lindo-Gladding method for determining potash:—

(1) The volume of the solution is decreased by the bulk of the precipitate formed on addition of ammonia and ammonium oxalate, which makes a plus error.

(2) The potash in solution is decreased by occlusion of potash by the heavy gelatinous precipitate formed.

These two sources of error are partially compensating.

It is impossible to wash out with hot water the potash occluded within the precipitate, but it may be separated to a certain extent by repeatedly dissolving the precipitate in hydrochloric acid, diluting to a large volume, precipitating with ammonia and ammonium oxalate, filtering, and determining the potash in the filtrates and washings. The use of pure salts for making known strength solutions shows that both iron and calcium phosphate, when precipitated with ammonia, occlude potash, and that a combination of the two is even more effective in producing occlusion.

C. M. M.

119. Preventing Salts from Creeping. W. O. ROBINSON (*J. Amer. Chem. Soc.*, 1918, 40, 197).—The author states that if the inner rim of an evaporating dish be painted with a strip of collodion about $\frac{1}{4}$ inch wide, creeping is entirely prevented, and the collodion has the advantage that it dries immediately and leaves no residue on ignition.

J. D. C.

120. Solubility of Silica. V. LENHER and H. B. MERRILL (*J. Amer. Chem. Soc.*, 1917, **39**, 2630).—Silica, even in the form of quartz, is somewhat soluble in water and dilute acids, and various workers have recorded that a quantitative estimation of silica is in error, due to the solvent action of dilute hydrochloric acid.

The authors have carried out determinations of the solubility of silica in various solvents. By their procedure, what was measured was the amount of silica which changed from an unfilterable to a filterable state. The solvents used were hydrochloric acid of various strengths, sulphuric acid, conductivity water, and water saturated with carbon dioxide. Most of the experiments were made with gelatinous silica, but other forms were also tested. The solubility of silica was found to be definite and to depend both on the temperature and the concentration. With gelatinous silica, equilibrium was reached in a few hours, or at most days, but with ignited silica, saturation was not reached in days or weeks. The solubility of gelatinous silica was the same, no matter how prepared. The true solubility of ignited silica is probably the same as that of gelatinous, but this could not be tested in any reasonable length of time.

The paper contains numerous tables and graphs of results.

J. D. C.

121. Determination of Moisture in Coke. A. C. FIELDNER and W. A. SELVIG (*Chem. News*, 1918, **117**, 172).—Owing to the more stable character of coke as compared with coal, much simpler methods may be employed for the estimation of moisture in the former, and, in fact, it may be sampled and tested very much in the same way as iron ores. It was found that the influence of temperature, humidity of drying atmosphere, and fineness of sample are of comparatively small importance, and these factors may be varied over a considerable range. Coke can be dried to constant weight in an oven without undergoing any increase in weight during heating, and oven temperatures ranging from 105° to 200° produced a maximum variation in the moisture results of 0.3 per cent. The effect of the fineness of the sample was tested by making moisture determinations as:—(a) sample crushed to pass 60-mesh sieve and dried at 105°, (b) sample crushed to pass 4-mesh sieve and dried at 105–150°, and (c) lump coke placed on a galvanised iron tray to a depth of 2 inches and heated on a hot plate to 100–200°. Practically the same result was obtained in each case, thus showing that moisture determinations on small lump coke are sufficiently accurate for practical purposes, thus obviating the necessity for grinding, etc.

The only sources of error to be feared are those connected with the taking and preparation of the sample. The authors discuss a suitable procedure for this.

J. D. C.

122. Valuation of Lime for Various Purposes. R. K. MEADE (*J. Ind. Eng. Chem.*, 1918, **10**, 214).—Lime may be valued according to its chemical composition or its physical properties.

For building purposes and plastering, the physical properties are of highest importance, and the author discusses suitable tests for these. As regards chemical composition, the sum of calcium and magnesium oxides should amount to 90 per cent. for selected and 85 per cent. for average quicklimes. Quicklime for most chemical purposes is valued on the sum of the free calcium and magnesium oxides, although in some industries the presence of magnesia is objectionable. The methods for the titration of the free calcium oxide or hydroxide were discussed. Water free from carbon dioxide is recommended for use. Twenty-eight grams of the lime are boiled with water for ten minutes, and then diluted to 1 litre and agitated. Fifty c.c. of the well-agitated milk are drawn off and titrated, using phenolphthalein as indicator. In a modification of this method, a preliminary titration is made with $N/1$ -hydrochloric acid on a milk prepared by boiling 1.4 grams of the finely ground material with 80 c.c. of water. The test is then repeated, using 5 c.c. less acid than was found in the preliminary test. Any small lumps are ground up with the round end of a thick glass rod, the pink mixture is transferred to a 250 c.c. graduated flask, diluted to the mark, and allowed to settle for half an hour. One hundred c.c. are then withdrawn and titrated slowly with $N/1$ -hydrochloric acid, using phenolphthalein as indicator.

Other methods described are: Lunge's oxalic acid titration method; Spencer's cane-sugar method, using a cane-sugar solution of 35 to 45 per cent. strength to dissolve the calcium hydroxide; Solvay's method, in which a solution of ammonium chloride is employed, this method being very trustworthy, but requiring a reaction flask of special design; and another method, which is sometimes used in caustic soda manufacture, in which the value of the lime is determined by causticising sodium carbonate and precipitating the excess of the latter with barium chloride before titration.

J. D. C.

123. Estimation of Lead as Phosphate and its Separation from Antimony. G. VORTMANN and A. BADER (*Zeitsch. anal. Chem.*, 1917, 56, 577).—The following method is stated to give trustworthy results for lead and a good separation of lead from antimony.

A solution containing 0.3 gram of lead is treated with 5 grams of tartaric acid, then made slightly ammoniacal, heated to 80°, and 100 c.c. of 10 per cent. ammonium phosphate solution are then added. The mixture is kept at 70° to 80° for sixteen hours, then cooled, the precipitate filtered off, washed with dilute ammonium nitrate solution, dried, ignited at a low temperature, and weighed. The amount of tartaric acid should be increased if much antimony is present. The antimony can be precipitated as sulphide from the filtrate from the lead phosphate precipitate.

J. D. C.

IX.—Machinery for the Working of Glass.

124. Automatic Glass Bottle Machines. (Brit. Pat. No. 111868). A. WILZIN (October 11th, 1916, No. 14445).—Relates to glass shaping and blowing machines of the kind in which, after the introduction of the glass into the parison mould, the several and subsequent operations on the parison and on the finished bottle are performed automatically and in proper sequence, the duration of the several operations being capable of variation at will and independently, as described in Specifications 7183/12, 20299/13, and 3146/15, and comprises automatically controlled means for (1) submitting the parison to an automatically controlled temperature equalisation process, the duration of which may be varied at will by means of a controlling device with adjustable dogs, etc., which connect with or disconnect the machine from the source of power, (2) forcing the glass into intimate contact with the walls of the parison mould, and (3) expediting the stretching of the parison. The operator delivers a quantity of glass from his gathering-rod into the parison mould 55, the penetration of the glass to the neck mould 75 being ensured by the connection of the mould to a source of negative pressure air passing through a pipe 135, and through a passage adjacent to the indenting plunger 76. By then pressing a pedal, a clutch is coupled up and a loose control wheel 24 is caused to make one revolution. The control wheel 24 carries a series of depressions, pins, and adjustable dogs, which control the times and sequence of the various operations of the machine. The first movement of the control wheel 24 cuts off the air and allows a pair of spring-actuated shearing blades, 99, 100, to sever the glass hanging from the gathering-rod. The continued rotation of the control wheel 24 intermittently operates a clutch so as to produce intermittent rotational movements in a pair of cam discs, 4, 5, secured to shaft 3. The first movement of the cam discs, by operating a rack 60 gearing with a pinion 59, rotates the parison mould 55 through 180 degrees, the plunger 76 being withdrawn from the neck mould by a cam groove 79 on the frame, and the lower end of the parison mould being closed by a bottom mould. An adjustable dog on the periphery of the control wheel 24 opens a valve and allows high-pressure air to pass through the pipe 135 and act on the cavity formed by the plunger 76, thus pressing the whole surface of the parison into intimate contact with the walls of the parison mould and minimising temperature variations due to local contacts.

The air is cut off and the cam discs 4, 5, again rotate, thus causing the hinged halves of the parison mould to swing open and leave the parison supported by the neck and bottom moulds only. Whilst in this condition, the inner heat of the parison restores the surface to a more uniform temperature, the duration of this pause, as also the other steps in the process, being regulated by the adjustable dogs on the control wheel 24. A further movement of the

cam discs 4, 5 removes the bottom of the parison mould and brings the bottom mould 103 of the finishing mould into position, and the stretching of the parison commences, such stretching being assisted, if desired, by the admission of puffs of low-pressure air liberated by means of pins projecting from the control wheel. A still further movement of the cam discs 4, 5 closes the finishing mould about the parison, and the blowing is completed by re-

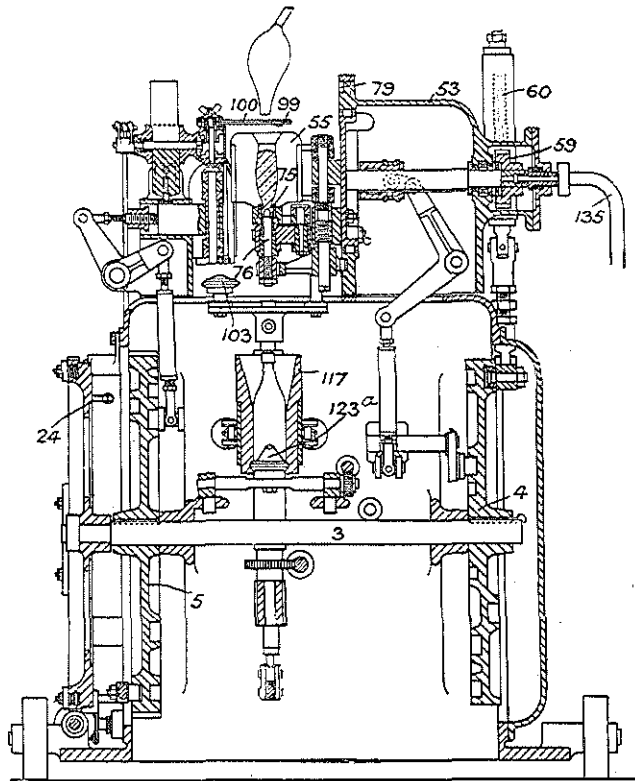


FIG. 14.

admitting the high-pressure air. On completing a whole rotation, the cam discs 4, 5 restore the various parts to their initial positions, and, by opening the finishing and neck moulds, drop the blown bottle into a divided cooling pot 117, whence, after the bottom of the bottle has been indented by a reciprocating spigot 123a, the bottle is tipped down a shoot. The hinged halves of the neck mould are held in closed position by a spring, and are opened to drop the bottle by the opening movement of the finishing mould. When dealing with bottles having internal screw-threads at the mouth, the plunger 76 is provided with a screw-thread of corre-

sponding pitch, and during its withdrawal is given a rotary movement by means of a gear connection, which is substituted for the cam 79.

H. G. C.

125. Automatic Glass Gathering. (Brit. Pat. No. 111701). A. WILZIN (December 4th, 1916, No. 17382).—Relates to a modification of the automatic glass-gathering device, shown in Fig. 16 of Specification 3146/15, wherein the molten glass is sucked into the parison mould 9 (Fig. 15) through a tube 4. According to the present invention, after removal of the parison mould, the tube is raised clear of the molten glass, thus allowing the furnace flames to pass through and around the tube, as shown in Fig. 16. The tube is

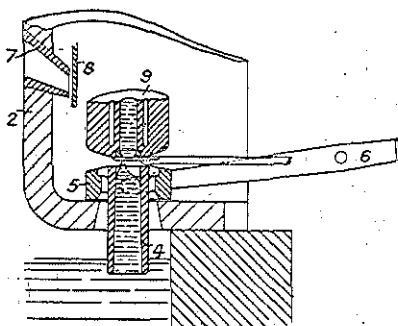


FIG. 15.

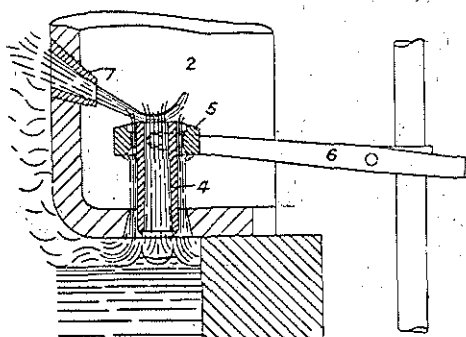


FIG. 16.

arranged within a pocket 2 projecting into the furnace, and is carried by internal projections on a collar 5 mounted on the end of a lever 6. The bore of the gathering tube is greater than that of the inlet to the parison mould, so that the rising glass forms an airtight joint between the two. The pocket 2 may be provided with a tube 7 to direct flame on the top of the gathering tube, a shield 8 being interposed when the parison mould comes into the gathering position.

H. G. C.

126. Glass-making Machinery. (Brit. Pat. No. 112007). E. ROIRANT (September 14th, 1917, No. 13190. Convention date, December 14th, 1916. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—The parison and finishing moulds of a glass-blowing machine are hinged on separate and fixed axes and have opening and closing movements only, and the opening or closing movement of the parison mould and the closing or opening movement of the finishing mould commence and finish at the same time. The halves 21 of the parison-mould carrier are hinged to one of the hollow columns 2 of the machine, and the halves 22 of

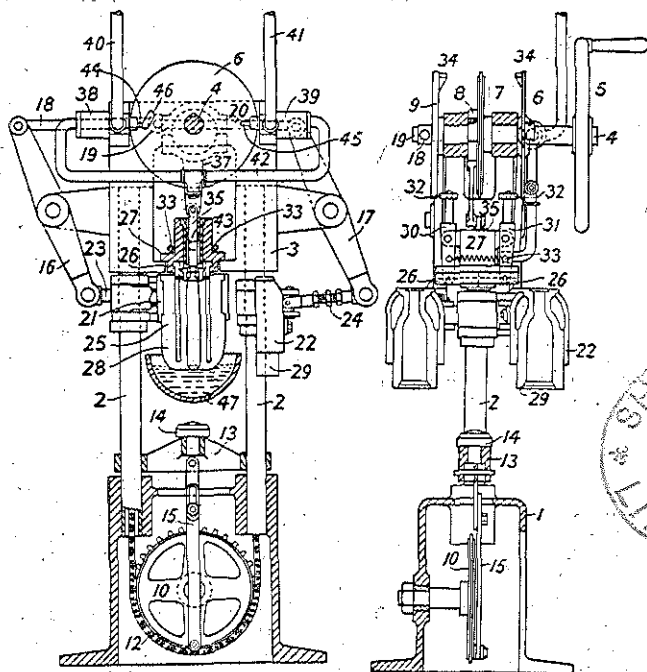


FIG. 17.

FIG. 18.

the finishing-mould carrier are hinged to the other column. The moulds are mounted at the same level, and are coupled by adjustable members 23, 24 to the lower ends of pivoted levers 16, 17, which are operated by rods 18, 20 from an eccentric pin 19 on a disc 9 on the driving shaft 4. The carrier 13 of the bottom mould 14 is moved up and down on the columns 2 by a rod 15 connected to a sprocket wheel 10, which is contained within the hollow base 1 of the machine and driven by a chain 12 passing through the columns 2 from a wheel 7 on the shaft 4. The bipartite neck mould 25 is carried by slides 26 mounted in a carrier 27 loosely seated on the lower part of the casting 3. Cams 34 on discs 6, 9 on the shaft 4 engage rollers 32 on the upper ends of levers 30, 31

pivoted to the carrier 27, and move the parts of the neck mould 25 apart against the action of springs 33. An eccentric 8 on the shaft 4 actuates the plunger 35. The carrier 27 is connected by pipes 43, 42 to chests 38, 39, which communicate by pipes 40, 41 with sources of vacuum and compressed air respectively, and the valves in the chests are opened sequentially by a cam 46 on the disc 6 to drain molten metal from the receptacle 47 into the parison mould 28 and to blow the parison in the finishing mould 29.

H. G. C.

127. Automatic Gathering of Glass by Suction. (Brit. Pat.

No. 111890). C. F. Cox (December 11th, 1916, No. 17791).—In a method of gathering glass from a furnace, the suction moulds 11, carried on a rotating table 12, dip into the glass, and during their passage through it create a circulation, as indicated by arrows, thus replacing chilled glass by hotter glass at the gathering place. Instead of creating the circulation by means of the moulds, a series of drags actuated by or independent

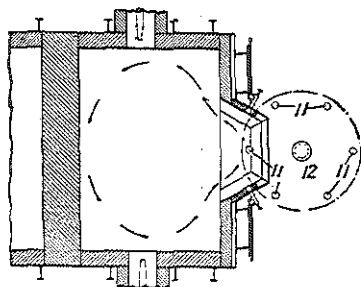


Fig. 19.

of the gathering machine may be drawn through the glass. Specification 2992/07 is referred to.

H. G. C.

128. Semi-automatic Bottle-making Machine. (Brit. Pat.

No. 111231). A. E. CLEGG (April 10th, 1917, No. 4983).—In machines for blowing glass bottles and of the type in which the molten glass is drawn into the ring mould of the preliminary mould 12 by suction produced by means of a hand-operated piston 8x working in a stationary cylinder 8, and in which the blowing in the preliminary and finishing moulds is effected by compressed air supplied thereto from a source independent of the suction cylinder 8, the piercing plunger 2 is normally held in the piercing position by a spring 1, and is retired during the concluding portion of the suction stroke of the piston 8x by means of a lever 6—fixed

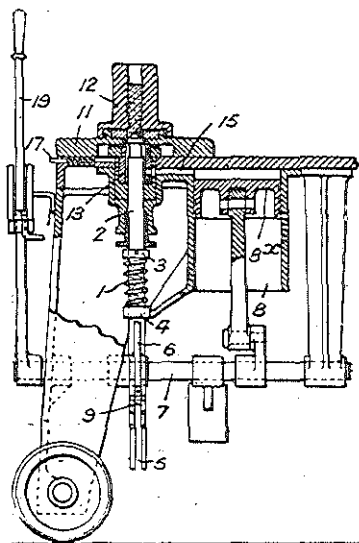


Fig. 20.

on the shaft 7 of the hand lever 19 which operates the piston 8. The spiral spring 1 is mounted on the plunger between a collar 3 and a stationary guide bracket 4, and the lever 6 works in a slot 5 in the lower portion of the plunger and engages an adjustable stop 9 thereon. A rotatable ring-like plug 13, formed with ports to communicate with the suction and compressed-air channels 15, 17, is mounted around the plunger immediately beneath the carrier 11 of the mould 12. The plug 13 is operated by means of a hand lever, the movement being limited by stops. H. G. C.

129. Automatic Electric Bulb-making Machine. (111258). WESTLAKE EUROPEAN MACHINE CO., Spitzer Building, Toledo, Ohio, U.S.A. (Assignees of A. Ladou, Spitzer Building, Toledo, Ohio, U.S.A. June 18th, 1917, No. 8757. Convention date, December 28th, 1916. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—In a machine for making electric lamp bulbs, etc., and of the type described in Specification 26222/11, in which sets of glass-forming apparatus are carried by an horizontally rotating support, and the blowing spindles, after receiving the gathers, are turned over to complete the blowing, the blank hanging downwardly from the spindle is elongated by imparting to it a series of reciprocating movements in the direction of its length. Each hollow blowing spindle 11 receives a solid blank from the gathering-ram while in the vertical position with the blank-holding means 12 upwards. The blank is blown into hollow form while the spindle is rotated through pinions 28, 27 and bevel wheels 25, 24 from a shaft 21 rotated through a worm gear and rack from a stationary cam as the support rotates. The spindle is then inverted to the position shown by a gear wheel 34 meshing with a gear wheel 35 keyed to a sleeve 36 forming part of the spindle support 23, the wheel 34 being rotated through a spiral pinion and a rack actuated

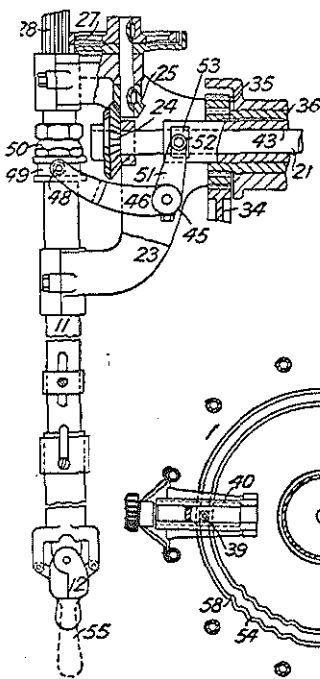


FIG. 21.

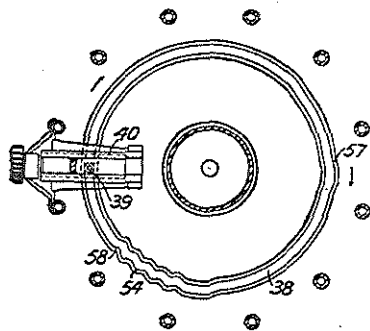


FIG. 22.

by a stationary cam. The spindle is then reciprocated longitudinally to elongate the blank 55 by a bell-crank lever 45 having a forked arm 46 with rollers 48 engaging a grooved collar 49 on the spindle and adapted to bear against a stop-nut 50. The other arm 51 of the bell-crank lever 45 is in the form of a fork having rollers 52 engaging recesses 53 in a sleeve 43, which is reciprocated on the shaft 21 by a slide 40 (Fig. 22) provided with a roller 39 engaging a stationary cam-way 38 having a series of bends 54 for this purpose. Bends 57, 58 on the cam-way 38 act respectively to raise the spindle 11 when it receives the blank from the gathering-iron, and to lower it when it is enclosed by the finishing mould. The reciprocation of the spindle may be accompanied by the controlled admission of compressed air. H. G. C.

130. Automatic Machines for Electric Bulb-making. (Brit. Pat. No. 111122.) A. E. WHITE (WESTLAKE EUROPEAN MACHINE Co.; Ohio, U.S.A., September 12th, 1916, No. 12895).—

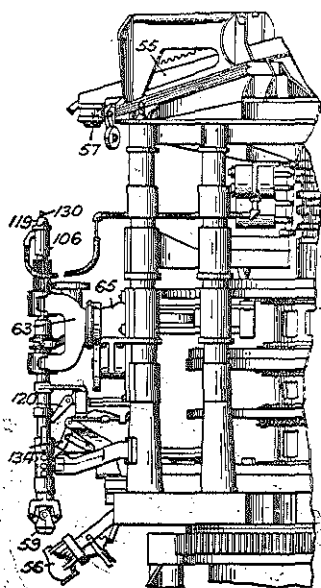


FIG. 23.

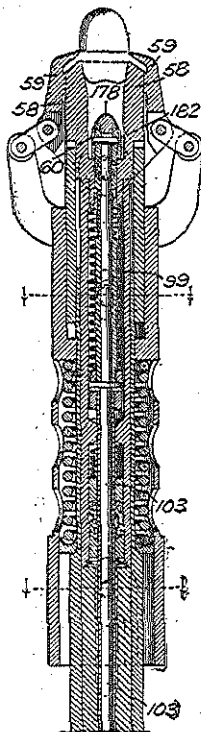


FIG. 24.

Relates to the type of automatic glass-blowing machine for making electric lamp bulbs, etc., described in Specifications 26222/11 and 26224/11, wherein a series of gathering mechanisms 55 (Fig. 23) carried on a rotating frame successively suck up metal from a furnace

into blank moulds 57 and transfer the blanks thus formed to their respective blowing spindles, the cycle of operations of each set of moulds and co-operating parts being the same. The blank-piercing plunger 60 (Fig. 24) is constructed with a tip 178 of graphite or copper, separated from the body portion to prevent over-cooling of the glass. The operating rod 99, 103 of the plunger is made in two separate sections arranged in alignment similar to the sectional plunger described in Specification 26224/11, and the sections are spring-pressed to obtain an instantaneous action of the plunger. The longitudinal air passage in the plunger communicates with a transverse duct 182 leading into grooves on the exterior of the plunger. The blowing spindle is slidably mounted in a yoke 63, which is rotatable in a casting 65 secured to the rotating frame of the machine. When the blank is received by the blowing spindle from the blank mould, the blank holder 58 is in its lower position and the pivoted jaws 59 are open, the spindle then having the opposite end up from that shown in Fig. 23. A fork 120 is then rocked away from engagement with a projection 119 on a casing 106, thus allowing springs within the blowing spindle to close the jaws 59 and to raise the blank holder 58 so as to grip the blank. The plunger 60 is caused by the action of an arm 134 on a tip 130 to indent the blank. The blowing spindle is subsequently turned almost to a horizontal position, and is caused to rotate about its longitudinal axis, preferably with the admission of air to the blank, the inversion of the spindle to the position shown in Fig. 24 being afterwards completed. The spindle is afterwards oscillated by a worm gearing and under the control of a brake with the blank hanging downwards, and the bulb is finished in the mould 56.

H. G. C.

131. Automatic Electric Bulb Machine. (Brit. Pat. No. 112221). A. E. WHITE (WESTLAKE EUROPEAN MACHINE CO., Ohio, U.S.A., September 12th, 1916, No. 5580/17).—Relates to glass-blowing machines of the type described in Specification 26222/11 for making electric lamp bulbs, etc., and consists in providing means for varying, during the operation of the machine, the intensity of the vacuum produced in the gathering mould while the blank is held therein and before it is delivered to the spindle. Means are provided for adjusting the opening of the suction valve and for varying the moment of activation of the actuating cam without interrupting the operation of the machine. The spring-pressed valve 717 (Fig. 25), which puts the gathering or blank mould in communication with the exhausting apparatus, is operated by a member 731 (Fig. 26) carried by an element 728 which is mounted on a bracket 730 carried by the rotating spider 50, and rocked on its pivot 729 by a cam 711 on the stationary drum 54 engaging a roller 745 on arm 746. The pin 731 is adjustable by means of worm gearing 733, 735 operated by a hand-shaft 736 to vary the distance between the end of the valve stem 718 and the head 732 of the pin 731. The arm 746 and roller 745 are adjustable later-

ally by means of a screw 756, a dovetailed projection 747 at the upper end of the arm engaging a groove in a block 751 forming the lower part of the rocking member 728. The end part 711a

FIG. 25.

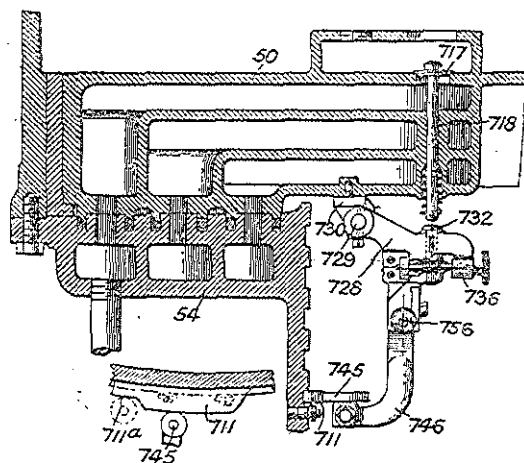


FIG. 27.

(Fig. 27) of the cam 711 is reduced so that, when the roller 745 rides on this part, the valve 717 is held only slightly open to diminish the vacuum at the back of the blank. Specification 111122 also is referred to.

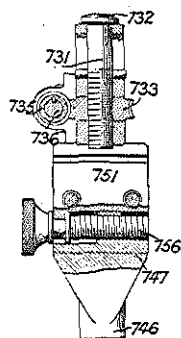


FIG. 26.

132. Automatic Machinery for Electric Bulb-making.
Brit. Pat. No. 112613). WESTLAKE EUROPEAN MACHINE CO.
(Assignees of A. KADOW, Spitzer Building, Toledo, Ohio, U.S.A.
June 18th, 1917, No. 8758. Convention date, January 11th. Not yet accepted. Abridged as open to inspection under Sect. 91 of the

Act).—Relates to gathering apparatus of the kind described in Specification 26222/11, in which one or more gathering rams or devices are carried on a rotating structure and periodically brought opposite to and thrust into the working opening of a stationary glass

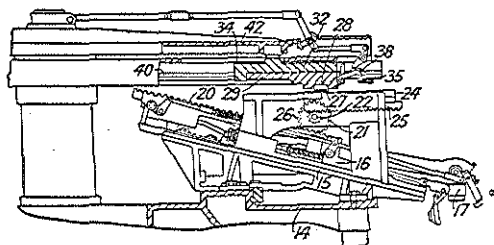


FIG. 28.

furnace with a closed top, and consists in making the gather by a radial movement of the ram without interrupting the continuous rotary movement of the ram and without arresting the rotary move-

ment of the supporting structure. The ram 16 carrying the gathering moulds 17 slides on an inclined support 15 on a plate 14 carried by the rotary structure, and a slide 24 in the upper part of the housing 15 has a rack 25 gearing with a pinion 26 on a shaft 22 carrying a pinion 21 gearing with a rack 20 on the ram 16. As the structure rotates, a roller 27 on the slide 24 enters a curved slot 28 in a slide 29 on a stationary structure opposite the opening of the furnace. The slide 29 is engaged with a slide 32, and the two slides are moved in guides 40 by a rotating cam 42. The slides 29, 32 are held together by a shoulder 34 on the upper slide 32 and by a spring-pressed dog 35 pivoted in the lower slide and engaging a notch 38 in the upper slide. By disengaging the dog 35, the ram 16 may be disconnected from its actuating mechanism.

H. G. C.

133. Machine for Drawing Glass Tubing. (Brit. Pat. No. 111521). E. C. R. MARKS (*Libbey Glass Co., Ash Street,*

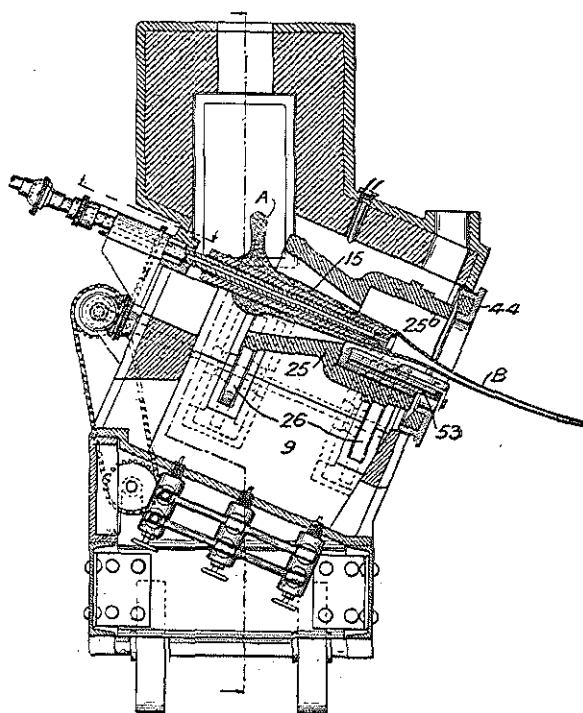


FIG. 29.

Toledo, Ohio, U.S.A., November 29th, 1916, No. 17132).—Relates to apparatus for drawing glass lengthways. The molten glass is

placed in a trough 3 (Fig. 30) above a furnace 2, and, after flowing down a step to eliminate air bubbles, passes beneath an adjustable gate 11, and flows in a stream *A* on to the exterior of a hollow rotating mandrel 15 (Fig. 29) situated in an independently heated furnace chamber 9. The mandrel, which may be adjusted longitudinally while in action, projects into a casing 25, which is continuously

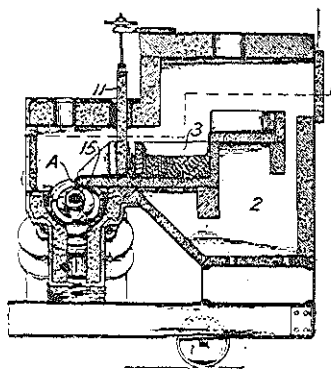


FIG. 30.

rotated on wheels 26 so as to radiate heat uniformly to the glass on the mandrel. The casing is enlarged at the exit portion 25*b*, thereby allowing a slight cooling of the glass before leaving the mandrel. A ring-like door 44 carrying a trough 53 to catch falling particles from the mandrel closes the furnace opening around the casing 25. In operation, the stream *A* of glass winds around and flows down the rotating mandrel, and is drawn off in the form of a tube *B* by means of any suitable drawing device, air under slight pressure or at atmospheric pressure being continuously supplied through a mandrel. In drawing a solid rod, the end of the mandrel is closed by an imperforate tip. In a modification, Fig. 31, the mandrel is surrounded by a conical casing 43, which is partially filled with molten glass, the thickness of the glass film being regulated by the size of the outlet. In a further modification, the rotating shell enclosing the mandrel is replaced by a stationary housing 68 (Fig. 32), and the molten glass in the furnace trough is shielded from direct contact with the flames. The

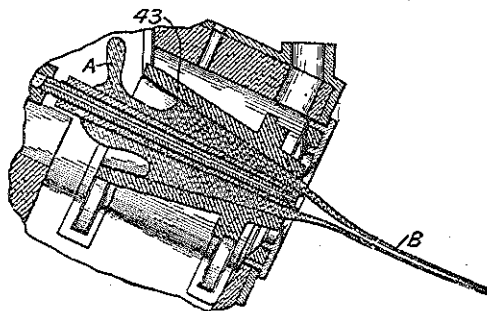


FIG. 31.

mandrel is rotatably mounted in a bearing 72 carried by an arm, which may be adjusted so as to vary the inclination of the mandrel without varying the height of the stream *A* of glass. The wide end of the housing 68 is closed by a vertically sliding door 81

with the exception of a slot 82 for the passage of the drawn glass, and the slot is restricted by a pair of suspended plates 87, these

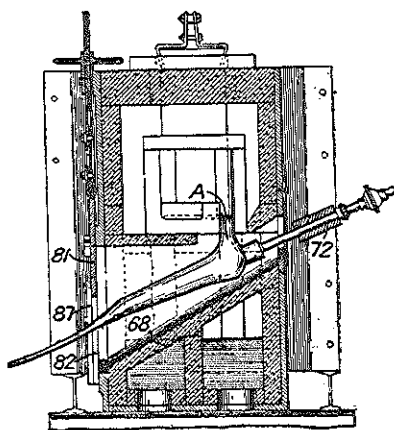


FIG. 32.

losures affording means for regulating the temperature of the housing 68. H. G. C.

134. Grinding and Polishing Machinery. (Brit. Pat. No. 111715). W. TAYLOR (December 7th, 1916, No. 17600).—In a machine for grinding spherical surfaces, and especially the convex surfaces of lenses made from discs of glass, of the type in which the work rotates about a primary axis and the work or grinding disc is also given a movement relatively to the grinding wheel about a secondary axis at right angles to the primary axis, the movement about the secondary axis is produced automatically and in such a manner that the grinding is effected at one side only of the axis of the work and during a single movement of the work about the secondary carried by an adjustable slide, *B*. The spindle, *F*, is carried in bearings in a slide, *F*₆, provided with micrometer adjusting means, and is driven through worm gear, *F*₇, *F*₈, by a band passing round a pulley, *F*₁₀. The band also passes around guide pulleys, *L*, *L*₁, carried by a bracket on a double-hinged arm, *L*₂, which is also connected to the worm shaft, *F*₉, by a strut, *L*₃, to maintain the tension in the band. The slide *F*₅ is supported on a carriage, *H*, adapted to be turned about the secondary axis, *I*. The grinding is done from the periphery to the centre of the work, and the rate of movement of the work may vary inversely with the resistance to grinding, but cannot exceed a definite rate. The movement about the axis *I* is controlled by a weight, *N*₃ (Fig. 34), which in falling carries with it a nut, *N*₂, working on a screw, *N*, the axis of which is coincident with the secondary axis, *I*. The weight is prevented from turning by a pin fixed in the column *O* and engaging in a groove in the weight. The nut *N*₂ is locked to

the weight as it falls, and causes the screw N to rotate. The weight is lifted to the requisite height by a treadle, O_1 , and cranks, O_3 , O_4 , on a stud shaft, O_2 . The speed with which the weight falls is controlled to accelerate or decelerate the movement of the work by means comprising a dash-pot, R , the crank arm R_1 of axis; further, the work and grinding disc are separated automatically when the grinding is complete. The work is mounted by spring means on a spindle, F , and is ground by the face of a cup-shaped wheel, A , which is connected by a link, R_2 , with a crank arm, R_3 , on the spindle, N . Further, the cranks O_3 , O_4 may be

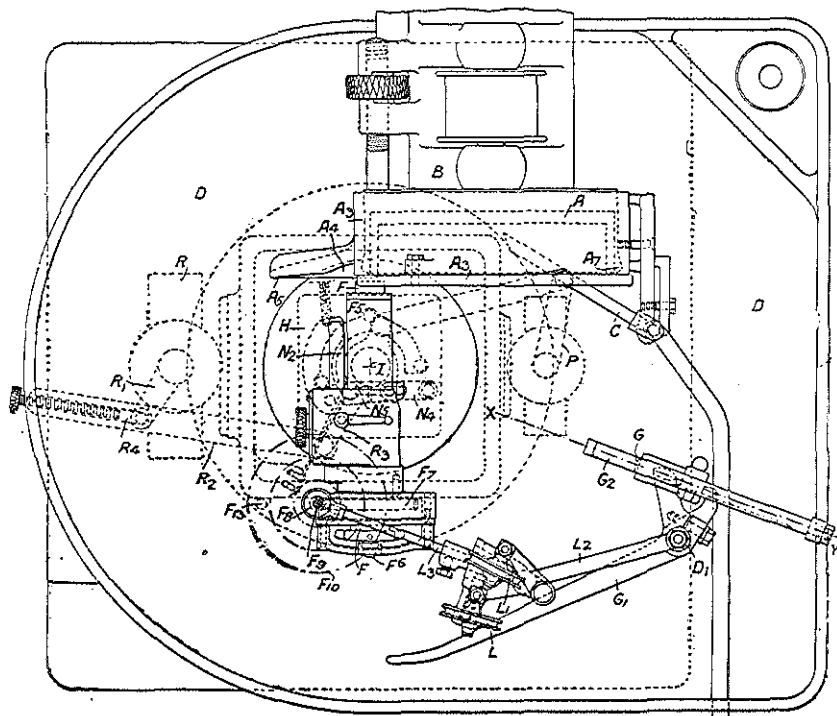


FIG. 33.

set so that the effective weight of the treadle, O_1 , varies during the grinding operation. Additional weights, N_{10} , N_{11} , may be added. When the grinding operation is finished, the toggle arms, N_4 , N_5 , which form the means whereby the nut, N_3 , and weight, N_3 , are locked together, are bent by a suitable projection to allow the nut to rotate within the weight, and a spring arm, P , to rotate the carriage H about the axis I to bring the axis of the work spindle into a position of rest, XF , where a handle (G_1) may be operated to press forward a thrust rod (G) and release the work by pressing the abutment, F_6 , against the action of a spring. The

pillar, D , which supports the parts G , G_1 , also carries a stop, G_2 , which is engaged by a projection, F_{13} , on the pulley, F_{10} , and prevents further rotation of the work spindle. When a fresh blank has been inserted, the weight, N_3 , is raised by a treadle, O_1 , and the weight and nut, N_2 , are locked together. The weight

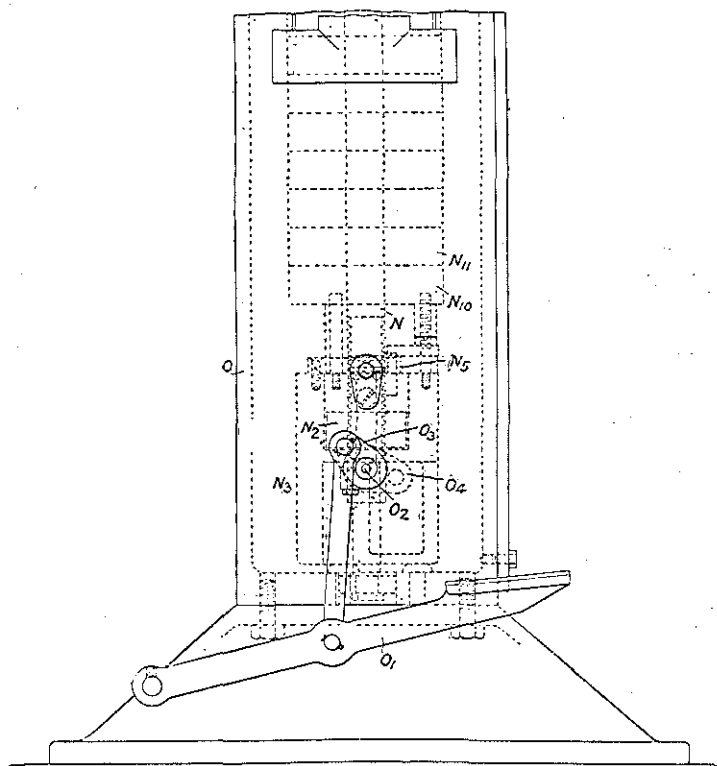


FIG. 34.

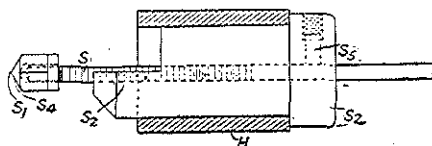


FIG. 35.

on commencing to fall turns the carriage H rapidly about the axis I into the working position. This movement is accomplished without opposition from the dash-pot R , which only comes into operation during the actual grinding. To allow this, the link, R_2 , is provided with a slot, R_4 , in which the end of the arm, R_1 , engages.

The position of the work may be fixed, and movement about the secondary axis be imparted to the grinding wheel. To grind concave surfaces, the work is withdrawn to the other side of the secondary axis, and is ground by the periphery of a disc. To ensure uniform thickness of the finished work, the work spindle, F , has limited end play in its bearing, and the end thrust is taken by an abutment, F_6 . To allow of accurate setting, a bar, S (Fig. 35), is mounted in the carriage, H , in a position parallel to the work spindle. The bar is graduated, and is clamped in the correct position in a slider, S_2 , by a screw, S_5 . The slider is set to abut against a fixed surface on the carriage, H , and the bar has an adjustable end, S_1 , with a diamond, S_4 , adapted to touch the grinding disc. The wheel A is provided with a guard, A_3 , adjustable longitudinally along the axis of the wheel. The guard has an opening, A_4 , at one side to permit the work to be applied to the wheel, and an opening at the bottom to permit the escape of the liquid supplied through the pipe C . The opening, A_4 , is screened by a curved part, A_5 , designed to prevent splashing of the liquid projected against it, and the interior of the guard has a groove, A_7 , curved to prevent atomisation of the water projected against it.

Specification 15375/15 is referred to in the Provisional Specification. H. G. C.

135. Grinding and Polishing Lenses. (Brit. Pat. No. 112297.) H. O. GOWLLAND (December 30th, 1916, No. 18681).—Multifocal lenses are produced by grinding one face to a spherical curvature and the other to a multifocal curvature, and smoothing

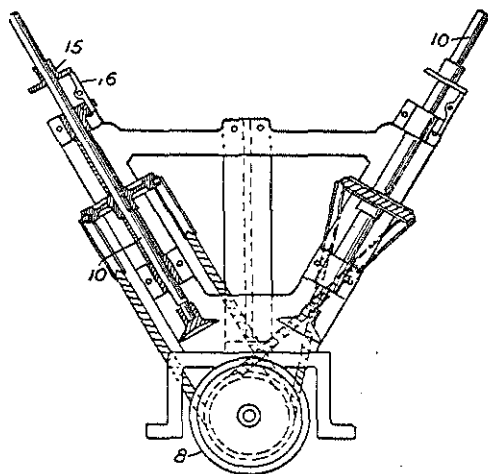


FIG. 36.

ing and polishing the face of multifocal curvature by elastic means incapable of changing the curvature. In the grinding machine shown, the lenses are mounted in holders on a pair of spindles 10 driven in opposite directions by bands from the shaft of a grinding wheel, 8, of parabolic or spiral, etc., section. The spindles may be moved endways to lift the lenses from the wheel, and they may be retained in the elevated position by

collars 15 engaging with cams 16. The smoothing is effected by a rotary tool having a resilient surface covered with chain-mail, as

described in Specification 111716, and the polishing by a similar tool covered with felt. The resilient surface may be provided by cork or sponge-rubber, or it may be a rubber disc under fluid pressure.

H. G. C.

136. Grinding and Polishing Machinery. (Brit. Pat. No. 111716.) H. P. GOWLLAND (December 7th, 1916, No. 17607).—

Tools for smoothing lenses after grinding consist of an elastic head covered with chain-mail fabric, or having a series of metal buttons secured thereon. The disc 1 mounted on the spindle 13 has clamped round its edge a sheet of elastic material 6, and is provided with means by which fluid may be forced into the space between the disc and the sheet, or a filling of cork or sponge-rubber may be used. The chain-mail fabric is secured over the elastic sheet by means of a clamping ring 10.

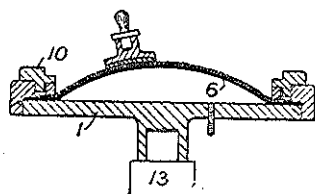


FIG. 37.

H. G. C.

137. Machinery for Grinding Glass, etc. (Brit. Pat. No. 112349.) W. TAYLOR (March 1st, 1917, No. 3045. Addition to 15375/15).—In the application of the method of "terrace grinding" as described in the Patent Specification to the formation of spherical surfaces on glass and like materials, the edge of the abrasive wheel is set so that it moves across the face of the rotating work, there being a slow movement of approach between the work and the wheel, the axes of which are set at the requisite angle to give the required radius. The rough grinding is accomplished with the wheel axis set relatively to the work axis out of one common plane, so that the wheel operates to one side only of the axis of the work. The finishing operation is accomplished by the wheel set with its axis substantially in one plane with the work axis. The annular grinding disc (e) is formed

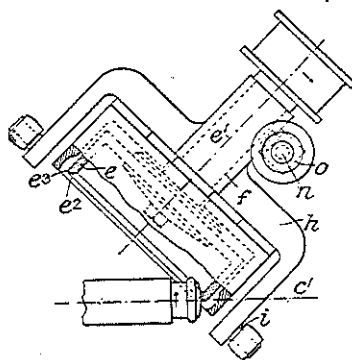


FIG. 38.

with a bevelled surface (e^2) to give the necessary clearance and an active surface (e^3) to give the abrupt step. The disc is carried on a driven spindle (f) in bearings in a yoke frame (h) supported on aligned pivots (i), which are mounted on a slide rest constructed as described in Specification 15377/15. The frame can be tilted about these pivots by a screw (n) passing through a nut (o) on the frame, to move the axis (e^1) of the grind-

ing dish out of the plane of the axis (c^1) of the work spindle. The rough grinding is accomplished with the axis (c^1) set at an angle to the axis of the work spindle. During this operation, the axis is gradually lowered until, for the finishing operation, it is in the plane of the work spindle. The axis of the pivots (i) passes through the axis of the work spindle at the active point of the grinding disc. The work-spindle axis may be tilted in place of the grinding-disc axis. A separate wheel may be used for the finishing operation, and may be mounted as described in Specification 15377/15, and in this case a number of work spindles may be mounted on a turret arranged and operated as described in the same Specification.

H. G. C.

X.—Glassware Accessories.

138. Boxes for Packing Electric Lamps. (Brit. Pat. No.

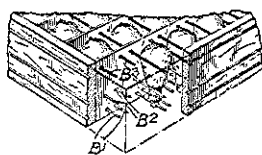


FIG. 39.

111151.) A. ASTLEY (November 14th, 1916, No. 16294).—Fittings, internal; partitioned and cellular boxes. In a box or tray for holding electric lamp bulbs, each bulb is held in place by one or two pairs B^1 , B^2 of wires, which grip the stem of the bulb, and by a pair B^3 of twisted hemp cords, etc., which grip

the large end of the bulb. The wires and cords pass through holes or notches in the partitions shown.

H. G. C.

139. Bottle Stoppers. (Brit. Pat. No. 111002). H. B. Fox BOURNE (January 20th, 1917, No. 1030).—Slate powder, with or without gas-retort carbon, is used in a rubber composition for hard vulcanised screw-stoppers for bottles. A suitable composition consists of indiarubber 4 parts (by weight), boiled oil 2 parts, sulphur 2 parts, ground slate 39 parts, and carbon black 1 part.

H. G. C.

140. Stoppering Bottles, etc. (Brit. Pat. No. 111011).

W. W. BUTLER and C. W. FLEAR (February 12th, 1917, No. 2080).—In a machine for inserting screw and like stoppers in bottles, etc., and of the kind in which the screwing spindle is driven through a helical spring, which absorbs any further rotation after the stopper is screwed home, the spindle (a) (Fig. 40) carrying the chuck (b) has its end working through a sleeve (d) which carries the driving pinion (e), and is mounted in an arm or bracket (f), and the coiled spring (g) is connected at one end to the sleeve (d) and at the other end to a plate or collar (g^1) on the spindle (a), to which a

chuck (*b*) is secured. Fig. 41 shows a machine with two screwing spindles (*a*) carried by brackets (*f*) disposed about the driving spindle (*h*), and having the pinions (*e*) on the sleeves (*d*) gearing

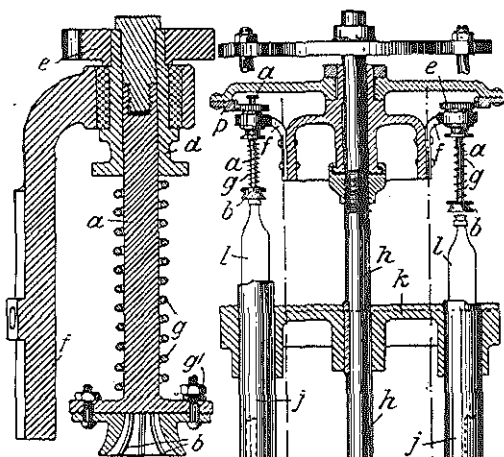


FIG. 40.

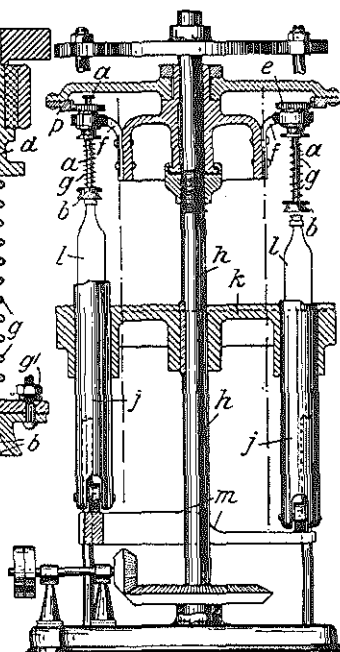


FIG. 41.

with a fixed toothed annulus (*p*). The bottles (*l*) are supported by rests or cylinders (*j*), which are arranged in sleeve parts of the rotating table (*k*), and are raised by a fixed cam (*m*) to bring the stoppers into contact with the chucks (*b*). H. G. C.

Reviews.

Reports of the Progress of Applied Chemistry. Vol. III., 1918. (Published by Society of Chemical Industry. 5s. 6d. net.)—The third volume of reports has recently come to hand, and despite the omission of the sections on ceramics and building materials, is a very comprehensive review of the whole field of industries based on the science of chemistry. Although some of the sections can only make an appeal to the trained scientific worker, there are others, particularly those dealing with Plant and Machinery, Fuel, Gas, Alkalies and Salts, and Glass and Refractories, which all manufacturers who desire to keep abreast of the time should read.

W. E. S. T.

I.—Glass-making Materials.

141. Separators for Sand. G. F. W. HOPE (Brit. Pat. No. 120763, November 19th, 1917, No. 17029).—In a separator for sand a chamber, 1 (Fig. 42), is divided by a series of screens, 3, which can be removed or reversed without stopping the machine. The screens are introduced into transverse guides, 2, within the chamber through openings in one or both walls, the openings being closed by air-tight doors, 4, held in position by means such as a wingnut. An air-space is arranged around the sides and top of the screens, and the dust-laden air is drawn by a fan or the like, 8, into a settling chamber, 7, or it can be passed back into the grinding mill. A fan, 9, draws the air from the mill or the like into the separator. A device for giving a sharp reciprocating or shaking motion to the screens is provided, such device comprising, for example, a sliding rod, 10, with forks, 11, engaging with the top edges of the screens, the rod being reciprocated by a lever, 12, which is rocked by a connecting rod, 14, from a crank-pin, 15. The upper part, 19, of the chamber, 7, may be expandible under air pressure. Two chambers, 1, preferably are employed, the current of sand-laden air being passed first through one chamber for a time and then shut off from this chamber and passed through the other.

H. G. C.

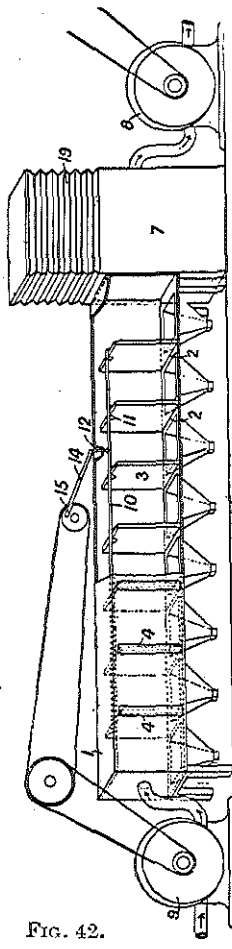


FIG. 42.

142. Preparation of Alumina. J. P. A. LARSON and W. D. BERGMAN, Stockholm (Brit. Pat. No. 120550, August 26th, 1918, No. 13873. Convention date, October 9th, 1917).—Clay, bauxite, or other natural substances containing aluminium together with iron and silicic acid is treated with sulphuric acid to yield an impure solution of aluminium sulphate. The

solution is acted on by a reducing agent such as sulphurous acid or a sulphite to reduce ferric to ferrous sulphate, and is mixed while at 70—100° with ammonium sulphate, allowed to settle at this temperature, and the decanted solution cooled to separate crystals of ammonium alum. The crystals are decomposed by exposing them to ammonia, either gaseous or in solution, to yield ammonium sulphate and aluminium hydroxide, which may be heated to obtain alumina. H. G. C.

143. Preparation of Alumina and Other Materials. E. E. DUTT and P. C. DUTT (Brit. Pat. No. 120838, March 4th, 1918, No. 3767).—A mixture of calcined clay or bauxite, or both, with calcium or other alkaline-earth chloride is heated to bright redness in a stream of arsenious oxide vapour, producing arsenious chloride, which is decomposed by steam into arsenious oxide and hydrochloric acid, and an aluminate. The residue is dissolved in hydrochloric acid and treated with calcium aluminate to precipitate alumina and re-form calcium chloride, which, after the addition of some lime to precipitate the iron, may be used again. H. G. C.

II.—Glass: Manufacture and Properties.

144. Exhibit of Samples of Glass showing Filming. W. H. WITHEY (*Trans. Optical Soc.*, 1918, 20, 40).—Five samples of optical glass were tested, at the National Physical Laboratory, by exposing broken surfaces to a moist atmosphere at 18°, for a week, and estimating, by means of iodeosin, the alkali liberated. Four of them gave excellent results, No. 3 being distinctly inferior. After a further two years' exposure on an open roof, No. 3 was distinctly best. No. 2 was very much more tarnished than No. 1, though it was of similar composition. It was concluded that the iodeosin test alone was not a sufficiently adequate test of filming, and that other tests are desirable. J. R. C.

145. Two Modes of Condensation of Water Vapour on Glass Surfaces. T. TROUTON (*Proc. Roy. Soc.*, 1907, A 79, 383.) A cylindrical glass bulb containing glass-wool and connected to a pressure gauge was evacuated. Small quantities of water were admitted into the apparatus at intervals of three days and the pressure observed. It was found that it could be arranged for a glass surface, holding a certain amount of water, to have a smaller vapour pressure than a drier surface; that is, it is possible for a relatively wet surface to act as a drying agent to a drier surface. The analogy of this supersaturation effect with Thomson's curve of transition from vapour to liquid was discussed. The phenomenon occurred at

a certain critical pressure, which might be a function of the temperature.

J. R. C.

146. The Technique of Optical Glass Melting. C. N. FENNER (*J. Amer. Cer. Soc.*, 1919, 2, 102).—The author dealt with the melting process and allied operations in the sequence in which they occur in practice.

As regards preliminary operations, the following points were emphasised: (a) the necessity for pure raw materials free from metallic oxides which impart colour, such as those of iron, nickel, and manganese, and free from such impurities as sulphates and chlorides, which tend to produce opalescence in glass; (b) the necessity for thorough mixing, avoiding iron tools; (c) the necessity for care in choice of ingredients. For mixing it was recommended that long, open, wooden boxes be used of such capacity that the whole batch may be shovelled from a pile at one end to a pile at the other, using flat wooden paddles or grain-scoops for the purpose. Sifting of all batch ingredients before adding to the batch, and sifting of the mixed batch were recommended.

In connection with the substitution of sodium for potassium compounds and the choice of suitable potassium compounds, the sulphate of potassium was unsuitable because of its tendency to segregate as a layer of "salt water" on top of the melt and because it had the effect, even in small quantities, of inducing milkiness in some glasses. The chloride was rejected for similar reasons and also because of its volatility. Commonly, most of the K_2O was added in the form of carbonate with about 25 to 33 per cent. as nitrate. The nitrate had the highly desirable function of producing oxidising conditions during the thermal dissociation and recombination of the batch ingredients. There was danger that the nitrate, if used in larger quantities than those suggested, would at comparatively low temperatures, be decomposed into a highly caustic liquid likely to attack the pot.

Since sodium compounds were ordinarily cheaper than potassium compounds the extent to which substitution of the former for the latter could be carried was carefully investigated. The use of a certain amount of soda appeared to be desirable, as it probably increased fluidity, but large quantities increased the colour, particularly of glasses high in lead or barium. In a baryta flint glass containing about 38 per cent. PbO , 6.5 per cent. BaO , and 3 per cent. ZnO , the author introduced Na_2O and K_2O in the ratio of 1 to 1.18. The colour of the glass was distinctly greater than when the whole of the alkali used was K_2O . Other evidence was obtained of the colour-inducing effect of Na_2O .

In the author's opinion it was unlikely that the soda itself gave colour, but that the effect was secondary. Possibly a large quantity of soda caused greater corrosion of the pot and led to a larger amount of iron in the glass; or the same amount of iron might show up more in a soda glass, or again the soda used might contain a small amount of sulphide or other material which reduced more

of the iron to the ferrous form, thus exerting a more powerful colouring effect.

With most of the raw materials the size of grain appeared to have little effect on melting. With sand, however, a coarse grain increased the length of time for melting, there being greater opportunity for liquation of the easily fusible materials, leaving the quartz floating on top. Slow melting was likely to mean poor fining.

The large quantity of glass rejected owing to optical and other defects represented considerable monetary value, and the author considered the manner in which this cullet might be used. Glass rejected owing to opalescence, bubbles, or striae might be used; in fact, any glass with defects which could be removed by re-melting might be used. There was no difficulty arising from the use of almost any quantity of cullet. The actual amount used should be decided by the way in which the properties of the cullet corresponded to those of the glass being made. On the other hand, certain properties of the glass would be affected at each re-melting. It would take up more and more iron and other material from the pot, and selective volatilisation would also affect the refractive index. For ease of handling the cullet should be broken up so as to produce a shaly mass.

As a preliminary to melting, the pot was heated to, and allowed to remain at, 1400° for one hour. The pot was then glazed with cullet, the object being to have the pores filled with material of the same composition as the glass to be made. At least three or four scoopfuls of cullet should be used, and it was best to pour it round the inside of the pot and allow it to run down to the bottom. The pot should then be allowed to stand for one hour longer. By maintaining the furnace for two hours at 1400° before starting to fill in the batch proper, all parts of the furnace and regenerative chambers should become well heated, and the heat would have penetrated the furnace lining to such a depth as to make available a certain store of heat for aiding in a quick melting of the batch. The quicker the batch melted down the more satisfactory was the fining likely to be. The normal first addition of batch should half fill the pot with unmelted batch. If the glass was apt to give trouble in fining it was well to reduce the amount of batch added at a time. When the first filling had melted to a level surface (or in about three hours) a second filling of the same quantity was put in and three hours later a third filling. Then one after another smaller additions were made, and finally the melt topped off by a few scoopfuls of batch. The level at which filling ceased should be that at which the melt was an inch or an inch and a half below the rim of the pot.

On the whole, the melting process was rather quiet. The presence of nitre insured that the conditions shall be oxidising, and the furnace atmosphere must not be allowed to reach a stage which involves reduction. The combination of the basic oxides with silica was likely to be slow, and as the silica was of relatively low specific

gravity, this gave an opportunity for gravitative differentiation. In flint glasses especially a surface layer containing large quantities of grains of undissolved silica was likely to persist for a long time. In very dense flints a bottom layer of excessive lead content was also formed. As an example of this differential melting, a glass, intended to have a refractive index of 1.648, showed, because of improper stirring, at the bottom a distinct layer, of about a foot in thickness, of glass of a pale greenish-yellow colour, having an index of about 1.690; above this a mass of glass in which the index varied from 1.630 in the lower portions to 1.610 in the upper. During the melting of this glass samples from the top had shown quantities of silica grains embedded in a glass having an index of about 1.545. Probably in most cases a glass of this kind had undergone a similar segregation, but in this example the subsequent procedure was faulty and the segregation was not destroyed by stirring. Possibly, also, in this case the fillings were not given time to melt down sufficiently before others were added. In the author's opinion, if the mixing were sufficiently thorough, a homogeneous solution should be formed.

The author considered that in most cases it was possible to dispense altogether with fining as a separate process. The glass was given a hand-stirring before the melting was really complete, and then, a short time after the last fill, the machine stirrer was set in operation and stirring continued until the pot was ready for removal. During fining the temperature must be kept as uniform as possible.

For most of the common types of glasses a temperature of about 1400° during melting and fining was required. It was essential, however, to see that the temperature did not rise appreciably higher than this, as excessive temperatures were injurious to the pot and increased the amount of selective volatilisation. The following data, given by Zschimmer as the melting temperatures used at the Jena works, were quoted:—

- 1000° Phosphate glass ($3\text{B}_2\text{O}_3$, $70.5\text{P}_2\text{O}_5$, $12\text{K}_2\text{O}$, 4MgO , $9\text{Al}_2\text{O}_3$, $1.5\text{As}_2\text{O}_3$ according to synthesis).
 1100° Dense lead silicate glass (20.8SiO_2 , 79PbO , $0.2\text{As}_2\text{O}_3$).
 1130° Borate glass ($52.5\text{B}_2\text{O}_3$, 1SiO_2 , $1.5\text{Na}_2\text{O}$, $1.5\text{K}_2\text{O}$, 6ZnO , 12BaO , 16PbO , $9\text{Al}_2\text{O}_3$, $0.5\text{As}_2\text{O}_3$).
 1320° Dense barium borosilicate glass ($14.5\text{B}_2\text{O}_3$, 39SiO_2 , 41BaO , $5\text{Al}_2\text{O}_3$, $0.5\text{As}_2\text{O}_3$).
 1370° Ordinary flint glass (45.7SiO_2 , $1.5\text{Na}_2\text{O}$, $7.1\text{K}_2\text{O}$, 45.4PbO , $0.3\text{As}_2\text{O}_3$).
 1410° Ordinary crown glass ($2\text{B}_2\text{O}_3$, 69.2SiO_2 , $8\text{Na}_2\text{O}$, $11\text{K}_2\text{O}$, 4CaO , 3.5ZnO , 2PbO , $0.3\text{As}_2\text{O}_3$).

The author discussed at length the origin of bubbles. The great majority of bubbles were, in his opinion, doubtlessly entrapped mechanically, but others appeared to be set free from solution in the glass, particularly during stirring and cooling. To assist in removal of bubbles entrapped mechanically, the author recommended ammonium nitrate wrapped in paper so as to form a package. The fact that the vaporisation of this substance was com-

plete and without residue and that the gas was oxidising in character, made this material almost ideal for the purpose. Other bubbles appeared to consist of gas which had been in solution at a high temperature and had been evolved on cooling. The author found that in some cases, after care had been taken to eliminate all other possibilities and the glass had become free from bubbles during fining, nevertheless, in the subsequent cooling during stirring, bubbles had reappeared and had persisted to the end. Crown glasses containing barium in small to moderate quantities appeared specially prone to dissolve gas and later evolve it as bubbles. Still another class of bubbles, which might be termed vacuum bubbles, appeared when glass was cooled quickly, causing a rigid crust to form over the surface while the interior was still hot. In such a glass, even minute bubbles became enlarged as the glass contracted from them, so that ultimately it might appear full of large bubbles. If, however, the glass were carefully heated to the softening temperature the bubbles collapsed until they were invisible or nearly so.

The author also discussed the function of arsenic in glass melting and suggested that bubbles of arsenic vapour not only gathered up gases which had already been set free as bubbles, but that they collected potential bubbles. Zschimmer's tables showed that at the Jena works the amount of As_2O_3 ordinarily put into the batch was about 0.3 per cent. of the weight of the glass. The author used about the same amount or a little more.

Adequate temperature control was considered by the author to be the most effective means of reducing leakage losses. Emphasis was also laid on the necessity for careful treatment of the pots used, as well as of their construction.

Care was also necessary in skimming to prevent material from the surface being forced down into the metal, whilst too much glass should not be removed during the operation. The composition of the surface layer immediately after fining did not represent the average composition of the melt, and the greater the quantity of glass removed the more the average composition of the whole was changed.

The type of stirring machine employed and the alterations of speed and radius of stirring motion were dealt with in detail; whilst the temperature charts and records of operations made during typical runs were also reproduced. The temperatures at which stirring should cease with different glasses are stated as:

Borosilicate crown	1050°
Light crown	1150°
Baryta flint	980°
Medium flint	950°
Light flint	925°
Barium crown	1025°

The percentage equivalents of batch compositions used by the author in the preparation of a series of optical glasses were as follows:

	Medium flint. $n_D=1.605$ $\nu=37.6$	Baryta flint. $n_D=1.619$ $\nu=37.6$	Light crown. $n_D=1.516$ $\nu=60.0$	Borosilicate crown. $n_D=1.511$ $\nu=64.1$	Light flint. $n_D=1.580$ $\nu=41.1$	Barium crown. $n_D=1.570$ $\nu=57.0$	Dense flint. $n_D=1.640$ $\nu=34.6$
SiO ₂	47.94	43.80	71.56	70.04	52.72	48.85	41.68
PbO	42.38	38.12	—	—	35.03	—	50.52
K ₂ O	5.07	8.32	9.01	12.02	5.54	4.30	3.50
Na ₂ O	4.32	—	8.08	7.44	6.32	4.31	4.00
ZnO	—	3.05	—	—	—	8.91	—
BaO	—	6.47	2.61	—	—	28.57	—
B ₂ O ₃	—	—	—	8.30	—	3.75	—
CaO	—	—	8.02	1.92	—	—	—
Al ₂ O ₃	—	—	—	—	—	1.01	—
As ₂ O ₃	0.29	0.26	0.72	0.28	0.39	0.30	0.30

In the author's view, the process of optical glass production must be treated as a laboratory operation carried out on a large scale, and must provide for attention to each pot individually as its requirements demand.

F. W. H.

147. An Improved Method of Optical Glass Manufacture.

G. W. MOREY (*J. Amer. Cer. Soc.*, 1919, 2, 146).—The author gave an account of modifications made in the usual furnace operations at the works of the Spencer Lens Company, which produced better glass with a doubling of output and correspondingly lower cost as the result of the new methods adopted.

The author stated that the melting of the batch takes place from the top downwards; the upper layer sinters together, then the more easily fusible components trickle down, leaving the upper layers impoverished in the substances usually called "fluxes." This results in the surface becoming rich in silica. Both flint and crown batches showed not only an actual accumulation of partially dissolved quartz grains, but also had a refractive index lower than that of the rest of the glass.

The fluxes, especially lead, tend to settle to the bottom. In the usual process this lead-rich layer was allowed to lie on the bottom of the pot throughout the filling and fining periods, resulting in greatly increased pot corrosion with all its attendant dangers. In addition, the impoverishment of the upper layers in fluxes increased the time required for complete solution of the batch ingredients.

This trouble, and also the question of removal of bubbles, the author suggested, may be overcome by hand-stirring during filling and commencing machine-stirring immediately after the fill, followed by stirring continuously, instead of allowing the glass to stand for fining and then stirring intermittently.

A sample schedule was given for a flint glass having $n_D=1.617$, $v=36.5$, the pot used being 26 inches high and 28 inches in diameter, inside dimensions. The time of filling on cullet was taken as starting point.

Time—hours.	Run at 1390°.
0:00	Add cullet.
1:00	Fill pot three-quarters full of batch.
2:30	Fill pot with batch.
4:00	Hand-stir; fill pot with batch.
5:30	" "
7:00	" "
7:30	Stirring-machine on.
15:00	Gas off.

F. W. H.

148. The Variation of the Transparency of Glasses to Ultraviolet Light with their Chemical Composition. E. ZSCHIMMER (*Phys. Zeitschr.*, 1907, 8, 611).—In order to obtain chemically pure glasses the melts were made in platinum crucibles and the purest materials used. Pieces of the glasses so obtained were carefully annealed, ground into plates and polished, and examined

by means of a quartz-fluorspar spectrograph. Electrodes of Mg, Cd, Zn, and Al were used to obtain an ultraviolet spark spectrum. Sometimes, also, other lines were observed, and these were ascribed to the fluorescing of the glass. The results obtained are as follows:—

Glass No.	Synthetic chemical composition.	Wave-length in $\mu\mu$ up to which the glass was transparent, and the thickness of the plate.
V.S. 1450...	B_2O_3 .	186 in 3 mm.
V.S. 1456...	$85B_2O_3, 15Na_2O$.	186 „ 3 „ faint.
V.S. 2161...	$74B_2O_3, 26Na_2O$.	226 „ 3 „ good.
V.S. 2164...	$70B_2O_3, 30Na_2O$.	275 „ 2 „ good.
V.S. 1676...	$79B_2O_3, 21K_2O$.	199 „ 3-4 „ faint.
V.S. 1453...	$41B_2O_3, 59ZnO$.	245 „ 3 „ good.
V.S. 1677...	$57B_2O_3, 43BaO$.	210 „ 3 „ faint.
V.S. 2159...	$50B_2O_3, 50BaO$.	231 „ 4 „ good.
V.S. 1674...	$64B_2O_3, 12Na_2O, 12K_2O, 12BaO$.	245 „ 2 „ good.
V.S. 1675...	$40B_2O_3, 55BaO, 5Al_2O_3$.	280 „ 3 „ good.
V.S. 2938...	$25B_2O_3, 65BaO, 10Al_2O_3$.	280 „ 5 „ faint.
V.S. 1671...	$66B_2O_3, 30CaF_2, 4Al_2O_3$.	226 „ 3 „ good.
V.S. 1700...	$56B_2O_3, 40CaF_2, 4Al_2O_3$.	257 „ 3 „ good.
V.S. 2524...	$40B_2O_3, 60BaF_2$.	257 „ $2\frac{1}{2}$ „ good.
V.S. 2022...	$40B_2O_3, 50BaO, 10PbO$.	346 „ $3\frac{1}{2}$ „ good.
V.S. 2139...	$\left\{ \begin{array}{l} 22B_2O_3 \\ 58SiO_2 \end{array} \right\} 5Na_2O, 15K_2O$.	275 „ 4 „ good.
V.S. 2944...	$\left\{ \begin{array}{l} 25B_2O_3 \\ 15SiO_2 \end{array} \right\} 15ZnO, 45BaO$.	275 „ 5 „ faint.
V.S. 2191...	$78SiO_2, 22K_2O$.	245 „ 3 „ faint.
V.S. 2182...	$68SiO_2, 32K_2O$.	275 „ 3 „ good.

The conclusion was drawn that the high transparency of pure B_2O_3 and SiO_2 decreased with increasing addition of metallic oxides, although the latter are not equally effective in increasing the absorption. K_2O had less effect than Na_2O , whilst PbO caused strong absorption. The author stated that these results were only of directive value, as none of the glasses enumerated was sufficiently durable or capable of production in large quantities free from small bubbles.

J. R. C.

149. The Electrical Conductivity of Soda-Lime-Silicate Glasses. R. AMBRONN (*Ann. Physik*, 1919, 58, 139).—A fuller account of the experiments referred to in this JOURNAL, 1918, Abs. 240. The difficulty of finding suitable electrodes, mentioned in the previous paper, was discussed at length. Finally, "burnt-in platinum" electrodes were made by covering the finely ground glass surface with a platinum solution and heating this to about 500° for two hours. The platinum covering so obtained gave good contact with the glass. Measurements were made at temperatures up to 450° , both while raising the temperature and again when it was falling. In the former case the conductivity was always greater than in the latter. This was considered to be due to a polarisation effect arising from the migration of the sodium ions to the electrodes.

The conclusions drawn from the experiments confirm those previously made. Assuming that the conductivity can be expressed in the form $L = L_{\alpha} e^{-\beta/\theta}$ where L_{α} and β are constants, depending on the chemical composition of the glass, and θ is the absolute temperature, the formula gives an accurate representation of the results within the limits of experimental error. For the lime-soda-silicate glasses the complete expression is:

$$L = (12.58c + 7.515k - 214.68)e^{\frac{-9803.7 - 59.045c + 174.00k - 3.4040ck}{\theta}}$$

c being the percentage, by weight, of Na_2O in the glass and k that of CaO . The values of L_{α} and β from which these constants were evaluated are appended. Two specimens were examined in each case.

No. of glass.	Percentage composition.			L_{α}	β .
	Na_2O .	CaO .	SiO_2 .		
4	22	8	70	124.2	9292.1
				123.8	9314.0
5	34	8	58	262.2	8210.6
				300.0	8275.1
6	15	12	73	69.65	10455.9
				69.86	10473.0
7	22	12	66	151.2	9724.4
				147.8	9726.9
8	28	12	60	249.3	9022.6
				203.3	8888.9
9	12	16	72	51.81	11120.0
				52.12	11109.4
10	20	16	64	134.1	10258.2
				155.6	10350.7
12	20	20	60	197.2	10819.8
				213.1	10816.6
13	36	4	60	265.7	7924.3
				273.1	7933.3

J. R. C.

150. The Occlusion of the Residual Gas by the Glass Walls of Vacuum Tubes. A. A. CAMPBELL SWINTON (*Proc. Roy. Soc.*, 1907, A, 79, 134, and 1908, A, 81, 453).—It was found that the walls of vacuum tubes, employed for some investigations in 1898, were roughened where the glass had been exposed to the bombardment of the cathode rays. When the glass was heated it became clouded, the effect being due to minute, spherical bubbles in the glass. Investigation showed that these were at a depth of 0.122 mm. from the surface. It was ascertained that the gas was hydrogen and that the occlusion was due to the mechanical driving in of the gas into the glass and not to any chemical combination.

In the second paper the author dealt with comments on his previous conclusions. J. J. Thomson suggested that the glass was heated by the bombardment of the cathode rays, thus allowing the gas to diffuse into the glass. It was shown that, although the original depth of the bubbles was only one-tenth of that previously measured (the heating causing the gas to travel inwards), the glass

did not become hot enough during the discharge to permit diffusion. Other suggestions were considered, but the author reiterated his former views.

J. R. C.

151. The Lime-Silica Series of Minerals. A. L. DAY, E. S. SHEPHERD and F. E. WRIGHT (*Amer. J. Sci.*, 1906, **22**, 265).—The authors state that only one well-defined mineral of this series is known, although, according to Boudouard, the freezing-point curve for the lime-silica system showed four eutectics and three maxima, which corresponded to the meta-silicate, the ortho-silicate, and the tricalcic silicate. These results were criticised owing to the adoption of Seger cones as the method of temperature measurement.

Continuing their experiments on the lime-silica series, the authors found that there were only two definite compounds of lime and silica capable of existing in contact with the melt, namely, (1) the pseudo-hexagonal metasilicate, melting at 1512° , and undergoing inversion to *wollastonite* at 1200° . This metasilicate is capable of taking up in solid solution a small amount of either lime or silica; (2) the ortho-silicate of calcium, melting at 2080° and possessing three polymorphic forms. The α -form crystallised in the monoclinic system and had a density of 3.27; the β -form in the ortho-rhombic system with a density of 3.28; and the γ -form, also in the monoclinic system, with a density of 2.97. The disintegration of the orthosilicate, and of all lime-silica mixtures containing more than 51 per cent. of lime, was due to the 10 per cent. volume change accompanying the $\beta \rightarrow \gamma$ inversion. The inversion point α to β was at 1410° ; $\beta \rightarrow \gamma$ at 675° . There were three eutectics in the series, namely, *tridymite* + the metasilicate at 37 per cent. CaO, 1417° ; the metasilicate + the orthosilicate at 54 per cent. CaO, 1430° ; and the orthosilicate + lime at 67.5 per cent. CaO, 2015° . The orthosilicate was readily attacked by water, which dissolved out the lime in large quantities.

Optical evidence, gained by the microscopic study of the crystallised products of mixtures of silica and lime, confirmed these findings, and also indicated that the metasilicate formed solid solutions with the orthosilicate as well as with lime and silica.

J. R. C.

152. Wollastonite and Pseudo-Wollastonite. E. T. ALLEN and W. P. WHITE (*Amer. J. Sci.*, 1906, **21**, 89).—In connection with a study of the *pyroxenes* it was desirable to prepare *wollastonite* and determine its properties. For this purpose a glass of the composition CaSiO_3 was made. The purest quartz and calcium carbonate were used and melted in a platinum crucible, a temperature of over 1500° being necessary. The molten glass thus obtained had a strong tendency to crystallise spontaneously, *pseudo-wollastonite* being formed. However, if, when the contents of the crucible were quite fluid, the latter was plunged into cold water, a brilliant, colourless glass was obtained. The glass was then heated in a platinum crucible over a Bunsen burner to a temperature of from 800° to 1000° , when it crystallised directly to *wollastonite*. The authors state that, in their opinion, *wollastonite* cannot be formed

in a glass melt at a temperature above 1180° . The average specific gravity of glass of the composition CaSiO_3 , determined at 25° , was given as 2.904. J. R. C.

153. Minerals of the Composition MgSiO_3 . E. T. ALLEN, F. E. WRIGHT, and J. K. CLEMENT (*Amer. J. Sci.*, 1906, **22**, 385).—A continuation of the general investigation referred to in abstract No. 151. It was found that there were four crystal forms of magnesium metasilicate, two of which occurred in nature, usually in mixed crystals with ferrous silicate. The first type, a monoclinic *pyroxene*, is formed by crystallising a melt of glass of this composition a little below the melting point (1521°), or by heating any form of the metasilicate to about 1000° , in molten magnesium chloride, traversed by a stream of hydrogen chloride. All the other forms passed into this one at temperatures between 1150° and 1300° . Crystals of the second type, ortho-rhombic *pyroxenes*, were made by heating the metasilicate glass to a temperature between 1000° and 1100° . The third crystalline form was a monoclinic modification corresponding to an *amphibole* in its optical properties. It was formed in very minute quantities when the glass melt was rapidly cooled. Form four was ortho-rhombic, very similar to the previous form, and was obtained by heating the molten silicate beyond the melting point (to 1600°) and then cooling rapidly in air; it could not be formed by heating the solidified glass.

Of the four polymorphic forms, the first was stable at all temperatures. The specific gravities at 25° were 3.192, 3.175, not determined, and 2.857 respectively. The experiments did not settle the uncertainty of the formation of unstable bodies, but they showed that temperature and viscosity were factors of prime importance. From glass melts, or silicate solutions, the stable monoclinic form of MgSiO_3 crystallised at the highest temperatures and the *amphiboles* at lower ones. J. R. C.

III.—Lamp-worked and General Scientific Apparatus.

154. A Device for Removing Plugs from Stopcocks. V. C. ALLISON (*J. Ind. Eng. Chem.*, 1919, **11**, 468).—A common

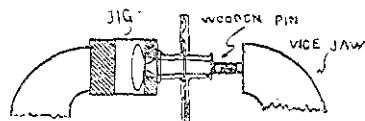


FIG. 43.

method employed to remove a stopcock key that has stuck is to place a small piece of wood on the end of the plug and to hammer till the plug is free. This often results in cracking the barrel or in chipping the key, and, in complex apparatus, in the breakage of important parts. If, however, a steady

pressure is exerted on the plug with the glass in contact with

nothing but wood, it can easily be removed without any damage to any of the parts.

A piece of hard wood is cut so as to allow the key of the stopper to pass freely through a hole which is not large enough to allow the barrel to pass (Fig. 43). A short hard wood pin is placed against the smaller end of the plug, and the whole is put between the jaws of a vice, which on being closed exert a strong, steady pressure. It is claimed that by this means stopcocks can be quickly removed without breakage. S. E.

155. The Use of Standard Dies in Making Ground Glass Joints. S. F. ACREE (*J. Ind. Eng. Chem.*, 1919, 11, 338).—

In view of the importance of ground glass joints, it is urged that a uniform taper should be adopted for all stoppers, stopcocks, etc. If such a standard taper and size were adopted, replacement of broken parts of apparatus would be very much facilitated. The angle of the morse taper corresponds to a general decrease in diameter of 0.625 in. per foot, and is nearly ideal for ground glass joints. At the present time there are eight different sizes of these standard tapers available, and although they do not completely overlap, the gaps are so small that practically any diameter of ground glass joint can be obtained.

The morse taper *A* (Fig. 44) can be used for making a tool steel collar, *B*, which is used for grinding the outside of the key. The grooves *D* in *B* and *C* hold the emery during grinding. The sets of such tools should be made and labelled 1, 2, and 3. No. 1 should be used for rough grinding, No. 2 for fine grinding, and No. 3 for finishing. Since the wear on No. 1 will be much greater than on 2 or 3 it will lose its shape first, and when it has become worn too badly it should be replaced by No. 2. No. 2 is replaced by No. 3, and a new No. 3 made to complete the new set.

These dies, it is stated, do not wear out rapidly under erosion by carborundum or emery, and the method has been found to be very satisfactory. S. E.

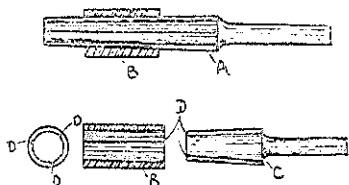


FIG. 44.

156. The Permanent Marking of Glass Vessels. J. C. BOCK (*J. Amer. Chem. Soc.*, 1919, 41, 359).—According to the author, glass vessels may be marked by a process very similar to that used in painting on glass. A suitable colour consisting of a mixture of low-melting silicates and colouring oxides is intimately mixed with a vehicle (4 parts copaiba balsam, 1 part clove oil, 1 part lavender oil), until it is of such consistency as to run from a pen. The desired markings are made on a clean glass surface, and the article

warmed so as to dry the oil. The place where the marking has been made is heated by holding against the side of a flame. The mark first turns black, due to the carbonisation of the oils, and then begins to glow at a dull red. At this stage the article is removed and allowed to cool a little, after which the marking is again heated until it begins to glow.

The mark so obtained presents a smooth, shiny surface, and cannot be removed by either mechanical or ordinary chemical means. Microscope slides can easily be marked by this method, but they should be heated in a muffle so as to avoid breakages. S. E.

157. A Simple Form of Apparatus for Estimating the Oxygen Content of Air from the Upper Atmosphere. F. W. ASTON (*Trans. Chem. Soc.*, 1919, 115, 472).—The samples of air to be analysed are contained in test tubes holding rather more than

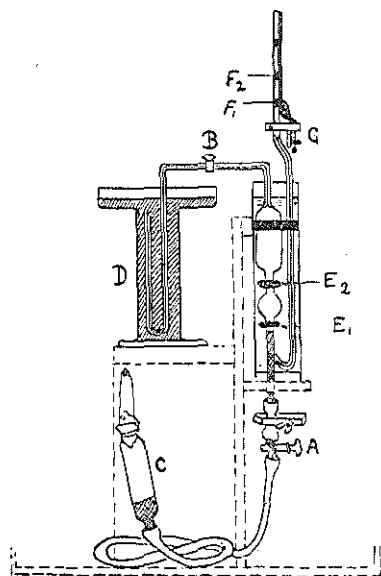


FIG. 45.

C, mercury is drawn in to fill the capillary tube and the stopcock B is turned off.

The volume of air thus introduced is constant, being that of the volume of the upper part of the barometer tube, the pressure being atmospheric plus the small difference in level between the top of the syphon tube and the mercury in the trough. This quantity is now accurately measured, and the air is then forced into a quartz test-tube containing a pellet of phosphorus, which on burning completely removes all oxygen. The nitrogen is returned to the burette, and the pressure measured at a definite volume. S. E.

158. On the Determination of Boiling Points of Solutions. F. G. CORRELL (*J. Amer. Chem. Soc.*, 1919, **41**, 721).

—The usual methods of determining the boiling point of a solution are regarded by the author as very unsatisfactory, the chief difficulty being that the thermometer must be placed in the liquid and consequently be affected by the superheating of the solution. The novel feature of the method described consists in placing the thermometer bulb in the gaseous phase, as in the case of a pure liquid, and making the boiling of the liquid pump some of the solution over it in a thin film, thus duplicating the same relations of vapour, liquid, and thermometer which ordinarily obtain in the determination of the boiling points of pure liquids.

A simple and easily constructed form of apparatus for doing this is shown in Fig. 46, in which *A* is a large test-tube, *B* a flat-bottomed specimen tube in the base of which two holes have been blown. Through these holes loosely pass the Beckmann thermometer *C* and the pump tube *D*, the thermometer as well as the tube *B* being entirely supported by the stopper *J*, while the tube *D* rests upon its shoulder *K*. As an alternative to this shoulder, a few turns of stout platinum wire may be wrapped round the tube. Another hole *E* is also provided in the side of *B* farthest from *C* to produce a balance between *A* and *B*, and to act as an overflow, thus fixing the level of the liquid in *B*. The water-jacket *F* secured by the rubber tubing *G* to the upper part of *A* forms with the latter a reflux condenser. The tube *H* serves for the introduction of the solute, and the tube *I* connects by means of a number of radiating channels through the stopper *J* with the annular condensing space between *A* and *B*. The portion of the boiling tube lying below the condenser may advantageously be protected from air currents by a wide glass tube *M*, resting on the asbestos plate *N* and covered by the mica sheet *O*.

When the liquid in *A* is boiling, part of the bubbles of vapour pass up the tube *D*, carrying a broken stream of liquid with them into *B*. The proper diameter of the tube *D* depends on the nature of the solvent used; for liquids such as ether or carbon disulphide it should be about 2 mm., but for liquids with a higher surface tension, such as water, it should be 4 mm.

The author believes that the use of this apparatus will considerably reduce any errors due to superheating, and make the boiling-point method of determining molecular weights at least as accurate as the freezing-point method.

S. E.

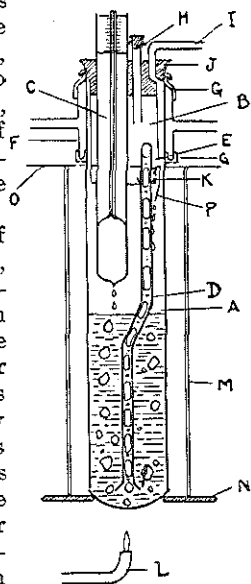


FIG. 46.

159. A Scrubber for Ammonia Distillations. B. S. DAVISSON (*J. Ind. Eng. Chem.*, 1919, 11, 465).—Two of the most

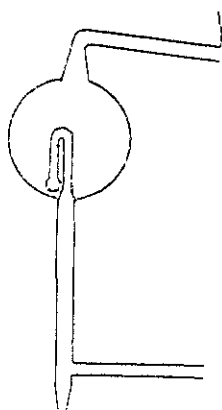


FIG. 47.

important errors encountered in ammonia distillations are those due to the entrained alkali and the soft glass used in the construction of distilling bulbs and adapters. The error from the solubility of the soft glass can be eliminated by using apparatus made of Pyrex glass, which has been found to be very satisfactory.

A distillation scrubber as shown in Fig. 47 has been found efficient in preventing alkali being carried over with the steam. The large bulb has a capacity of 200 c.c., which gives a satisfactory condensing surface. The small bulb on the inlet tube has three openings in the same horizontal plane.

The first steam passing into the bulb condenses, and, in flowing through the small bulb, acts as a scrubbing solution for the remaining vapours. As soon as

this water becomes hot it is subjected to a long period of steam distillation, thus removing all the ammonia. For delivery of the condensed liquid a special adapter with a perforated bulb is recommended. S. E.

IV.—Decorated Glass.

160. A Method of Depositing Copper on Glass. F. D. CHATTAWAY (*Proc. Roy. Soc.*, 1907, A, 80, 88).—The close relation of copper to silver led to the conclusion that it should be capable of deposition in the same way. The author found that phenylhydrazine served as a suitable reducing agent, and the following method of employing it was recommended. A mixture of one part of freshly-distilled phenylhydrazine and two parts of water is heated until a clear solution is obtained. To this about half its bulk of a warm saturated solution of cupric hydroxide in strong ammonia is added. The cupric salt is reduced to cuprous hydroxide, which remains dissolved in the ammoniacal liquid, and does not undergo any further appreciable reduction till heated. A hot 10 per cent. solution of potassium hydroxide is next added until a slight permanent precipitate of cuprous hydroxide is produced. If this colourless or pale yellow liquid be cautiously heated in contact with a perfectly clean glass surface, metallic copper is deposited upon it in the form of a thin, coherent, perfectly reflecting film.

The nature of the surface on which the metal was deposited played an important part in the process, since both silver and copper

were deposited much better on blown than upon polished glass, and upon surfaces which had not for long been exposed to the action of the air or of water. The author considered it probable that the glass surface acted as a catalyser and locally accelerated the action.

J. R. C.

V.—Optics and Optical Instruments.

161. Two-Lens Combinations. T. CHAUNDY (*Optician*, 1919, 56, 276).—The Gaussian first order geometry of a lens system, whilst enabling the first order properties of a chosen system to be determined, helped little towards the choice of a system possessing stipulated properties. The author, in this paper, dealt with the case of a pair of separated thin lenses. He showed that the “shape” of an optical system, as opposed to its “size,” depends on the ratio of the distance between the principal points, to the focal length of the combination. An expression for B , the value of this ratio, in terms of the powers of the two lenses, and the distance between them, was derived, and examples given of the use of curves plotted, from this relation with the powers of the lenses as co-ordinates. Since the condition of achromatism was a function of the same variables, it could be determined, whether achromatism was or was not possible with a given combination. The results were arrived at on the assumption that the power of the combination was positive; but the author indicated the manner in which the method could be applied to the reverse case.

J. R. C.

162. Some Generalised Forms of an Optical Equation. T. SMITH (*Trans. Optical Soc.*, 1918, 20, 23).—The equation for refraction at a spherical surface, upon which the general theory of image formation in optical instruments is based, applies strictly only to paraxial rays. In this paper the author showed how the equation may be modified, by the inclusion of an additional factor, so as to be applicable to all rays. The modification did not lead to an exact method of ray tracing, but it enabled the departure from the paraxial law at any surface to be estimated to a considerable order of accuracy.

All the angles required to specify a ray could be expressed in terms of three angles, some one of which vanished when the rays passed through any one of the three pairs of conjugate points at which there was freedom from aberration. The additional factor to be introduced was the product of the tangents of the halves of any two of these three angles, and three exact equations of refraction were thus found. The correcting factor had only to be known approximately to enable the refraction of the ray to be determined to a high order of accuracy. When rays were to be traced through a series of surfaces the most convenient form of the equation at each

surface was $\mu'/(x'-p) - \mu/(x-p) = (\mu' - \mu)/(\tau - p)$, where p was to be regarded as a correction to the radius of curvature and as a displacement of the effective unit points.

A number of illustrative calculations formed an appendix to the paper, and the results obtained were compared with the values derived by tracing rays through the system. The method, it was suggested, should prove convenient in studying eyepieces and other systems in which the obliquity of a ray to the axis was very large.

J. R. C.

163. Spectacle Lens Blemishes. J. SCOTT (*Optician*, 1919, 57, 165).—The author described the microscopical appearance of some blemishes on glass surfaces, including the ordinary scratches of "herring bone" appearance, and "glass flaws" similar to the etch effects described by Quincke (this JOURNAL, 1918, Abstr. No. 83). It is stated that crystals of *wollastonite* have been found in a glass, forming a centre from which fine cracks radiate. The appearances described are illustrated.

J. R. C.

164. The Spherical Aberration of a Thin Lens. T. Y. BAKER and L. N. G. FILON (*Trans. Optical Soc.*, 1918, 20, 58).—The Gaussian equations for the determination of the size and position of the image of a small object, formed by a thin lens, were not exactly satisfied as the rays are not paraxial. One of the defects of the image due to the departure from these equations was spherical aberration, which, if good image formation was required, must be made as small as possible. Curves of the first order caustic for different image positions were plotted, and it was shown that there was only a limited range of image positions for which over-correction of spherical aberration was possible, and that the amount of over-correction was minute. There was a physical limit beyond which the over-correction must not be applied, or it would be impossible to manufacture the lens.

J. R. C.

165. An Empirical Formula for the Longitudinal Spherical Aberrations in a Thick Lens. T. Y. BAKER and L. N. G. FILON (*Trans. Optical Soc.*, 1918, 20, 67).—The authors showed that a formula of the type $q = At_4'/(1 + Bt_4'^2)$, where t_4' is the tangent of the angle made with the axis by the Gaussian ray which passed through the geometrical image, provided a rapid and practically accurate method of obtaining the longitudinal spherical aberration in a lens, without the use of laborious trigonometrical calculations.

J. R. C.

166. The Eikonal. A. PELLETAN (*Journal de Physique*, 1907, 6, 782).—The author pointed out that construction of optical instruments had given rise to mathematical investigations which had led to many practical results. The author stated that little attention had been paid in France to the calculation of the elements of an optical system by modern methods, and he therefore gave a sum-

marised account of the theory of geometrical optics. Its development was traced from Gauss's researches to Hamilton's "characteristic function." The function known as the Eikonal was then defined and applications of it considered. The various aberrations were discussed, and the paper concluded with a chapter on objectives. J. R. C.

167. A New Half Shade Polarimeter. L. ZEHNDER (*Ann. Physik*, 1908, 26, 985).—The instrument was designed for the investigation of the polarisation produced by reflection. The light was linearly polarised previous to incidence on the reflecting surface, and after reflection was received by a modified Babinet compensator. Emerging from this again linearly polarised, it was examined by a half shade analyser, which consisted of a nicol, capable of measurable rotation, and a smoked glass plate. It was claimed that for measurements of elliptically polarised light the instrument was more accurate than the ordinary Babinet compensator combined with an analysing nicol.

For such purposes as the measurement of the rotation of plane polarised light, the compensator could be removed and the half shade analyser used alone. J. R. C.

168. The Dispersion of Artificial Double Refraction. L. N. G. FILON (*Phil. Trans. Roy. Soc.*, 1907, A, 207, 263).—When glass is compressed unequally in different directions it behaves like a crystal the optic axis of which is along the line of stress. If T_1, T_2 are the principal stresses in the wave front, μ_1, μ_2 , the refractive indices for the two rays for which the directions of vibration are along T_1, T_2 , then the relative retardation is $R = (\mu_1 - \mu_2)\tau = C(T_1 - T_2)\tau$, where τ is the thickness of the glass traversed, and C is the "stress-optical coefficient" of the glass. Wertheim found that C is independent of the wave-length of the light employed, but experiments by Pockels (Vol. II., Abs. Nos. 96, 182, and 264) and the author (Vol. II., Abs. No. 265) did not confirm this. The experiments described in this paper were undertaken to find how C varied with the light used. The method of investigation and the apparatus employed were fully described, and the various corrections discussed in the first half of the paper.

In the second half the experimental results were considered, and an empirical formula, $C = C_0 / (1 - \lambda_0/\lambda)$, C_0 and λ_0 being constants, was found to represent them. Theoretical considerations led to a formula of the type $C = \Sigma C_p / [1 - (\lambda_p/\lambda)^2]$, where λ_p is the wave-length of light belonging to one of the free periods of the atoms of the glass. The results did not fit this so well.

The majority of the glasses were borosilicates made by Zeiss. The compositions are appended. Glasses 3453 and 3296 exhibited systematic deviations from the linear law. The deviations were local, and were probably due to an absorption band corresponding to a free period efficient in producing double refraction under stress. On the whole, it was found that B_2O_3 increased and K_2O decreased the

coefficient C_0 , λ_0 being unaffected by the chemical composition. The dispersion of double-refraction was thus roughly proportional to the stress optical-coefficient. For the glass 2783, Hooke's law was not valid, and it was found that the optical effect was proportional to the stress, and not to the molecular strain.

Table of Percentage Chemical Compositions.

Number of glass.	1809.	3453.	2783.	3296.	935.	3413.	3749.
SiO ₂	35.4	68.1	52.7	67.5	32.5	31.6	70.2
PbO	18.7	—	31.6	—	28.2	23.6	—
Al ₂ O ₃	3.7	—	0.6	—	8.5	8.0	—
ZnO.....	—	—	1.2	—	—	—	—
MgO	0.5	5.4	—	0.4	—	—	—
B ₂ O ₃	34.3	5.7	1.4	15.4	27.7	33.0	5.9
K ₂ O.....	7.4	20.8	12.5	16.7	3.1	3.8	23.9

J. R. C.

169. A New Method of Measuring Directly the Double Refraction in Strained Glass. L. N. G. FILON (*Proc. Roy. Soc.*, 1907, A, 79, 440).—The author showed, by simple analysis, that a rectangular glass slab, under flexure in a vertical plane perpendicular to the direction of the incident light, by which it was examined, deflected the wave front like a prism. It did so to a different extent, according as the ray was polarised in the plane perpendicular to the plane of flexure or in that plane. If, therefore, a beam of unpolarised light was analysed, after refraction, by means of a grating, the spectrum lines all appeared doubled. By measuring the shift of the spectrum lines, the stress-optical coefficients for the two directions of polarisation could be found, and hence the absolute changes in the indices of refraction could be calculated.

J. R. C.

170. The Polarisation of Light by Reflection from Glass. L. ZEHNDER (*Ann. Physik*, 1908, 26, 998).—The instrument described in Abs. No. 167 was used to examine the polarisation of light reflected from glass surfaces. The glasses were all transparent, and it was found that ordinary unpolarised light, on reflection, became elliptically, not linearly, polarised, even when it was incident at the polarising angle. The component polarised perpendicular to the plane of incidence never vanished in the reflected beam, but had a minimum, very small, value for the principal angle of incidence. If the polarising angle was defined as that for which the component, polarised perpendicular to the plane of incidence, was least, then the principal angle of incidence and the polarising angle coincided. But this was not exactly the angle calculated from Brewster's law by means of the refractive index as determined by the method of minimum deviation, or any other method. For the six specimens examined the polarising angle experimentally ascertained was greater than the calculated angle by amounts varying up to one degree.

J. R. C.

VI.—Illumination and Illuminating Ware.

171. Preparation of Thorium Compounds. J. V. CLARKE and W. A. CLARKE (Brit. Pat. No. 120748, September 21st, 1917, No. 13617).—The specification refers to the treatment of solutions containing thorium, obtained, for instance, by dissolving in water the product of the action of sulphuric acid on monazite sand.

H. G. C.

VII. Fuels, Refractories, and Furnaces.

172. The Standardisation of Tests for Refractory Materials. II. Provisional Specification (COMMITTEE OF CERAMIC SOC., *Trans. Cer. Soc.*, 1918, 18, 251. Compare abstract of Part I, this JOURNAL, 1918, 2, A., 162).—*The Grading of Clays according to the Size of Grain*.—It is proposed to separate clay particles into groups, so that the sizes of the particles in each group range between certain specified limits determined by means of sieve analysis and elutriation.

Standard lawns established by the Institute of Mining and Metallurgy are suitable for the sieve analysis. The material should be slopped and the fine stuff washed through each lawn; the residue is then dried and weighed.

For the elutriation there are several forms of apparatus. A description and diagram are given of a convenient form to use with distilled water. Distilled water is recommended for comparison work owing to the fact that the salts dissolved in hard water tend to flocculate the clay particles.

Each elutriation should be standardised, so as to determine the volume, v , of outflow per sec.*

E. Schöne found empirically that if V represents the velocity of a stream of water in millimetres per sec., the maximum diameter, D , of spherical sand grains of specific gravity 2.65, which will just move with the stream can be represented by the expression

$$D = 0.0314 V^{0.636} \dots \dots \dots (1)$$

provided the velocity of the stream is between 0.1 and 12 mm. per sec.† It follows that when

Velocity =	0.166,	0.717,	1.460,	3.020 mm per sec.
Diameter =	0.010,	0.025,	0.040,	0.063 mm.

* This is equal to the number of millimetres of a given column of water which flows past a given point in a second multiplied by the sectional area.

† These are the limits usually employed in the analysis of clays.

When dealing with grains of specific gravity, S , appreciably different from 2.65, equation (1) becomes

$$D = 0.0518 \frac{V^{0.636}}{S-1} \dots \dots \dots (2)$$

In order to obtain fractions with the limiting sizes suggested above, the corresponding velocities can be calculated from the expression:

$$V = 104.7(S-1)^{1.57} D^{1.57} \dots \dots \dots (3)$$

These formulæ have been found to agree very closely with results obtained by actual measurement.

The following fractions have been in use for some years, and are recommended for grading finely-ground materials, fireclays, etc.

Proposed Fractions for Grading Fireclay, etc.

Maximum velocity mm. per sec.	Extreme diameters mm.	Average diameters mm.
0.18	Below 0.01	0.0063
0.30 (200's lawn)	0.01 to 0.063	0.042
Residue (120's lawn)	0.063 to 0.107	0.087

The advantage of this classification is that two of the three fractions can be separated by sieves and only one fraction is left for the elutriation.

It is often difficult to compare the fineness of two or more clays, even when knowing the fractions. For example, if a powder has the three fractions 45, 10, 45 per cent. and another the fractions 35, 25, 40 per cent., the question arises as to which is the finer powder. One method of classification employs what is called the *surface factor*.

In this system the surface area of the particles, assumed to be spherical, in each group is computed, and the surface area of the particles in all the groups added together make the so-called surface factor.*

Let W_1 , W_2 , and W_3 denote the respective weights of the fractions, W_1 being the finest, of unit weight of powder, and d_1 , d_2 , d_3 the corresponding average diameter of the grains in the fractions. The surface factor then reduces to

$$SF = 359W_1 + 53.9W_2 + 26.0W_3.$$

The clay having the smaller surface factor is the finer one of the two.

Sifting as an absolutely trustworthy guide is open to objection since spherical particles are never obtained, whilst fine sieves introduce difficulties as they hold particles in their meshes. Elutriation appears to give a more trustworthy classification.

It is suggested that speeds should be standardised in terms of water levels and nozzle apertures only. The grading limits of 0.01 and 0.05 mm. were suggested as convenient. A recommendation

* The principles are discussed in *Trans. Cer. Soc.*, 1910, 9, 94.

was also made that sand, silt, and mud should be differentiated as three big groups, with grain size:

Sand	...	...	1 mm. to 0.1 mm.
Silt	...	...	0.1 mm. to 0.01 mm.
Mud	...	...	<0.01 mm.

Each of these could be subdivided into three fractions as indicated above.

The Corrosive Action of Flue Dusts on Refractories.—A furnace in which town's gas and compressed air were used was designed and used for observing qualitatively the effect of flue dusts on refractories. The dust-feeding device consisted of a hopper with an internal cone, screw controlled by a small hand-wheel. The lifting of the cone allowed the dust to pass through a glass tube into the burner, where it became mixed with the incoming air and gas.

Bricks were placed centrally in the bottom of the firing chamber, heated slowly up to the maximum temperature, which was maintained for half an hour; a steady stream of dust was then allowed to pass into the burner and the furnace conditions kept constant for a period of thirty minutes, after the whole of the dust had been used.

The points requiring attention were:—

- (1) The distance the brick was placed from the burner.
- (2) The rate of heating.
- (3) The maximum temperature reached.
- (4) The nature of the flame (oxidising or reducing).
- (5) The time the brick was exposed to the maximum temperature before the dust was allowed to enter.
- (6) The amount and grain-size of the dust, and rate at which it was fed on to the brick.
- (7) The space between the brick. There was a tendency for dust to penetrate from the side.
- (8) The time the brick was kept heated after the dust had all been used.

A. M. J.

173. The Apparent Causes of Failure of Lead Glass-pots. A. F. GORTON (*J. Amer. Cer. Soc.*, 1918, 1, 648).—The author ascribes the strains set up in a glass-house pot during its working existence as due to (1) irregular heating in the pot arch, caused by uneven distribution of the heat; (2) mechanical strain set up during transference of the pot from the pot arch to the furnace; (3) sudden chilling on the introduction of cold (sometimes damp) batch; (4) the erosion of the clay due to the ebullition of the metal during the found; and (5) the hydrostatic pressure of the glass, which was sometimes sufficient to cause the pot walls to bulge. There were also chemical actions giving rise to weakness in the pot, such as the corrosion of the clay by the glass and the slagging action due to iron.

It was frequently very difficult to decide the exact cause of any particular pot failure, but the general defects were as follows: (1) Pitting and corrosion of the bottom usually resulting in a leak.

This was particularly marked at the junction of the bottom and side walls; (2) cracking of the bottom; no corrosion except in the crack; (3) cracking in the sides, the cracks extending through the walls and causing leakage of the pot contents; (4) holes in the sides, usually a foot or more above the bottom; (5) furrows in the side-walls, from the metal line downwards; (6) bulging of the pot sides; (7) holes through the back of the pot; (8) vertical cracks through the back of the pot; (9) cracking under the hood; (10) cracking or caving in of the crown.

From a study of the collapse of 379 pots the author found that 81 per cent. broke in the bottom, 11 per cent. in the side, and 6 per cent. in the back. Most of the bottom failures were due to cracks, and as the pots had a comparatively short life, the cracks were probably caused (1) during drying, (2) during arching, or (3) in setting. When cracks open in drying they were always from side to side. The majority of cracks ran from front to back, and in one case corresponded exactly to the situation of the prongs of the fork during the pot setting.

Corrosion was apparent in many cases, and in a great majority of instances the presence of iron was detected. In some cases the author found metallic lead at the bottom of cracks and hollows, embedded in a mass of slagged clay, from which he concluded that metallic iron reduced the lead silicate, forming ferrous silicate and metallic lead.

Iron might have an effect due to entering from the batch or from the material of the pot itself. To prevent the accidental presence of metallic iron in the batch the author recommended magnetic separation and screening just before the batch was introduced into the pot, as he regarded the corrosion as due principally to metallic iron in the batch. When iron was not the cause of the trouble, the corrosion might be due to the convection currents set up in the molten glass, which rose up the sides of the pot and tore away small portions of the clay from the sides of small crevices caused by the chilling action of the cold batch. The corrosion took place much more extensively in the more porous parts of the pot, particularly the bottom, whereas the vitrified dense portions were not acted upon to anything like the same extent.

Holes in the sides of the pot might be caused by the glass attacking a surface particle of pyrite, and then, when the more resistant surface layer had been penetrated, continuing the attack on the more porous material beneath.

Deformation of the pot was caused chiefly by the use of a pot clay not sufficiently refractory for the temperature and conditions under which it was employed, and might result directly from (1) failure to take down the stopper at the correct period of the fining process; (2) "forcing" a pot; or (3) excessive heating due to uneven distribution of heat in the furnace.

The bottom of the pot was always more porous, and therefore more liable to attack and corrosion than the sides. Lining the pot with an aluminous or porcelain-like material was unsatisfactory.

owing to the danger of the lining cracking and exposing the porous clay below. The only safe method was to burn the pot thoroughly at a temperature of about 1400° , the heat being applied directly to the bottom of the pot.

The author concluded that it was highly desirable search should be made for a material superior to fireclay both in regard to its refractoriness and resistance to corrosion.

J. H. D.

174. Method for Determination of the Air in Plastic Clay. H. SPURRIER (*J. Amer. Cer. Soc.*, 1918, 1, 710).—After studying the manner in which plastic clay disintegrates under the action of boiling water the author concluded that the disruption was due to the expansion and subsequent escape of the contained gas vesicles. Clay prepared by different methods, for example, by throwing, filter pressing, or extrusion, showed distinctive disintegration on treatment with boiling water.

The method adopted for determining the amount of air contained in a sample of pugged clay was as follows: The measured (or weighed) sample of clay was placed in a strong 600 c.c. flask fitted with a two-holed rubber stopper. In one hole was fitted a gas collecting tube so arranged that suction could be applied by means of a vacuum pump. Through the other hole a piece of glass tubing was passed which could be connected at will with reservoirs of kerosene or boiling water. The apparatus was filled completely with kerosene, which was then displaced by boiling water by means of the pump. The boiling water disintegrated the clay, and the gases released were collected and measured in the gas-collecting tube.

A sample of air-free clay after being passed through a pug mill was found to contain 9.61 per cent. by volume of air. On passing this clay through another pug mill with well-set blades, the air-content was found to be 9.88 per cent., and on passing another sample five times through a special pug mill the air content was found to be 13.18 per cent.

The method was adapted for use in ascertaining the proper blade setting of pug mills and the soundness of pugged clay so far as the air-content is concerned.

J. H. D.

175. Notes on Sagger Clays and Mixtures. G. H. BROWN (*J. Amer. Cer. Soc.*, 1918, 1, 10, 716).—The author points out that the requisite properties of saggars are (1) refractoriness, (2) mechanical strength, (3) resistance to deformation, and (4) resistance to chemical changes.

Porosity and shrinkage curves are given showing the behaviour of four typical clays under heat treatment. Type (1), a vitreous bond clay, showed high shrinkage and low porosity at 1150° . At about 1250° the shrinkage attained a maximum and the porosity a minimum, both remaining practically constant for further temperature increases; type (2), a refractory open-burning clay with high porosity and low shrinkage at 1150° , both becoming constant at 1300° ; type (3), a clay with high porosity and low shrinkage at

1150°; the porosity decreasing and the shrinkage increasing steadily with increasing temperature, but equilibrium not attained until a very high temperature was reached; type (4), the shrinkage increasing and porosity decreasing up to a temperature of 1275°. On further heating, the shrinkage decreased and porosity increased rapidly, showing the development of a vesicular structure.

Type (1) was suitable for a bond clay and type (2) for a base clay, but types 3 and 4 were unsuitable for saggar making.

The mechanical strength of the burnt clay depended upon (1) the extent to which the bond clay vitrified at the finishing temperature of the kiln, (2) the size and grading and the proportion of grog, and (3) the presence or absence of hair cracks produced during drying and firing. The greater the amount of bond clay in the mixture the greater its mechanical strength, but the smaller its power of resisting temperature changes. By varying the proportions of bind clay, base clay, and grog, saggars of any desired mechanical strength could be produced. The author suggested as a good mixture the following proportions: Bind clay (vitrifying clay), 20; base clay (open burning clay), 30; and grog, 50 parts.

The causes of hair cracks were either (1) grog of too large a size or of improper grading, or (2) the use of a bond clay which had too great a drying and firing shrinkage.

Deformation of the clay at high temperatures could usually be corrected by the substitution of some or all of the vitrifying bond clay by open burning refractory clay.

To obtain resistance to temperature changes the structure of the saggar should be as open and porous as possible, consistent with sufficient mechanical strength in the cold. The presence of free quartz should be avoided as far as possible.

The author favoured the mixing of the saggar clay by the wet-pan process, and claimed that this produced a more intimate mixture than soaking and mixing by hand. To obviate crushing the grog during the mixing process, the rolls should be raised slightly from the bottom of the pan.

J. H. D.

176. The Corrosive Action of Flue Dust on Firebricks.

J. W. MELLOR and W. EMERY (*Trans. Cer. Soc.*, 1918, 18, 230).—The furnace used was that described in abstract No. 172. The following types of dust were investigated:—

- (1) Boiler flue-dust of a slate-brown colour.
- (2) Boiler flue-dust of a brown colour.
- (3) Deep red-coloured dust from the top of the retort bench of a gas works.
- (4) Dust from slag chamber between steel smelting furnace and regenerator.
- (5) Dust from blast furnace Cowper stove.
- (6) Bull dog.
- (7) Red hæmatite ore.
- (8) Tap cinder.
- (9) Lime from calcined marble.

- (10) Lime and common salt, in equal proportions.
- (11) Salt.
- (12) Sodium sulphate.
- (13) Salt and potash spar, in equal proportions.
- (14) Sodium silicate and calcium silicate in equal proportions.

The chemical composition of the dusts was stated. Only the fraction passing a 60 lawn mesh was used. At temperatures below 1300° the action of the dust was mechanical rather than chemical. Each dust had its own critical temperature, but in this survey the temperature was kept at 1400°. Five types of firebricks were used with each dust. Analyses of these are given and also a description of the texture.

A description was given of the extent of attack of each dust on each type of brick.

It was not possible to express the results of the corrosive action of flue-dusts in a quantitative manner by weight, by measurement, or by graphic diagram. Photographs of the firebricks after attack did not express the extent of attack, nor was sufficient reliance to be placed on the depth of penetration of attack to enable it to be offered as a quantitative test.

The following table attempts to summarise the results:—

Dust.	Firebrick.	Silica brick.	Fine-grained Silica-brick.
Boilerdust high in lime and ferric oxide	d.P. ; m.C.	—	—
Ferruginous boiler dust	s.P. ; s.C.	—	—
Ochreous dust from retort brick	k.P. ; s.C.	d.P. ; g.C.	—
Basic slag	d.P. ; s.C.	d.P. ; m.C.	—
Ferruginous dust high in lime	k.P. ; m.C.	d.P. ; m.C.	—
Bull dog	—	d.P. ; s.C.	—
Hæmatite (reducing flame)	—	d.P. ; s.C.	s.P. ; s.C.
Tap cinder	d.P. ; m.C.	d.P. ; m.C.	d.P. ; s.C.
Lime	s.P. ; m.C.	s.P. ; m.C.	—
Lime and salt	s.P. ; m.C.	s.P. ; m.C.	—
Salt	d.P. ; s.C.	s.P. ; m.C.	—
Sodium-sulphate	s.P. ; s.C.	s.P. ; m.C.	—
Salt and felspar	s.P. ; s.C.	s.P. ; m.C.	—
Soda-lime glass	s.P. ; s.C.	s.P. ; m.C.	—

P = penetration ; C = corrosion ; s = slight ; d = deep ; k = complete
m = medium.

g.C. = great corrosion or slagging.

It was possible that the test on a refractory could be best carried out by moulding mixtures of the dust and the ground refractory in definite proportions in the form of cones and determining the fusing point.*

In general, the penetration of the dust was greater in fireclay than in silica bricks. In most cases the bond was attacked first and the coarser grains last. In silica bricks the depth of penetration by the dust was generally less the finer the grain. The bond of a silica firebrick offered the feeblest resistance to the attack of a corrosive

* *Trans. Cer. Soc.*, 1913, 13, 12.

slag. Under oxidising conditions iron oxide did not corrode silica bricks to any noteworthy extent, but under reducing conditions ferrous silicate acted as a corrosive flux. As a rule, iron oxides corroded fireclay bricks more than silica bricks.

The dusts apparently exerted an influence on the conversion of the quartz into the low specific gravity form or forms even when the coarse grains have apparently not been penetrated.

When the dust was such that it could form a surface glaze the brick was protected from further attack, or, rather, the subsequent rate of attack was considerably diminished. Attempts to give a brick a resistant face by fusing the surface by means of a blow-pipe flame were not satisfactory because the surface skin peeled off.

A. M. J.

177. Some Notes on Silica and other Refractory Bricks made from Non-Plastic Materials. G. W. MOTTAM (*Trans Cer. Soc.*, 1918, 18, 148).—The author was led to the conclusion that in the making of refractory bricks there was a marked shortage of very fine material employed. Bricks were therefore made containing 90 per cent. of grog and 10 per cent. of fireclay by grinding the raw clay to a fine slip with two or three times its weight of grog and afterwards mixing the resulting mixture with the remainder of the ground grog. Bricks made on this principle from calcined Stourbridge fireclay showed no contraction after repeated burning, and, after a week's exposure in the port of an open-hearth steel furnace came out with the edges quite sharp.

The method is stated to be specially applicable to the grinding and preparation of materials for silica bricks. By grinding 15 to 30 per cent. of the material with lime, clay, or other binder to a fine slip and then adding this mixture to the remainder of the graded silica material there is not only the necessary fine material assured to fill in the voids and act almost as a cementing medium, but the binder is brought into intimate contact with every particle of the silica. Up to 95 per cent. of grog can be used. The degree of porosity of the resulting product depends upon the fineness and treatment of the mixture.

The author referred to the fact that Le Chatelier had been working on similar lines as regards the introduction of very fine grinding into the preparation of the mixture for silica bricks, and the following conclusions had been drawn on tests of such bricks carried out in a French works.

1. With "all fine" material the crushing strength reached 4,540 lb. per sq. in.
2. With "coarse" grains passing 100-mesh, and retained on 120-mesh, 993 lb. per sq. in.
3. With "fine" + graded grains up to $\frac{1}{2}$ in. the average was 3,095 lb. per sq. in.

All these bricks were burned at 1300°. The durability of bricks made on this system—in the same works—from similar material, and used under similar conditions, was some 200 to 300 per cent. in

excess of bricks made with the usual method of grinding, and up to the time of publication they were giving every satisfaction.

When "all fine" grinding was used the permanent expansion could be eliminated, but in the graded mixture which was preferred, it amounted to 1.6 per cent.

The author stated that the graded mixture, containing large particles, as used in the ordinary method of making, gave the best results. The fine material produced a stronger article. In silica bricks this fine material was more rapidly converted than the larger particles. Fifteen per cent. of the very fine was a decided advance on the present practice, but 25 per cent. and sometimes more was preferable.

The extra cost of grinding, with a properly arranged plant, was not a serious matter, as was evident by the price at which Portland cement (180 to 200 mesh) could be sold in normal times.

The author also pointed out that where calcination was desirable (for magnesite and some silica rocks) it would be more effectively done, and at much less cost than in shaft or chamber kilns, by reducing the rock to a powder and passing it through a rotary kiln. He suggested further that the burning of bricks, particularly the question of up- *versus* down-draught kilns, was deserving of close attention.

A. M. J.

178. Study of Silica Products. Part II. Bricks. A. BIGOT (*Trans. Cer. Soc.*, 1918, 18, 165; compare this JOURNAL, 1918, Abs. 168).—In the present paper the author dealt only with silica products used in the Martin or similar furnaces.

The products were tested analytically, physically, and micrographically, (a) on products dispatched from factories, (b) on the same products submitted to the temperature 1710° for an hour or two or to 1650° for the time necessary for their complete expansion.

In (a), the physical tests included determinations of density, porosity, and resistance to crushing. It was concluded that if the burning had been high enough and long enough the absolute density of silica products should be below 2.40 for materials made from quartzites and below 2.25 for materials made from compact flint.

In regard to porosity, certain bricks had a value of 8 per cent., others higher porosities, sometimes reaching 20 per cent. If of good quality the porosity should decrease when the products were heated to 1710°.

The resistance to crushing at ordinary temperature was measured by the process adopted by the Conservatoire National des Arts et Métiers. According to the physical properties of the products, the resistance to crushing at ordinary temperature varied from 120 to 500 kilog. per sq. cm.

In tests (b) the burning of the bricks to 1710° was performed in Bigot and Bodin's recuperative furnace. After the burning the expansion, density, porosity, and resistance to crushing when cold and at 1500° were determined. Pieces which on burning to 1710° had either softened and deformed or had melted were of inferior

quality and not suitable for use in a Martin furnace. Where they had resisted without either melting or being deformed, three principal cases occur:

(1) With increase of temperature the siliceous grains increased in volume and porosity; the cement which surrounded them was partially vitrified, contracted, and resisted (without cracking) the expansion of the silica grains. The porosity of these products decreased in proportion as they were heated to higher temperatures. The best silica products presented this peculiarity.

(2) The grains expanded too much and broke the enwrapping cement; the porosity of the product consequently increased. Such products became friable, less resistant to crushing, and were more easily attacked by the dusts and slags of furnaces.

A manufacturer wishing to use a rock the increase of volume of which was considerable should grind it finely and avoid the use of all large grains.

(3) The grains themselves fall to powder, whilst the enwrapping cement preserved its consistency and did not crack. Here, again, the porosity would have increased, the resistance to crushing at ordinary temperature decreased, and the resistance to crushing at 1500° become zero.

The author describes the results of experiments made with silica bricks taken from the arches of Martin furnaces at Creusot. Each brick showed three very distinct zones, D, E, F, D being unattacked silica brick in contact with atmosphere; E, brown in colour and containing silica grains analogous to those in D, their size decreasing as the part F was approached; F, grey, and no longer containing grains visible to the naked eye.

The following represented the mean values for a series of analyses:

	Silica.	Lime.	Magnesia.	Iron oxide.	Alumina.	Man- ganese oxide.
Grey part ...	84.60	3.55	1.05	9.25	0.60	0.95
Brown part ...	78.45	4.95	1.15	13.10	1.20	1.15

The iron in the grey part was in the ferrous state (even though the working conditions of the furnace were not, in general, reducing). In the brown part it was partially ferric; about half was attracted by a magnet. Cones made of the three materials all remained intact when heated up to 1690° ; about 1710° the brown part (E) melted and liquefied abruptly; whilst about 1730° D and F became pasty without actually melting.

The author's experiments lead him to conclude that:

(1) Contrary to the usual view that silica products are only of good quality if they contain 94—95 per cent. silica, the grey parts of the bricks which contain only 85 per cent. silica are as refractory as products with 95 per cent. silica, and far superior as regards crushing resistance at all temperatures.

(2) An excess (over 3—4 per cent.) of lime and iron oxide is not necessarily detrimental in silica products.

(3) Refractory products can be classified as (a) those of which the crushing resistance presents a maximum at about $1,000^{\circ}$; (b) those which do not present a maximum. In the first category occur kaolins, clays, bauxites, silica products, and products with carborundum as basis. In the second category should be placed products of chromite and magnesia.

The author suggests that the occurrence of a maximum crushing strength may be connected with the decrease in the coefficient of expansion which some refractories show in the neighbourhood of 1000° .

A. M. J.

179. Magnesia Ware. T. D. YENSEN (*J. Amer. Cer. Soc.*, 1918, 1, 730).—The author's process was as follows: Calcined magnesite was fused in the electric arc, and the resulting fused magnesia crushed through a 40-mesh screen. The product was mixed with 5 per cent. of hydrated magnesia and moulded into crucibles in a steel mould. The crucibles were afterwards dried and finally heated to 1800° in an electric furnace. The crucibles were strong and uniform, had little shrinkage, and showed no sign of softening at 1800° . The finished product contained 95 MgO, the remainder being chiefly SiO_2 , Al_2O_3 , and Fe_2O_3 . A purer and more highly refractory product could be obtained by using a purer raw material.

J. H. D.

180. Notes on Certain Characteristics of Porcelain. A. V. BLEININGER (*J. Amer. Cer. Soc.*, 1918, 1, 697).—The physical properties of porcelains, such as thermal expansion, heat conductivity, and electrical resistance, vary widely at different temperatures. This variation is due to variation in the stage of development of equilibrium conditions in the porcelain. The attainment of equilibrium depends upon the composition, fineness of grinding, intimacy of mixing, rate and temperature of firing, and the rate of cooling, so that as a result the amounts of undissolved silica, of glassy matrix, of undecomposed clay, and of *sillimanite* vary within wide limits in any particular porcelain. In low-fired porcelains (fired to about SK.10) the amount of undissolved quartz is large and of *sillimanite* small, and therefore it would be expected that this type would show changes in specific volume on heating corresponding with the quartz-cristobalite inversions. It would also be expected that with the employment of higher firing temperatures, causing more complete solution of the quartz and formation of *sillimanite* from the clay substance, the porcelain structure would become more homogeneous and therefore more balanced. The development of *sillimanite* is held to be desirable on account of its stability, density, low thermal expansion, and its not being subject to transformation changes.

Porcelains of excellent stability, as shown by the resistance of the bodies to sudden heating and cooling, have been obtained, in which the quartz has been replaced both by clay and by synthetic *silli-*

manite (prepared by heating a mixture of 258 parts of kaolin, 102 parts of calcined alumina, and 7.2 parts of boric acid to SK.20 and grinding the product). The porcelain obtained from a mixture of 40 parts of the *sillimanite* calcine, 40 parts of clay, and 20 parts of flux showed excellent resistant properties as regards sudden heating and cooling, and also high mechanical strength. Similar results were obtained by the use of other minerals not subject to molecular transformations, such as fused alumina and zirconium oxide.

It was found that the higher the felspar content in porcelain the lower was the electrical resistance. By eliminating the felspar and increasing the maturing temperature of the porcelain to SK.18—20 bodies of good resistance were obtained. Replacing the felspar by synthetic silicates containing beryllium oxide, magnesia, etc., had a similar result in improving the resistance of the porcelain. With high felspar content polarisation phenomena become evident, indicating that the felspar acts as an electrolyte. J. H. D.

181. Zirconia and its Uses. A. GRANGER (*Moniteur Scientifique*, 1919, p. 5).—Among the chief zirconia-containing minerals mentioned by the author are those recently discovered in Brazil, *zirkite* and *baddeleyite*. The working up of various minerals which are compounds of zirconia and other oxides with silica, can be effected with the aid of hydrofluoric or sulphuric acid, by fusion with alkalis, or by transforming the zirconia into a carbide. An often troublesome impurity is iron oxide, which can only partly be extracted by acids, and which stands in the way of the much-attempted utilisation of zirconia for rendering glasses and enamels opaque. The minerals and zirconia itself are not very satisfactory as abrasives because a suitable binder is difficult to find. This is also the main trouble in the use of zirconia as a refractory material, for which it is held to be otherwise excellently suited. Crucibles and tubes for electrical resistance heating have been made from zircon, using calcium oxide, sodium silicate, organic compounds, and clay as binders. The crucibles were satisfactory, but the resistance tubes were soon destroyed by arcing. Zirconia bricks with tar as binder have proved very satisfactory and economical when used for lining open hearth steel furnaces; such bricks, however, are attacked by fluorides and acid sulphates. S. E.

182. Zirconia: Its Occurrence and Application. H. C. MEYER (*Trans. Cer. Soc.*, 1918, 18, 264).—The word “zirkite” was used by the author to designate any commercial ore of zirconium such as that furnished by the deposits near Caldas, Brazil. This was essentially a mixture of *brazilitite*, *zircon*, and a new and unnamed zirconium silicate.

The zirkite could be roughly divided into two classes: (1) Alluvial pebbles ranging in size from $\frac{1}{2}$ in. to 3 in. in diameter and carrying about 90 to 93 per cent. of zirconium oxide. These pebbles, known as “favas” and having a specific gravity ranging from 4.8 to 5.2,

were found along small stream beds and on the talus slopes of low ridges. (2) Zirconia ore proper, which ranged in shade from a light grey to a blue-black. The lighter coloured material carried a higher percentage of zirconium silicate; the blue-black ore contained from 80 to 85 per cent. ZrO_2 . This ore had the same crystalline form as zircon (67 per cent. ZrO_2), but it was readily soluble in hydrofluoric acid, whilst zircon was not affected.

No extensive development had yet been attempted; most of the mines were many miles from the railroad, and primitive carts requiring eight to sixteen oxen had to be used for transport over the mountainous roads. To indicate the variation in the character of zirkite, six representative analyses were given:—

	1.	2.	3.	4.	5.	6.
ZrO_2	93.18	81.75	86.57	85.93	82.00	71.88
SiO_2	1.94	15.49	2.50	9.35	11.38	25.31
TiO_2	0.69	0.50	1.43	1.84	0.36	0.63
Fe_2O_3	2.76	1.06	5.29	1.92	2.08	0.43
Al_2O_3	0.64	0.85	1.00	0.36	0.62	0.15
MnO	trace	trace	—	—	—	—
H_2O	0.47	0.63	3.32	1.56	3.35	1.56
	99.68	100.28	100.11	100.97	99.79	99.96

The other important ore of zirconia was the silicate known mineralogically as *zircon*. Unlike zirkite, there were several important deposits of this type of zirconia ore in various parts of the world, namely, N. Carolina, Florida (U.S.A.), S. Norway, and Brazil. In the case of the Florida and Brazil deposits the *zircon* was secured as a by-product in the electro-magnetic concentration of monazite sand.

Zircon sand consisted of minute, glassy crystals and had very much the appearance of a fine, white sea sand.

A theoretically pure *zircon* only carried 67 per cent. of ZrO_2 ; an average *zircon* sand carried about 64 per cent. of ZrO_2 , whereas even the low grades of zirkite carried a minimum of 70 per cent. of ZrO_2 . This low oxide content coupled with the fact that *zircon* was not so amenable to chemical treatment as zirkite made an extensive demand for *zircon* doubtful.

The high melting point, low coefficient of expansion, and low thermal conductivity caused zirkite to rank as a refractory of the first order. Zirkite itself had little or no plasticity, and the selection of the proper binder governed the melting point and fire-shrinkage of zirkite brick. Briquettes had been made to test various binders, electrically dead-burnt magnesia and water-ground zirkite having given the best results.

The cost of electrically dead-burnt magnesia was so heavy that it was often replaced by ordinary calcined magnesia, although it had an extremely high shrinkage.

The following formulæ were used in the making of briquettes which were carefully dried and burnt at a temperature of 1427° approximately:

Formula 3A.

- 45 grams of zirkite (ground to pass 80-mesh screen).
- 45 grams of magnesium oxide (calcined).
- 10 grams of water-ground zirkite.

Formula 3B.

- 72 grams of zirkite (ground to pass 80-mesh screen).
- 18 grams of magnesium oxide (calcined).
- 10 grams of water-ground zirkite.

The briquettes made from the two formulæ had much the same appearance—a brownish-yellow cast, a rather loose texture, but quite resistant to abrasion, and of a fair tensile strength. The fire shrinkage in each case was approximately 8 per cent. linear measurement. One of the briquettes at a white heat was dropped into a beaker of water, but no cracks were developed and the material was apparently as solid as before quenching.

Some standard-sized firebricks were also made, using zirkite ground to pass an 80-mesh screen and 5 per cent. clay. The mass was slightly moistened and formed into bricks in the same manner as was pursued in the manufacture of silica or chrome bricks. After thorough drying, the bricks were burnt in a silica brick kiln at an estimated temperature of at least 1649°. Such bricks were tested in various ways. A temperature of 1800° appeared to be the upper limit at which such bricks could be safely used; for while the bricks did not fuse or flow under their own weight at that temperature, they were readily affected by pressure. Used in a furnace up to 1800°, the bricks would have been deformed.

Whilst not entirely free from shrinking and cracking, these bricks were better in this respect than magnesite bricks, although not so good as carborundum. Their heat conductivity was apparently less than that of other high refractories.

After heating to 1800° in contact with the carbon of a resistance furnace the surface of the bricks was slightly pitted and spongy, but the effect is not so bad and can probably be controlled.

A satisfactory commercial process has now been perfected for the manufacture of zirkite brick in the U.S.A.

Metallic Zirconium.—This has been produced in small quantities by Dr. C. James, of New Hampshire College, U.S.A. It is in the form of a greyish-black, amorphous powder, which gives a powerful evolution of hydrogen when treated with hydrofluoric acid. When shaken near a flame the metal produces brilliant sparks, and small quantities can be readily ignited with a match. There are two other forms of metallic zirconium, namely, the crystalline and the graphitic types. The crystalline form has a density 6.4 and a melting point 1500°.

Summary of the Commercial Uses of Zirconium.

A. 1. The metal alloyed with iron is now finding application in the steel industry as a hardening agent.

2. As a scavenger for removing nitrogen and oxides from steel.
 3. For the manufacture of drawn filaments for incandescent lamps. (Such filaments are claimed to have the property of selective radiation; in other words, emit more light than corresponds with the temperature to which they are heated by the electric current.)
 4. To alloy with nickel for the production of high-speed cutting tools.
- B.* 1. The carbide is employed as a filament for incandescent lamps.
2. As an abrasive.
- C.* 1. The oxide is employed as a refractory body either in its pure form or in the semi-purified state known as zirkite.
2. In the manufacture of zirkite bricks.
 3. In the manufacture of small, highly refractory utensils for laboratory purposes.
 4. Combined with yttrium earth oxides for the manufacture of Nernst glowers.
 5. As a substitute for calcium oxide in "lime" light cylinders and in the manufacture of pencils for the Blériot automobile headlight.
 6. As an acid-proof enamel.
 7. As a substitute for bismuth salts in making X-ray photographs.
 8. As an addition to fused silica ware for the prevention of devitrification.
- D.* 1. The nitrate has been employed as a food preservative.
2. In the "lighting" fluids used in the manufacture of incandescent mantles.
- E.* 1. The basic acetate is employed for weighting silks.

A. M. J.

183. Refractory Compositions. G. MARSH (Brit. Pat. No. 120471, December 3rd, 1917, No. 17893).—Ground furnace slag, slate waste, infusorial earths, and similar materials in admixture with Portland, Roman, or hydraulic cement, and, if desired, plumbago, are mixed with a solution of a proteid substance such as casein, blood, glue, gelatin. The solution may contain also sodium or potassium silicate, with or without addition of borax, boric acid, or ammonia. The mixture, when dried, is intended for use as a refractory material. Slate dust, slate waste, marble, granite, or similar material, mixed with Portland, Roman, or hydraulic cement, is mixed also with a similar solution to form artificial slate.

H. G. C.

184. A New Type of Recuperative Furnace. W. ROSENHAIN and E. A. COAD-PRYOR (*Engineering*, 1919, 107, 702).—In this paper, read before the Ceramic Society, the authors describe a new type of experimental furnace suitable for glass melting and for the firing and testing of refractories requiring very high temperatures for a considerable time. Since it was regarded as essential that

a "night-shift" should be avoided, furnaces with air-blast from fan or blower and furnaces of the regenerative type were ruled out at once, whilst existing types of recuperative furnaces did not appear to be adaptable for use in small sizes, owing to the relatively large dimensions of the recuperator blocks and the thickness of the walls of the passages through which the interchange of heat takes place. The authors therefore designed a furnace with a natural draught which they state is not only eminently successful and satisfactory for their special purpose, but appears adaptable both to much larger and to smaller sizes.

Coal gas was the fuel used, and the authors considered that the principal factor must lie in the design and construction of the recuperator, and this in turn determined the entire design of the furnace. The only form of recuperator which gave promise of afford-

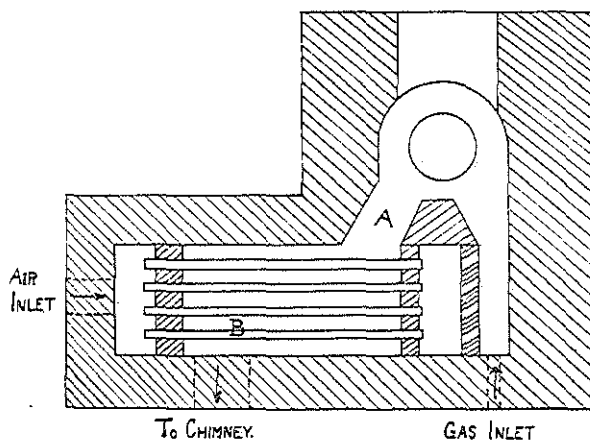


FIG. 48

ing the desired efficiency appeared to consist of a nest or battery of tubes through which the incoming air is drawn, while the products of combustion circulate about the interior of the tubes. Sets of tubes made of vitreous silica, of the best fireclay, and of "salamander," rapidly failed in succession either by breakage or "sagging." Tubes made of a mixture of carborundum and China clay or good fireclay, proved eminently satisfactory. The composition of the tubes used varied somewhat, a larger percentage of clay being permissible in those tubes intended for use in the cooler parts of the recuperator. For the hottest parts, reaching a temperature of between 1400° and 1500° , a mixture of about 20 per cent. of China clay and 80 per cent. of silicon carbide was found quite satisfactory, although successful tubes were made with China clay up to 40 per cent. Care must, however, be taken to see that the China clay is of the most refractory type, and not contaminated with foreign fluxes. The tubes were fired up to a temperature of fully 1500° , a temperature higher than that at which they were

to be used. This is important, since carborundum articles exhibit a great tendency to deformity the first time they are raised to a given temperature. During the firing they must, therefore, be carefully supported, and must not be used at a higher temperature than that to which they have been initially fired.

In the first furnace designed for glass-melting experiments, the combustion space was approximately cylindrical with a diameter of 24 in., and a height of 18 in., with a total volume of 4.8 cu. ft. and an internal surface of 16 sq. ft. The general arrangement of this furnace is indicated in the diagram Fig. 48, which shows a horizontal section. The recuperator contained fourteen tubes each 4 ft. long and $1\frac{1}{2}$ in. in diameter. The products of combustion took an uninterrupted course direct from the combustion chamber to the outlet flue, from *A* to *B* in the horizontal section, Fig. 48. The incoming air was not sufficiently heated, and there was undue heating in the chimney. The arrangement was, therefore, modified

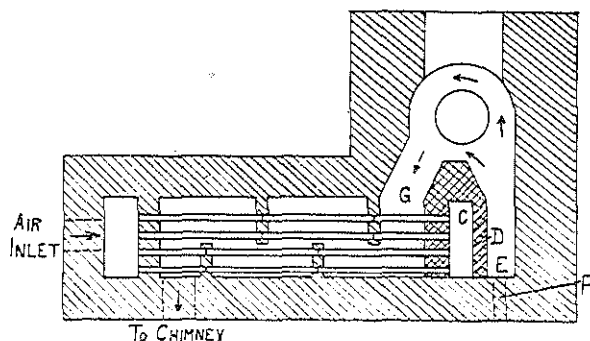


FIG. 49.

(Fig. 49). The number of tubes was increased to twenty and the recuperator lengthened by 13 in., the diameter of the tubes remaining the same as before. The course of the products of combustion through the recuperator were, however, controlled by four baffles, which caused the gases to follow a zig-zag and, consequently, much longer path from the combustion chamber to the outlet flue. This type of furnace gave very satisfactory service, temperatures of 1550° being obtained with ease in the melting chamber, whilst adjustment and control were easily achieved. From Fig. 49 it will be seen that pre-heated air leaving the tubes passes into a collecting chamber (*C*), and is then directed by a series of baffles (*D*) into a mixing chamber (*E*). Here it meets the coal gas, which enters by three horizontal tubes or burners (*F*); the flame is developed in chamber (*E*) and in the space around the pot in the combustion chamber, and passes out through the exit (*G*) into the recuperator. This particular furnace was provided with an opening at the front, through which the pots could be inserted or removed, and a working opening in the roof for manipulating the glass or other contents of the pot. In the subsequent development of the furnace the recuperator tubes

are much more numerous, thinner, and of smaller diameter, whilst the system of baffles was used more extensively.

Figs. 50 and 51 illustrate in horizontal and vertical section a

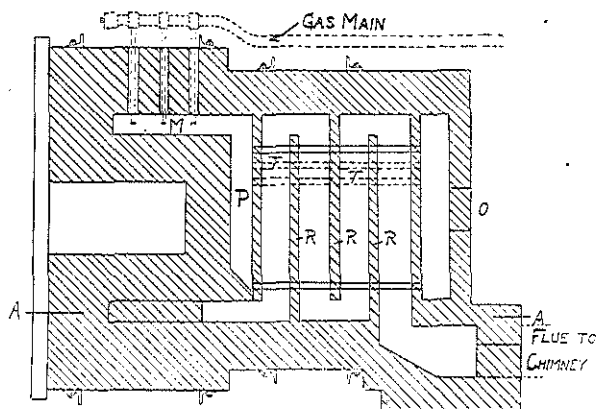


FIG. 50.

furnace for the experimental firing and testing of refractories at high temperatures. The working chamber of this furnace has a floor area of 2 ft. 9 in. wide by 1 ft. 6 in. deep, having an arched

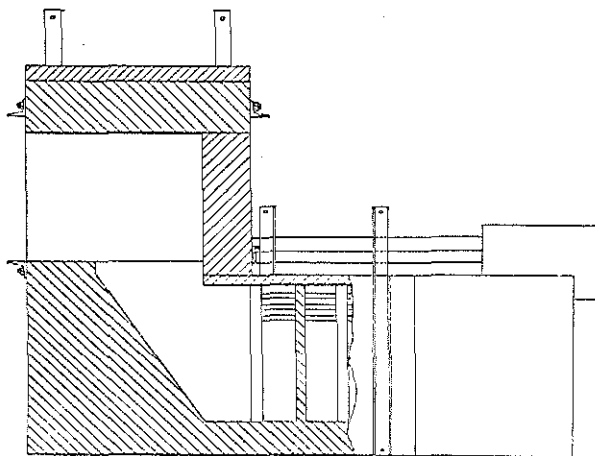


FIG. 51.

roof with a minimum of 20 in., thus giving a total volume of 10 cu. ft. The flame passes horizontally across this space and a very uniform heat is produced, the variation from the inlet end to the exit end being of the order of 20° at temperatures in the neigh-

bourhood of 1500° . Temperatures as high as 1650° have been attained.

Air entering at (*O*) passes through the tubes (*T*) into a collecting chamber (*P*), and thence into the mixing chamber (*M*). Here it meets the coal gas, the flame is formed and ascends into the furnace chamber, which is placed at a higher level than the recuperator. From the combustion chamber the hot gases descend and pass through the recuperator, being forced to take a long zigzag course by the three baffles (*R*).

The recuperator contains nine courses of tubes, each course consisting of thirteen tubes, each tube being made up of four 8 in. lengths. To prevent the cracking and breakage of the tubes as the result of thermal expansion, shrinkage or other movements occurring in the furnace and the baffles, the latter are not attached rigidly to the furnace, but stand on the floor of the recuperator chamber on a layer of grog of a refractory clay. They are not fastened to the walls, but fit loosely in slots, the leakage through these crevices being very small. The joints of the tubes rest loosely on the baffles.

Magnesite bricks were found to fail rapidly in consequence of "spalling"; crude zirconia bricks lasted longer than the magnesite, but failed through the same cause. The zirconia bricks, however, were eminently successful from the point of view of heat conservation, the gas consumption of the furnace for a standard working temperature of 1500° being decreased from 1200 cu. ft. per hour to 720 cu. ft. per hour. A marked diminution in the temperature of the external walls of the furnace was noticed.

The furnaces described are constructed of good quality firebrick protected by a wash of carborundum made by mixing the powdered carbide with 5 per cent. of China clay, in the form of a slip, and applying this with a brush.

The draught used in the working of these furnaces is obtained from chimneys less than 35 ft. in height, forced draught, of low pressure, derived from a fan, only being resorted to in exceptional circumstances. The gas consumption of the kiln furnace described, running at a temperature of 1500° , was 600 cu. ft. per hour of town gas of approximately 500 B.T.U. The air temperature, where the air left the recuperator, was between 250° and 300° below that of the working chamber of the furnace. With the furnace running at 1400° , the row of tubes nearest to the furnace chamber attained 1200° , the second row 900° , and the third row 650° .

Careful control of gas and air supply was necessary. The atmosphere in the furnace when working at fullest efficiency should be slightly oxidising. The authors found it an advantage to use a carbon dioxide recorder on the flue gases as a means of securing a proper adjustment of gas and air.

F. W. H.

185. Regenerative Liquid Fuel Furnaces. A. M. AUBERT, FRANCE (Brit. Pat. No. 120559. October 10th, 1918, No. 16518. Convention date, October 22nd, 1917. Not yet accepted.)—In a tilt-

ing furnace having reversible regenerators at the ends, a pair of interchangeable connections is provided between each regenerator and the furnace, one suitable for the supply of air, and the other for the exit of the combustion products. As shown, each connection, d, e (Fig. 52), is in two parts, d^1, d^2 , and e^1, e^2 , on the regenerator and furnace respectively, and these parts are carried by sector plates, b, f , mounted on pins, c , so that either the parts forming the air inlet connection or the combustion product outlet can be

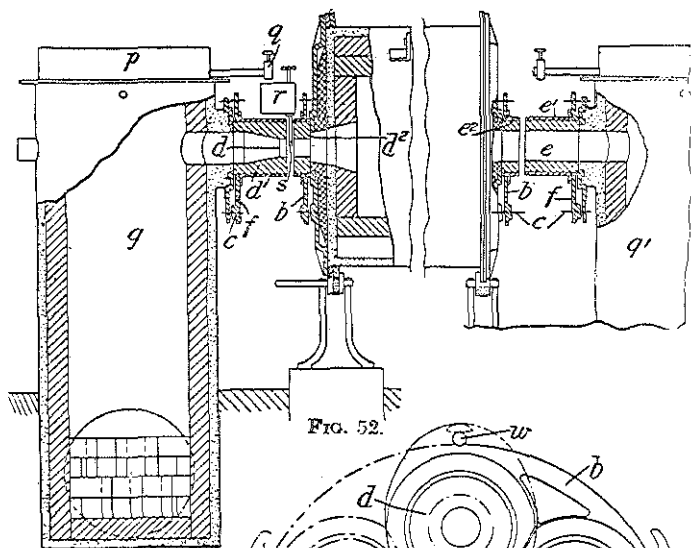


FIG. 52.

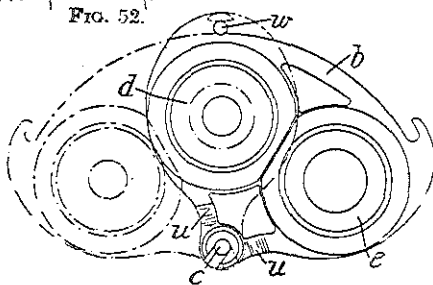


FIG. 53.

brought into operative position between the regenerators and the furnace. Each part consists of a metal casing with a refractory lining of suitable form. The sector plates are manipulated by tools inserted into sockets, u (Fig. 53), and their range of movement is limited by threaded pins, w , carrying locking-nuts. Mounted on each regenerator, g, g^1 , is a melting tank, p , from which molten pitch passes through a filter, q , to a tank, r , with a valve-controlled delivery pipe, s . In addition to the regenerative chambers, g, g^1 , a second set of chambers is provided. The reversing device consists of a double breeches-pipe with four pivoted valves. H. G. C.

186. Fittings for Furnace Doors. W. WRAGG (Brit. Pat. No. 120502, February 22nd, 1918, No. 3161).—The door, *a* (Fig. 54), of a metallurgical or other furnace is provided with detachable flanges, *b*, which are formed with slotted lugs, *b*², preferably kinked, to engage recesses round the periphery of the main plate, *a*, and are secured by cotters, *c*. The plate, *a*, may be made of malleable iron or steel.

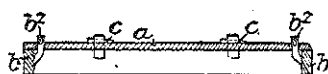


FIG. 54.

H. G. C.

187. Preheating of Air. A. HOLLIS (Brit. Pat. No. 113534 April 4th, 1917, No. 4862).—In an air-, steam-, or gas-heating furnace, more particularly intended for superheating the air supply to a gas-producer, the furnace chamber is fitted with baffle-walls, *b*, *c*, Fig. 55, depending from the roof and springing from the floor respectively, and vertical portions of the heating-pipes are arranged to continue the line of the baffles, *b*. The ranges of vertical pipes,

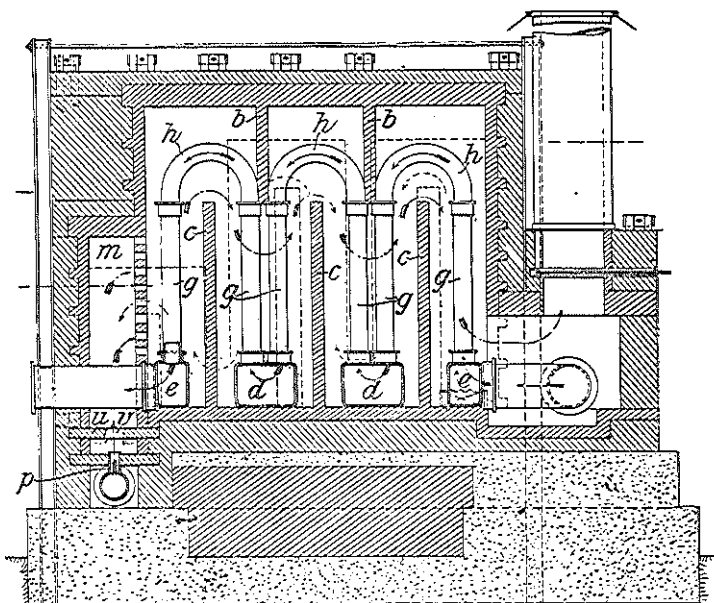


FIG. 55.

g, are connected together by headers, *d*, arranged symmetrically beneath the baffles, *b*, and headers, *e*, and U-bends, *h*. The furnace is heated by the combustion of gas and air in a chamber, *m*, at one end, and the products flow in counter-current to the air or gas to be heated. The air for combustion is heated in flues in the side walls of the furnace, and is supplied to a flue beneath a partition, *u*, having coned openings, *v*, in alignment with the burner nozzles, *p*.

H. G. C.

188. Regenerative Coke and Muffle Furnaces. SIMON-CARVES, LTD., and J. H. BROWN (Brit. Pat. No. 113696, March 24th, 1917, No. 4255).—In a coke oven or muffle furnace installation with heating-flues between the walls of adjacent ovens, the air and gas for combustion are heated in passages situated between flues for the outgoing products of combustion. In the coke oven (construction shown) pairs of heating-flues are connected in the form of an inverted U and are provided with burner ports at the base of one limb, and outlets for the products of combustion at the base of the other, leading by passages, *F*, *f*, to flues, *b*¹, *b*², in regenerators situated vertically beneath the ovens. The air and gas are heated in the passages, *H*, *h*, of adjacent regenerators, and flow through sole flues, *E*, *e*, and burner ports, *E*¹, *e*², to the heating-flues. The regenerator passages are preferably baffled by chequer brickwork. A portion of the air may be mixed with the gas to be heated, and passages, *O*, beneath the heating-flues may be provided for the supply of rich coke-oven or other gas.

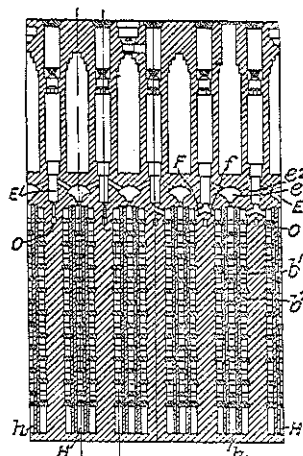


FIG. 56.

H. G. C.

189. Atmospheric Gas Burners. FLETCHER, RUSSELL & Co., T. W. FLETCHER and W. BANKS (Brit. Pat. No. 113355, March 27th, 1917, No. 4413).—The detachable burner nozzle, *d* (Fig. 57), is supported on a flange, *f*, on the secondary rectangular box-shaped mixing chamber, *c*, of a furnace burner, and is provided with a depending extension, *g*, projecting into the mixing chamber, *c*, and open at its lower end or provided with slits or saw cuts, *h*, for the passage of the gaseous mixture. The joint between the rim on the nozzle and the flange, *f*, is made by an asbestos washer or suitable cement. The nozzle may have one or more orifices, and may be made of steatite or cast iron. A central tube, *j*, may be arranged within the nozzle, *g*, and its upper end may be flush or extend above the orifice of the nozzle; in the latter case, the upper edge may be flared outwardly. The removal of dust, etc., from the tube, *j*, or the admission of air to it may be effected by means of sliding doors, *k*. When the nozzle, *d*, fits the tube, *j*, the body of the nozzle is provided with slits or saw cuts for the passage of the gaseous mixture.

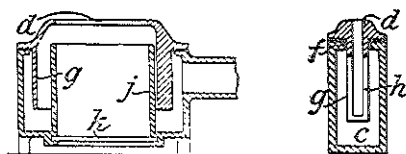


FIG. 57.

H. G. C.

190. Removing Clinker from Furnaces. C. CROCKWOOD and S. J. R. ALLWOOD (Brit. Pat. No. 113190, April 24th, 1917, No. 5716).—The non-combustible residue which collects at the sides of boiler and other furnaces is removed by means of an endless chain or toothed-like conveyor, 6 (Fig. 58), some or all of the links, 11, of which carry teeth or cutters, 12, which may be shaped as shown in Fig. 59, and which have overlapping joints so as to prevent clinkers from falling between them. The chain passes around

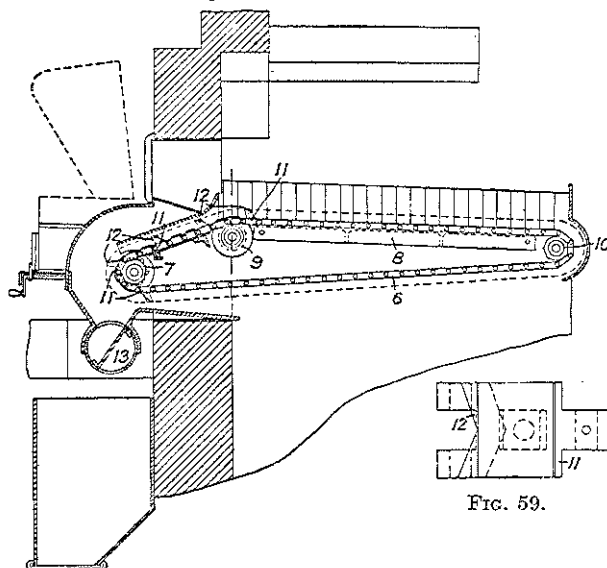


FIG. 59.

FIG. 58.

rollers, 9, 10, and a driving sprocket, 7, and is supported on its upper run on a skid bar, 8. The clinker so cut off and removed is delivered by an oscillating discharge lock, 13, to a quenching receptacle clear of existing ash-pits and boiler settings. Instead of an endless chain, a reciprocating or oscillating toothed bar with cutters may be used together with a separate conveyor. H. G. C.

191. Charging Gas Producers. E. W. HARVEY and E. N. WRIGHT (Brit. Pat. No. 113203, May 10th, 1917, No. 6626).—The shoot, *A* (Fig. 60), is mounted on trunnions, 2, 3, in bearings and carried by a casing, *E*, supported on rollers, 19, and rotated by a worm, 22, and worm-wheel. The casing is sealed at both ends by troughs, 7, 15, both of which are protected from falling material, the upper by a down-turned flange, 13, and the lower by an extension of the casing. To oscillate the shoot, an arm, 5, is fixed to one of the trunnions, and within a slot in this arm works a pin on a crank-disc, 27, which is rotated by the engagement of a bevel-pinion, 33, with a fixed rack, 34. The feed hopper, *G*, and delivery device, *D*, are carried by a casing, *F*, supported in a standard, *H*. The delivery device, *D*, is rotated from

the worm-shaft, 23, through a crank-disc, 42, link, 40, and a slotted lever, 38, which carries pawls engaging ratchets on the drum shaft.

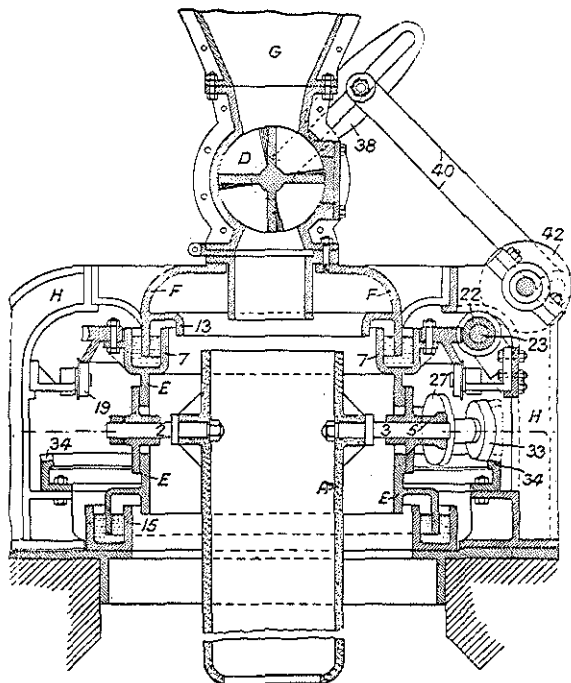


FIG. 60.

The lower end of the shoot, A, is bent in its plane of oscillation. Specification 21382/14 is referred to.

H. G. C.

192. Gas Producers. J. STEWART (Brit. Pat. No. 113182, April 10th, 1917, No. 4982).—The rotary conical base of a gas-

producer is formed with two or more grids or grates in the form of internally projecting pockets, 14 (Fig. 61). Fixed water-cooled stirrers or pokers, 19, are provided, having arms extending over and under these grates. An inlet for air, or air and steam, is provided at 24 between the stationary body of the producer and

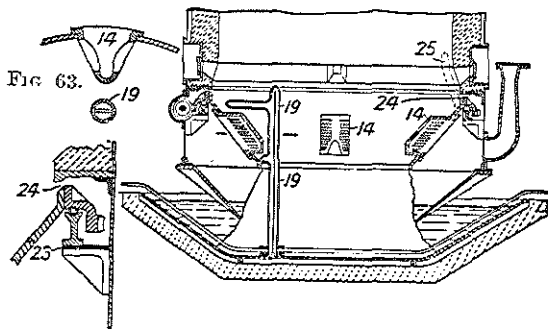


FIG. 62.

FIG. 61.

provided at 24 between the stationary body of the producer and

the top of the rotary base. This inlet may be divided off from the ash-pit by a plate, 23 (Fig. 62), on which the ball race of the bearing for the rotary base is mounted as shown in Fig. 63. The rotary base may carry upwardly projecting stirrers as indicated by dotted lines to 25 to agitate the fuel.

H. G. C.

193. Furnaces for Utilising Powdered Fuel. H. BATCHELOR, U.S.A. (Brit. Pat. No. 120522, May 17th, 1918, No. 8285).—Finely powdered coal dust and heated air are mixed together in predetermined proportions, according to an analytical determination of the carbon and hydrogen content of the coal, and the mixture is then discharged continuously into a combustion chamber in the presence of heat. As shown in

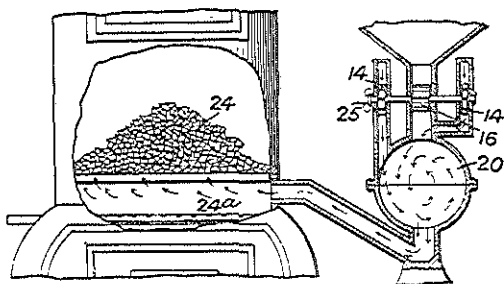


FIG. 64.

of fuel to the mixing chamber, 20, is effected by the flow of previously heated air under pressure which drives vane wheels, 14, secured to the shaft of a rotary recessed drum feeder, 16, a variable frictional resistance being controlled by a wingnut, 25. From the mixing chamber, the mixture passes beneath the grate, on which is supported a mass of refractory material, 24. At starting, the mixture is ignited by a burner, 24a.

H. G. C.

194. Metallurgical Reheating Furnaces. E. J. W. RICHARDS and W. SHANE (Brit. Pat. No. 120469, December 3rd, 1917, No. 17844).—Metal-

heating, annealing, welding, and like furnaces are constructed with a waste-gas chamber, 8 (Fig. 65), beneath the hearth, and with an air-heating chamber, 9, below, from which air passes through vertical passages, 6, to a gas- and air-mixing chamber, 3, arranged between the gas-producer, 5, and the furnace chamber. The gases from the mixing chamber pass downward to the furnace chamber. Gas enters the mixing chamber through ports arranged above the air-inlet ports.

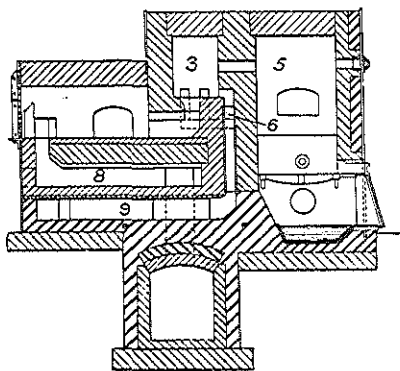


FIG. 65.

H. G. C.

195. Reversing Valves for Regenerative Furnaces. E. J. W. RICHARDS (Brit. Pat. No. 121316, December 3rd, 1917,

No. 17843).—Gas- and air-reversing valves for regenerative furnaces are constructed with a cylindrical chamber or bell, 1 (Fig. 66), having a diametral division wall, 2, which is seated in an annular

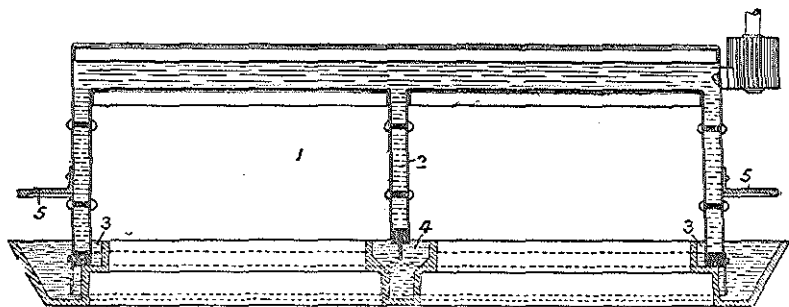


FIG. 66 (a).

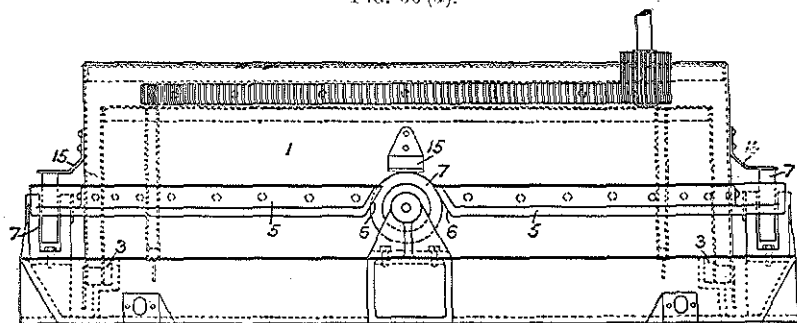


FIG. 66 (b).

water trough, 3, having cross troughs, 4, dividing the inlet and outlet ports. The chamber, 1, is rotated, and lifted and lowered

at the same time, by the action of inclined portions, 6, of an interrupted flanged ring, 5, attached to it, which ride over rollers, 7, mounted on fixed supports. The division wall, 2, is thus lifted out of one cross-trough and lowered into the other. Spring devices are provided to take the shock when the chamber, 1, is lowered. These may consist of blade springs, 15, adapted to bear on the rollers, 7, or of spring-mounted rollers, on which the flanged ring, 5, rests when in its lowest position.

H. G. C.

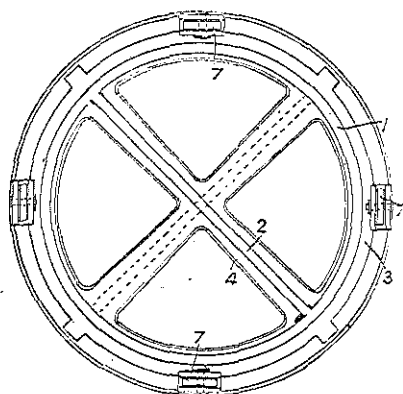


FIG. 66 (c).

196. Electric Furnaces. C. H. VON BAUR (Brit. Pat. No. 120444, November 10th, 1917, No. 16507).—Two-phase current is supplied to three pendent electrodes, C , C^1 , C^2 (Fig. 67), arranged in a furnace of oval shape in plan, such that the distance of each electrode from the walls is proportional to the current traversing it. As shown, the walls comprise circular portions of radii $1:\sqrt{2}:1$, preferably

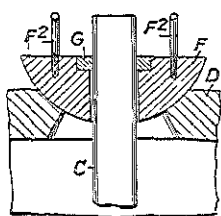


FIG. 68.

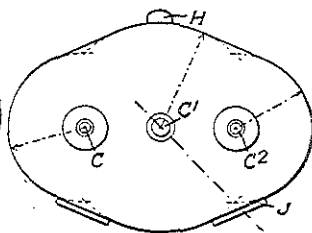


FIG. 67.

joined by tangential portions. Each outer electrode preferably enters the furnace through a partly spherical block, F , seated in the roof, so as to allow of movement over the surface of the charge. The blocks are provided with handles, F^2 (Fig. 68), and asbestos packing, G . Arcs are maintained between the electrodes and the slag, and not directly between electrodes. The furnace has charging and working doors, J , a spout, H , and a curved base unprovided with electrodes.

H. G. C.

197. Glass Re-heating Furnaces. BURDINS, Ltd., and W. BURDIN (Brit. Pat. No. 121100, August 9th, 1918, No. 12956).—In a glory-hole furnace for re-heating glass bottles, etc., the holes, j , for the reception of the bottles open into spaces, c (Fig. 69), separate from, but in communication with, a combustion chamber a , heated by a liquid-fuel or oil-gas burner. From the spaces, c , flues, d , lead the combustion products either direct to the atmosphere through the flues, e , or to the chamber, f , containing the air-supply pipe, g , for the burner. The flues, d , are restricted in size, so that a portion of the combustion products is forced to escape round the bottles through the holes, j .

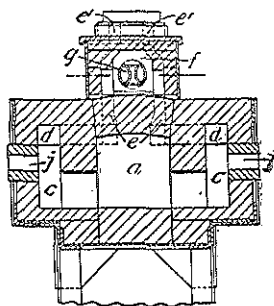


FIG. 69.

H. G. C.

198. Cooling Device for Gas Ports. O. C. BOCKMAN, Norway (Brit. Pat. No. 121111, May 17th, 1918, No. 8274. Convention date, November 27th, 1917. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—The walls of a port or passage, through which hot gases are conducted, are protected by a screen of cool gas delivered through tangentially-arranged orifices. In the construction shown, the cool gas is delivered through a hollow bushing fitted in the port, and the arrangement of the orifice is such that an annular screen of cool gas is formed

between the walls of the port and the centrally-delivered hot gas. The cool gas may be neutral or active with regard to the hot gas or the furnace charge. H. G. C.

199. The Basis and Methods of Pyrometry. F. HENNING (*Phys. Zeitschr.*, 1919, 20, 34).—Thermodynamical considerations form the theoretical basis of all methods of measuring temperature. A brief exposition by the author of the thermodynamical behaviour of an ideal gas was followed by an indication of its use in gas thermometry. Actual gases, however, deviated somewhat from the laws which the ideal gas was assumed to obey, so the theory had to be modified. Even with this alteration, gas thermometers were not practically applicable to the measurement of high temperatures, so the conception of black body radiation was introduced. The laws of Kirchhoff, Stefan, Wien, and Planck were used to develop at some length the theory arising from this conception, and an explanatory reference made to Planck's constant.

The greater part of the paper was devoted to the methods of measurement of temperature and to the instruments used. The latter could be divided into two groups, namely, contact thermometers and radiation thermometers. The former had an upper limit of applicability at that temperature at which their behaviour was uncertain on account of irreversible changes of the thermometric substance, as, for example, the boiling of the mercury in a mercury-in-glass thermometer. For very high temperatures radiation pyrometers were always used.

Among contact thermometers the author mentioned the gas thermometer, the mercury thermometer (which in the case of the gas-filled type made of Jena glass 59^{III} could be used up to 600°), and the thermo-element. The theoretical basis of the last-named was explained. The following table was given of the electromotive force, in millivolts, obtained with various couples when one junction is at 500° and the other at 0°:

Couple.	E.M.F.	Couple.	E.M.F.
Pt/90% Pt 10% Rh...	4.21	Fe/Constantan	27
Ni/90% Ni 10% Cr ...	10.0	Ag/Constantan	28
Fe/Ni	12.0	Cu/Constantan	28

It was stated that either of the formulæ $e = at + bt^2$ or $e = at^b$, expressing the *E.M.F.* as a function of the temperature, may be used for extrapolation, provided the temperature to be ascertained was not too high. In this group also were classed resistance thermometers, which depended on the variation of the electrical resistance of a metal wire with temperature. If the wire was of platinum such an instrument would give a reading correct to 0.01° up to 500°.

Radiation thermometers might be of two kinds, Fery's pyrometer being a specimen of one kind. In this and similar instruments the radiant heat from the hot body or furnace was concentrated on an iron-constantan thermo-element, to which was attached a blackened

silver plate. This plate increased the absorption of the heat rays and the *E.M.F.* produced by the consequent heating of the thermoelement provides the means of measuring the temperature. The second kind of radiation thermometer was the optical pyrometer, of which there were several modifications. Two of those were mentioned as typical. The first is that of Le Chatelier, based on the photometer of Lummer and Brodhun. The other was devised by Holborn and Kurlbaum, and in this case the hot body was viewed directly. In all its variations the optical pyrometer consisted essentially of a means of equalising the intensity of the light, of a definite wave-length or spectral band, radiated by the hot body, with that of the same wave-length emitted by a standard. The theory of the two instruments to which reference was made was developed.

The theoretical basis of all radiation pyrometers was that of "black body" radiation. In actual practice, however, perfect black body radiators were not encountered, and the author discussed the modifications of the theory which were necessary in order that the results obtained therefrom might be practically applied. Mention was also made of the difficulty of measuring the temperature of transparent bodies, such as gases, by radiation thermometers.

J. R. C.

VIII.—Chemical Analysis.

200. Sampling Granular and Like Materials. L. J. RILEY (Brit. Pat. No. 121084, June 14th, 1918, No. 9799).—A device for obtaining a sample of dry or moist granular and like materials throughout the whole depth of the heap or other bulk consists of a tapered tube (Fig. 70) open at both ends and having a removable handle passed through holes, *c, c*, in the side of the tube near the larger end. The tube is inserted in the heap and then carefully withdrawn, and the sample thus obtained removed through the larger end of the tube.

H. G. C.

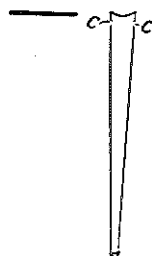


FIG. 70.

IX.—Machinery for the Working of Glass.

201. Glass-shaping Machines. HARTFORD-FAIRMONT CO., U.S.A., assignees of K. E. Peiler and E. H. Lorenz (Brit. Pat. No. 120907, November 11th, 1918, No. 18460. Convention date, November 20th, 1917. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—Relates to glass moulding and blowing machines of the rotary-table type, and particularly to duplex or multiple machines, and consists of interlocking mechanisms to secure the proper co-ordinate action of the parts and to allow any single element to be operated independently of the others.

The invention is described as applied to a machine with two rotary tables, 4 (Fig. 71), similar mechanism being fitted to both tables. The tables carry the usual moulds, 5, and are given an intermittent rotation so as to stop at the charging, pressing, and delivering positions. Fig. 72 shows, in plan, the mechanism arranged below the left-hand table, the corresponding mechanism being arranged under the right-hand table. The driving-shaft, 8, actuates, through worm and screw-gearing, cams, 13, 14, the former of which gives motion to a rocking lever, 16 (Fig. 72), and the latter acts against a roll, 20, carried by the lever. The lever, 16, actuates an arm, 22, connected by a link, 23, with an arm, 24, pivoted on the hub of the table and carrying a spring bolt, 26, adapted to engage any

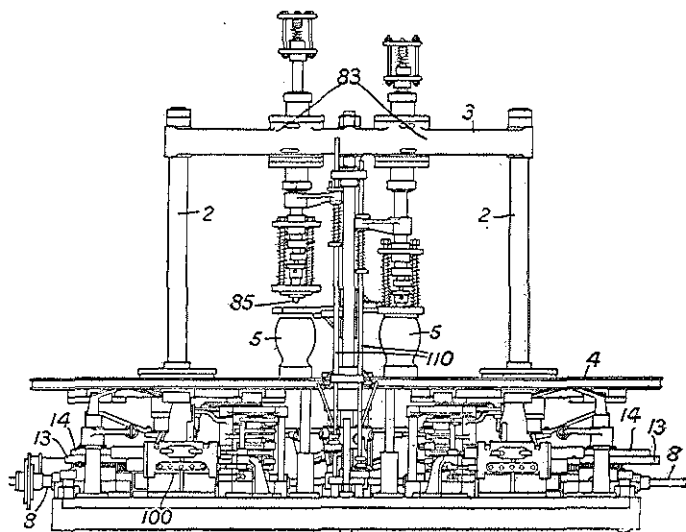


FIG. 71.

one of a series of notches, 28, formed in blocks fitted to the underside of the table. The notches also serve to receive a locking-bolt, 40, for holding the table stationary. The oscillating lever, 16, drives the table at gradually increasing speed for the first half of its motion, and during the second half is retarded by the cam, 13. The bolt, 26, is withdrawn by an arm, 36, actuated by a cam, 34, and adapted to hold it retracted during the return movement of the arm, 24, but allows the table to be moved by hand. The locking-bolt, 40, is withdrawn by a lever, 43, actuated by a cam, 47. The bolts, 26, 40, are interconnected so that, if the latter does not properly engage a notch, the arm, 36, cannot move to release the former. Both bolts may be released by a hand-lever, 51, the inner end, 52, of which holds back the lever, 43, thus leaving the table free to be rotated by hand. The bolt, 26, can be put out of action independently of the bolt, 40, by operating a treadle connected to

a rod, 55, pivoted to an arm, 54, fixed to the controller arm, 36. The table is fitted with an adjustable band brake actuated by a cam connected with the cam, 34, that actuates the bolt, 36. The moulding-plungers, 85, are of usual construction and are actuated by pneumatic cylinders, 83, mounted on a cross-bar, 3 (Fig. 71), carried by standards, 2. Air is supplied to the cylinders from a

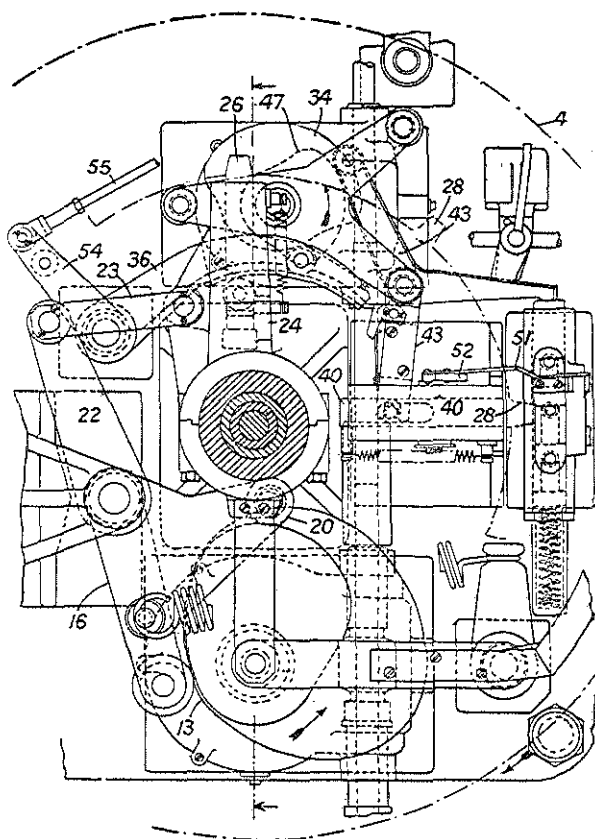


FIG. 72.

valve-chest, 100, through an automatically-operated valve, but the valve may be closed by hand when required.

The cam operating the valve interacts with the cam, 47, actuating the locking-mechanism, so that the plunger cannot descend if the bolt does not properly engage. Rods, 110, are mounted so as to move vertically with the plungers, and are connected to the table-driving mechanism, so that the table is stopped if the plunger does not rise owing to its sticking to the glass, or, if the plunger should descend while the table is moving. The plungers are cooled by air circulation. The transfer of the blank may be effected auto-

matically, and a blowing-head may be fitted to the machine and connected with the driving mechanism by interlocking mechanism.

H. G. C.

202. Semi-automatic Bottle Making Machine. E. H. LANGWELL and E. DURAND (Brit. Pat. No. 114193, March 21st, 1917, No. 4114).—Relates

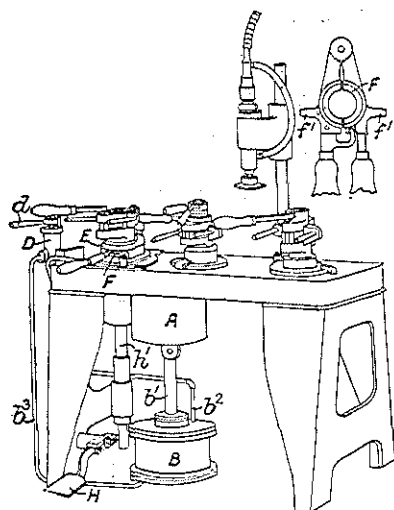


FIG. 73.

to a manually-operated machine for blowing glass bottles, and of the kind in which the suction and preliminary blowing in the parison mould are effected by two pistons working in unison in separate cylinders, to one of which compressed air is admitted by a four-part valve. According to the invention, a parison mould without a removable cover is used, and the neck ring, *F*, is made in two parts hinged together with a lug, *f*¹, on each part to support the ring in position in the parison and finishing moulds. The pistons, which work in cylinders, *A*, *B*, are connected by pipes, *b*², *b*³, to the valve, *D*, which is operated by means of a handle, *d*. The exhaust air may

be used for cooling the parison mould, *E*. The plunger of the parison mould is operated by a treadle, *H*, and rod, *h*¹, as usual.

H. G. C.

203. Bottle Making Machine. T. B. KITSON and G. O. TOGUE (Brit. Pat. No. 114477, April 5th, 1917, No. 4927).—In apparatus for making glass bottles and jars, in which the parison and finishing moulds are arranged alternately round a revolving table, all the operations of suction and blowing and of the opening and closing of the moulds, except the transfer of the parison, are effected automatically and controlled by two cams only. A barrel cam, *D* (Fig. 74), engaging rollers, *A*¹, on the underside of the table, *A*, rotates the table step by step; slides, *C*, operated by cams, *d*, *d*², on the central pillar, *B*, cause the opening and closing of the parison and blowing moulds, *a*, *b*. The divided neck-rings, *e*, are secured to arms, *e*¹, hinged together at *e*², and are adapted to fit in recesses in the brackets, *a*², *b*². The sliding bracket, *g*, carrying the plunger is moved up and down on a guide, *g*¹, by a lever having two spring-controlled arms, *g*², *g*³, mounted on a pivot, *g*⁴, and operated by collars, *g*⁶, on a central spindle, *h*, which is reciprocated vertically by an arm, *D*⁸, on a shaft, *D*⁶, carrying a lever, *D*⁵, which engages a cam, *D*², on the end of the barrel, *D*. Fig. 75 shows the

plunger, f , and suction arrangement for the parison moulds. The suction pipe, f^{11} , is connected to a cup, f^5 , which is supported in an opening in the annular flange, g^7 , of the bracket, g , by springs, g^8 , upward movement being limited by a flange, f^1 , on the cup. A

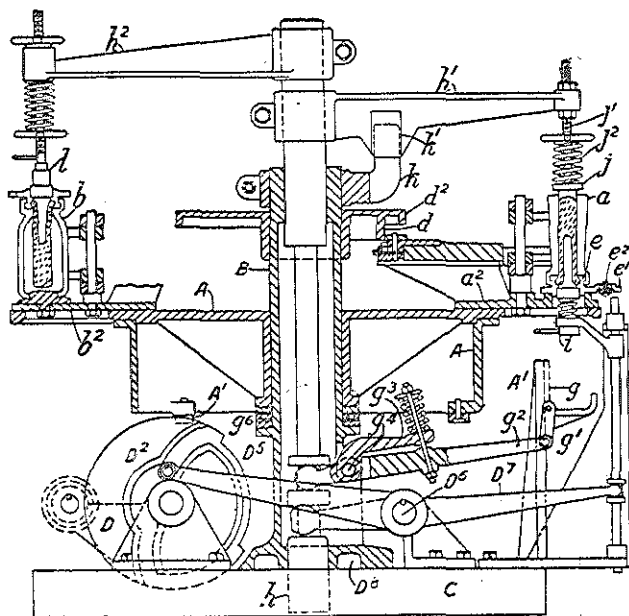


FIG. 74.

block, f^2 , on the plunger stem, f^1 , is provided with an air-groove, f^8 , from which a passage, f^9 , leads to an annular channel, f^{10} , which communicates with the mould channel, e^4 , by a fine annular slit, e^5 . A spring, f^4 , is arranged between the block, f^2 , and the cup, f^5 . The cover, j (Fig. 74), of the parison mould is carried by a cushioning-spring, j^2 , at the lower end of an adjustable screw, j^1 , on a radial arm, h^1 , adjustably secured to the spindle, h . Rotary movement of the pillar, h , and arm, h^1 , is prevented by a bent arm, k , carried by the pillar, B , and engaging a socket, k^1 , on the arm, h^1 . The adjustable blow-cap, l , is carried by a radial arm, h^2 , which is adjustable on the spindle, h , in order that it may be set so that a blowing-mould does not reach it until the parison has equalised its heat after leaving the parison mould. In operation, the parison mould having been

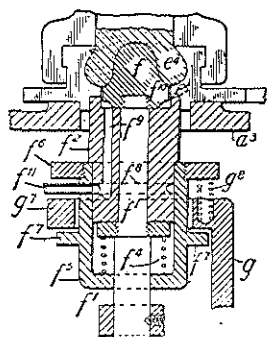


FIG. 75.

charged with glass, the plunger, *f*, is lowered by the arm, *D*¹, thus cutting off the suction by the block, *f*², being pressed upwards by the springs. The table then advances a step, whereupon the cover, *j*, descends on to the inverted parison mould and the preliminary blower, *i*, is raised by the arm, *D*¹, to blow the parison. In the next position, the parison mould having been opened by its cam, the parison is transferred by hand to one of the open blowing-moulds. During the next step, the blowing-mould is closed by the cam, *d*², and the blow-cap, *l*, descends on to the neck-ring, *e*¹, and the bottle is blown. As the table moves through the last step and completes a revolution, the blowing-mould is opened by its cam and the finished bottle is removed by the operator.

H. G. C.

204. Machinery for Glass Bottle Manufacture. SHAW-BRUNER, LTD., G. C. PYLE, and G. C. DAGER (Brit. Pat. No. 114709, June 1st, 1917, No. 7879).—In apparatus for making hollow glass-

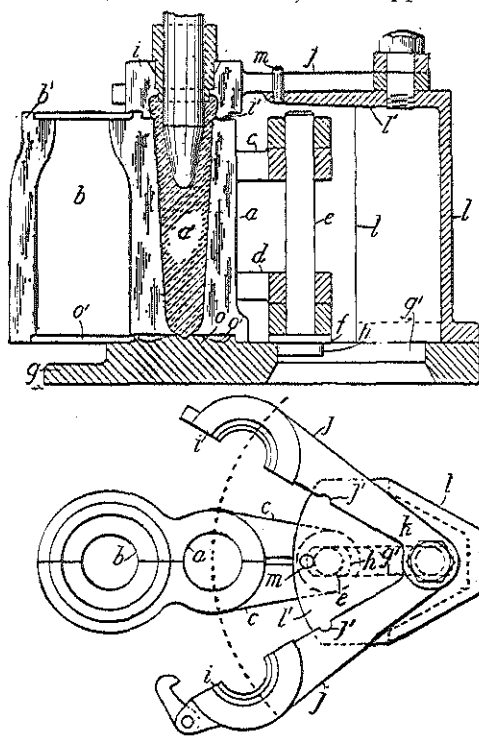


FIG. 76.

ware the parison is held at one end by the neck-mould and at the other end by a centring device or bottom mould which serves to support the parison during its transfer from the parison mould to the blowing-mould and whilst being blown in the latter. As shown, the parison mould, (*a*) (Fig. 76), and the blowing-mould, *b*, are both carried by the same set of arms or jaws, *c*, *d*, which are mounted on a hinge-pin, *e*, having at its lower end a collar, *f*, and slide, *h*, to engage a guideslot, *g'*, in the base, *g*. The divided neck-mould, *i*, is carried by arms, *j*, mounted on a pin, *k*, on the top, *l'*, of the bracket, *l*, on the base, *g*. The base-ring or

slide, *h*, reaches the other end of the slot, *g'*. When the arms, *j*, are close together, recesses, *j'*, in the arms embrace a pin, "*m*," on the part, *l'*. A short reduced portion, *i'*, of the neck-ring, *i*, engages a collar, *b'*, at the top of the mould, *b*. The mould may be stationary, and the parison carriers move from one position to the other. The arms and guides of the double mould may be carried in a reversible frame, so that the parison can be inverted.

H. G. C.

205. Glass Bottle Machines. W. FORSTER (Brit. Pat. No. 114678, April 21st, 1917, No. 5604).—Relates to machines for making glass bottles, etc., and of the type having a revolving frame or plate carrying parison moulds on opposite sides of its horizontal

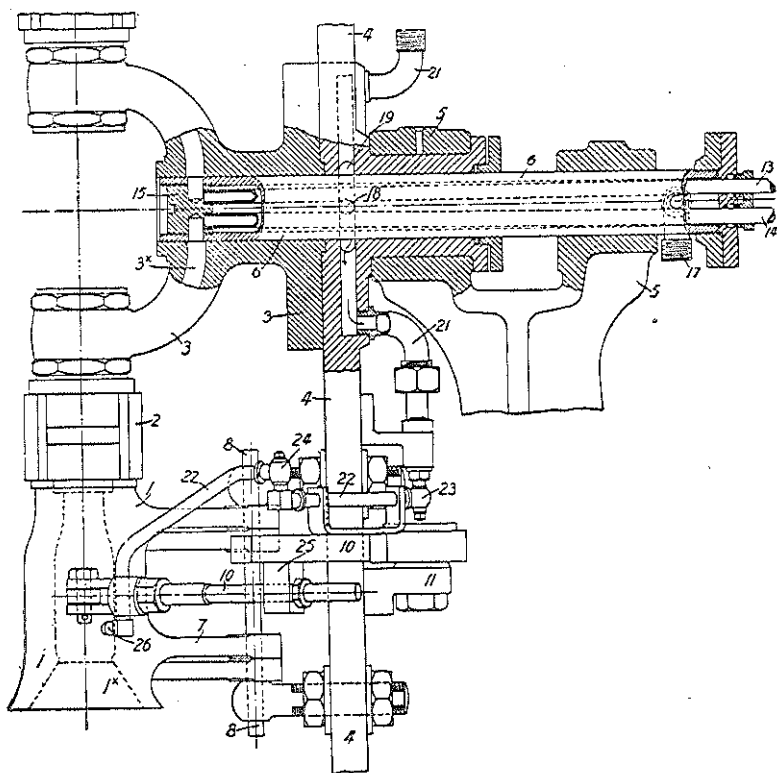


FIG. 77.

axis and two sets of neck or mouth mould carried on the terminals of a hollow double arm. The machine is constructed so as to have a vacuum and a positive air pressure in the neck or mouth mould parts alternately while in their opposite positions, and air is constantly blown on to the parison moulds for cooling them. The

neck-rings, 2 (Fig. 77), are carried by a hollow double arm, 3, on the revolving frame, 4, which is mounted on a stationary hollow

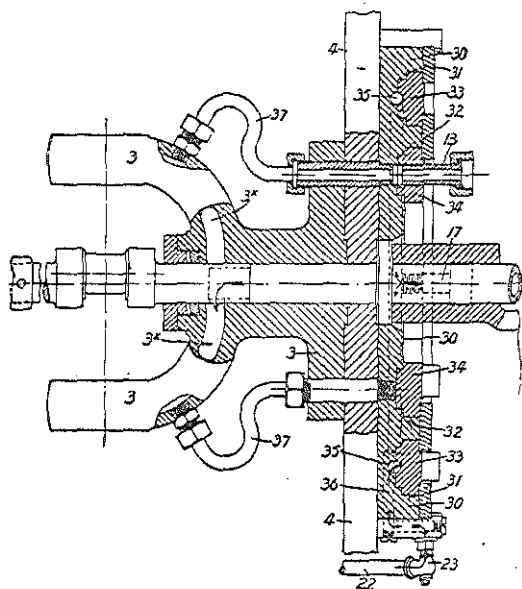


FIG. 78.

shaft, 6, within bearings, 5. The parison moulds, 1, are mounted by arms, 7, on pins, 8, carried by the frame, 4, and are opened and closed by arms, 10, mounted on pivots, 11. Tubes, 13, 14, extending through the shaft, 6, into a ported plug, 15, at the end of the shaft supply suction and compressed air to the passages, 3*, in the arms, 3, when the latter are in the upper and lower positions respectively. Air for cooling the moulds is supplied by a pipe, 17, to the shaft, 6, and passes by a port, 18, into an annular port, 19, in the frame, 4, whence pipes, 21, lead to double articulated pipes, 22, with nozzles, 26. The joints, 23, 24, of the pipes 22, are axially in line with the pivots, 11, and the joints, 25, of the arms, 10, respectively. In a modification (Fig. 78) a circular ported plate, 30, attached to the swing frame, 4, is formed with annular recesses, 31, 32, in its face to work over stationary rings, 33, 34. Compressed air passes from a connexion, 17, to an annular port, 35, in the meeting faces of the recesses, 31, and ring, 33, and then by ports, 36, to the joints, 23, of the cooling air-blast pipes, 22. The vacuum pipe, 13, is connected to the upper part of the ring, 34, and pipes, 37, on opposite sides of the axis of the plate, 30, lead to the passages, 3*, of the arms, 3, so that, when an arm is in the upper position, its passage, 3*, communicates with vacuum.

H. G. C.

206. Machinery for Drawing Glass Cylinders. A. E. SPINASSE, U.S.A. (Brit. Pat. No. 114819, November 26th, 1917, No. 17474. Convention date. April 12th. Not yet accepted. Abridged as open to inspection under Sect. 91 of the Act).—In drawing glass cylinders the hollow bait used is coated on the glass surfaces of contact with an adhesion-preventing substance. The bait is preheated to a temperature at which molten glass adheres

to it, and the coating may be applied before, but is preferably applied after, heating. Resin, tallow, oils, and waxes, or compounds of these materials, are mentioned as suitable substances for coating an iron bait heated to about 400° F., and powdered lime, magnesia, etc., for a bait heated to about 900° F. Lime in the form of paint, whitewash, or some oily emulsion of clay, paint, lime, or graphite, which may be in powdered or pasty form, is stated to be most suitable. The coating may be shaped or moulded into the form of an envelope and slipped on to the bait.

The bait may be made of cast iron, chrome, or nickel steel, etc. Fig. 79 shows a sectional bait with the sections, 4, supported by pins, 3, in socketed ears, 2, on the air-pipe, 1. Each section is fitted with a handle, 5, and there may be slots or openings, 6, between the sections. A bowl-shaped open-bottomed bait is shown in Fig. 80, the sections, 4, being carried by

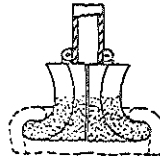


FIG. 82.

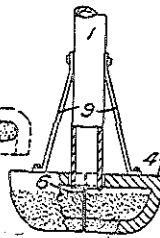


FIG. 80.

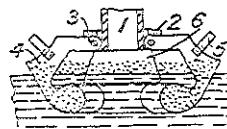


FIG. 79.

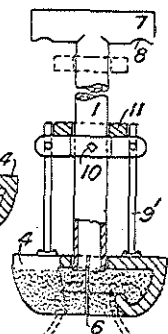


FIG. 81.

spring arms, 9. In the form shown in Fig. 81 the pivoted sections, 4, are hook-shaped and supported by rods, 9¹, from a collar, 10, a weighted ring, 11, serving as a stop to limit the swing and keep the sections loosely together. Air is introduced through openings, 8, in the arms of the T-shaped top, s, of the bait handle. Fig. 82 shows a sectional bait provided with out-turned hooks to engage the cylinder cap on its interior. A bait made of spring metal with the sections integral with the air pipe may be used. The invention is applicable to drawing-glass sheets.

H. G. C.

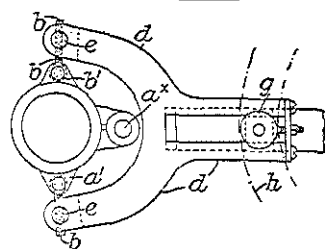
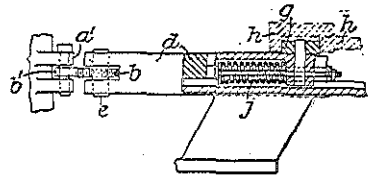


FIG. 83.

207. Glass-blowing Moulds.

L. N. BRUNER and S. D. OLSEN
(Brit. Pat. No. 120416,
November 2nd, 1917, No. 15993).

—Relates to means for opening and closing the blowing moulds of blowing-machines, so that they are held firmly closed without locking devices. The mould is divided longitudinally as usual, and the halves are

mounted on a fixed axis, a^* (Fig. 83). The halves are operated by a forked slide, d , the ends of which carry pivoted pins, e . Connecting links, b , adjustably mounted in the pins, b' , are connected to lugs, a' , on the mould halves, and are disposed so that, when the mould is closed, they are radial or almost radial thereto. The slide, d , is actuated by a stationary cam, h , through a roller, g , and a spring, f .

H. G. C.

208. Drawing Glass Cane and Tubing. J. GRAY, General Electric Co.; Schenectady, New York, U.S.A. (Brit. Pat. No. 113892, June 12th, 1917, No. 8400).—Relates to apparatus for

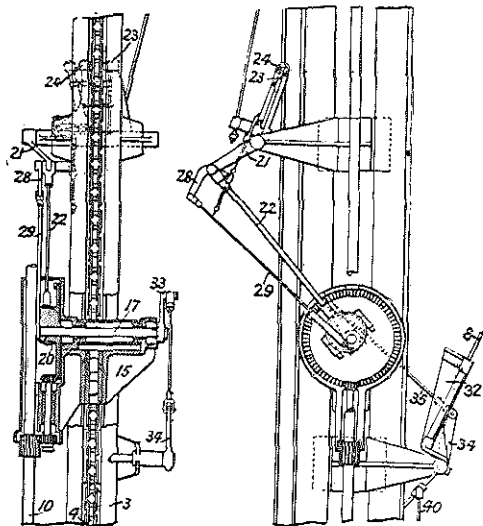


FIG. 84.

drawing cane glass and tubing of the form described in Specification 105285, and consists of driving the chilling, cutting, and delivery devices through mechanism independent of the chain conveyor, in order that the machine may be driven at greater speed. A motor drives the chain carrier, 4 (Fig. 84) described in the prior specification, and independently actuates mechanism carried by a bracket, 15, on the standard, 3, for operating the chilling, etc., devices. A shaft, 17,

mounted in the bracket and driven through gearing as shown from a vertical shaft, 10, carries an eccentric, 20, and a crank-arm, 33. The eccentric actuates the cutting devices, 23, 24, through links, 22, 29, and bell-crank levers, 21, 28, the operation of the cutters being similar to that described in the prior specification. The delivery devices, 8, carried on the pivoted frame, 32, are actuated by a link, 35, and arm, 34, by the crank, 33. The cooling and chilling devices are initially adjusted by a hand-wheel, and are afterwards automatically actuated by ratchet mechanism operated by a rod, 40, from the arm, 34.

H. G. C.

209. Feeding Device for Glass Bottle Manufacture. R. E. McCauley, U.S.A. (Brit. Pat. No. 113665, March 2nd, 1917, No. 3075).—Relates to a method of, and means for, controlling the supply of molten glass from a furnace or tank to the parison

moulds used in the manufacture of bottles and jars. The glass flows from the main tank or furnace into an extension, 4 (Fig. 85), which contains a vertical refractory cylinder or tubular member, 14, the lower open end of which is situated below the surface of the molten glass and above the discharge orifice, 15, but does not close this orifice. The upper end, 19, of the cylinder is flared and held by a clamping-plate, 27, bolted to the upper plate, 8, of the extension, 4; and a plate, 25, carrying tubes, 23, 24, fitted with valves, 32, 34, is held on top of the cylinder by bolts, 26, engaging the plate, 27. The pivoted valve-operating lever, 36, is connected to the valves by rods, 33, 35. When the mould is charged with glass, the lever, 36, is operated to open the suction valve, 32, and close the vent valve, 34, so that the flow of glass is stopped and the mass of glass in the opening, 15, is drawn up and re-heated. On closing the valve 32 and opening the valve 34 so as to reduce the vacuum in the cylinder, 14,

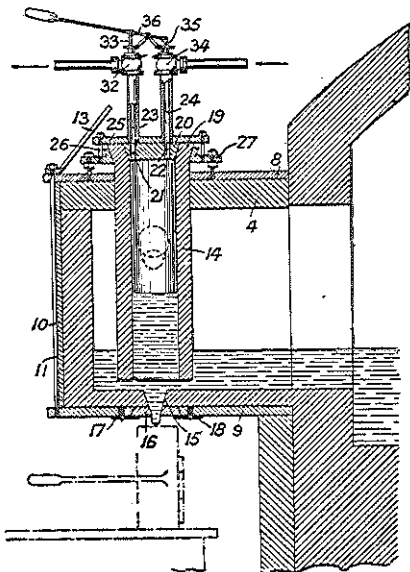


FIG. 85.

molten glass flows from the orifice, 15. Heat may be applied through apertures in the extension, 4, to heat the glass in the extension and the cylinder, 14. The extension is preferably built of firebrick, and is held in place by upper and lower plates, 8, 9, and an end-plate, 10, which are held together by stay-bolts, 11, and supported by suitable braces, 13. A renewable fireclay dish, 16, with a central aperture is fitted to the orifice, 15, and held in place by retaining-plates, 17, 18, and screws. A cap, 20, with apertures, 21, 22, corresponding with the tubes 23, 24, is situated in the upper end of the cylinder, 14.

H. G. C.

210. Grinding and Polishing Glass. PILKINGTON BROS. and F. E. SLOCOMBE (Brit. Pat. No. 120594, October 10th, 1917, No. 14682).—Apparatus for grinding or polishing plate glass comprises two discs mounted on two horizontal shafts, which are out of line but approximately parallel, one at least of the shafts being driven and one or both of the discs being provided with sucker devices for securing glass thereto. As shown in Fig. 86 the apparatus comprises a disc, 1, fitted with suckers and mounted on a shaft, 3, driven by a motor, 11, and gearing, 9, 10. The second disc, 2, is mounted on a shaft, 4, supported in bearings, 6, 14, on a frame,

8, which is adjustable along guides, 15, 16, by means of a screw, 20, and may be given a slight angular adjustment by set-screws, 26, with heads bearing against ribs, 24, on the fixed underframe. The disc 1 is forced towards the disc, 2, by fluid pressure admitted to a cylinder, 13, and the pressure may be transferred to the opposite side of the piston periodically by a valve, 31, actuated by a cam, 30, on a shaft geared to the shaft, 3. At the separation of the discs, 1, 2, a valve controlling the supply of abrasive material is actuated. The cam, 30, is preferably shaped to give a rapid withdrawal of the disc, 1, and a gradual return. The axial movement

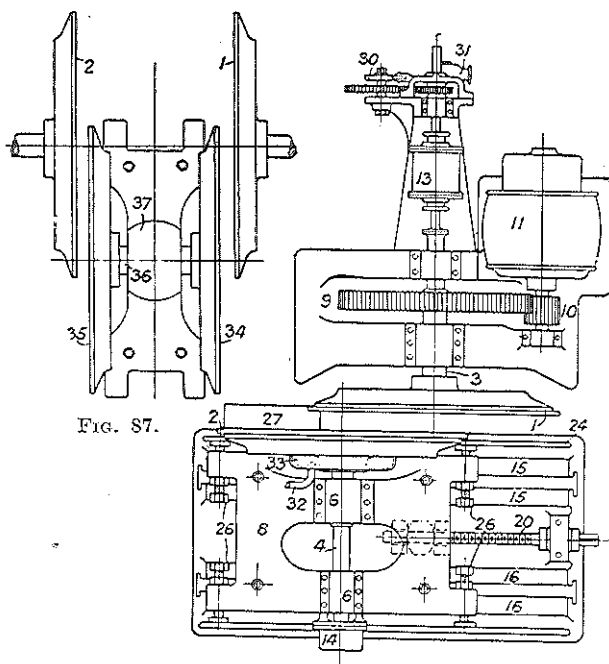


FIG. 87.

FIG. 86.

may alternatively be effected by a cam acting directly on the shaft, 3. The exhaust passage for actuating the suckers on the disc, 1, passes axially along the shaft, 3, to a pipe leading to a pump. Abrasive material may be supplied to the disc 2 by a hole through its shaft, or by a pipe, 32, leading to an undercut ring, 33, at the back of the disc. It may be supplied also to the face of the disc by a spreading-plate, 27. The disc, 2, also may be provided with suckers for securing waste or other glass thereto, so that the glass surfaces may grind each other by means of abrasive supplied between them. The abrasive may be supplied through holes in the discs, the glass being arranged to leave gaps over these holes. Glass plates may be transferred to or from the machine by dummy discs fitted with suckers and with side-cramps for securing them to the

machine discs during the release of one set of suckers and the application of another set. Two dummy discs may be used for reversing the glass sheets. The suckers on all the discs are arranged in the same relative positions to facilitate transference. In the arrangement shown in Fig. 87, a pair of discs, 34, 35, are mounted on a shaft, 36, running in a spherically-seated bearing, 37, placed between two driven discs, 1, 2. All the discs may carry suckers, those on the discs 34, 35 being exhausted by a pump and motor attached to the back of one of the discs, and current being supplied by slip-rings on the shaft, 36. Pressure cylinders similar to the cylinder 13 (Fig. 86), may be arranged for each of the discs, 1, 2, cylinders being controlled by the same set of valves.

H. G. C.

211. Feeding Device in Glass Manufacture. R. E. McCauley, U.S.A. (Brit. Pat. No. 114583, October 20th, 1917, No. 15247).—The glass flows from the tank, 1 (Fig. 88), into a detachable extension, 2, the bottom of which is provided with a nozzle, 16, the upper edge of the nozzle rising above the level of the glass. A vertical cylinder, 19, is slidably mounted in the top of the extension, and can be raised and lowered by a hand-lever pivoted in lugs 21. Pipes 35, 36, communicate with the cylinder, and are connected respectively with a source of compressed air, or the atmosphere, and to a suction pump. At the commencement of the operation, the outlet is closed by a plug, 48, until the movement of a cam, 41, has opened the cylinder to the exhaust and closed the compressed-air pipe by valves operated by a lever, 39. The glass is drawn into the cylinder to a level, 49, and is discharged when the valves are reversed. A vacuum relief valve, 47, is arranged to prevent excessive exhaustion. The outflow synchronises with the movement of a rotary table, 42, carrying the moulds, 43. During the suction stage, the glass is drawn back into the nozzle so as to prevent chilling. The extension is composed of firebrick, and is supported by metal plates, 4, held together by rods, 7, and fixed to the tank by stays.

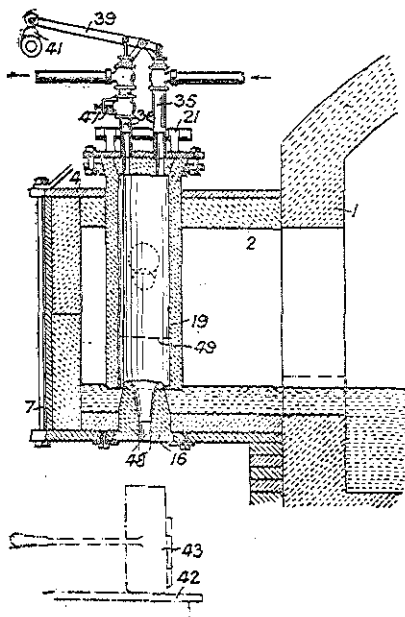


FIG. 88.

H. G. C.

212. Automatic Flowing Device for Feeding Molten Glass. G. E. HOWARD, U.S.A. (Brit. Pat. No. 120744, August 10th, 1917, No. 11513).—Relates to the feeding of molten glass from tanks, furnaces, or other supply reservoirs to moulds, etc., and consists in continuously causing the glass to flow through an orifice in the reservoir, and acting on the glass, at or after it has passed the

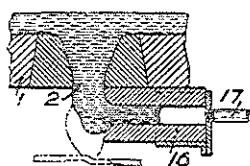


FIG. 91.

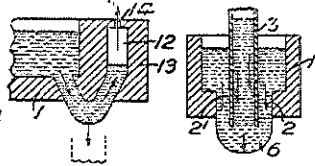


FIG. 90.

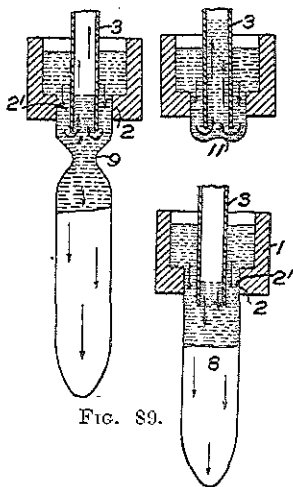


FIG. 89.

orifice, to vary the forces of suspension in the glass without checking, stopping, or reversing the flow of the glass through the orifice and separating or detaching the mass from the supply body. As shown in Fig. 89, a tube, 3, is mounted within the tank, 1, with its lower end projecting slightly beyond the discharge opening, 2. When suction is applied to the tube, the glass is drawn up inside it, the relative diameters of the opening, 2, and tube, 3, being

such that the suction does not stop the normal flow of the glass through the annular orifice, 2'. As the globule, 6, elongates, the glass in the tube, 3, is forced out to fill the centre of the globule so that it assumes the form shown at 8. On again applying suction, the globule contracts at 9, whereupon it is cut off, the lower end or chilled portion, 11, being drawn up into the tube, 3, so that it is incorporated in the glass flowing down and around the tube. The end of the tube may be situated within the discharge opening or slightly above the bottom of the vessel. As shown in Fig. 90, the tube is replaced by a lateral passage, 12, formed in an offset, 13, of the reservoir, 1, and connected by a passage, 14, to a source of vacuum. The passage, 12, takes the glass from and adds it again to the sides of the drop. In another arrangement, Fig. 91, a lateral horizontal passage, 16, just below the opening, 2, is connected by a pipe, 17, to a source of vacuum.

H. G. C.

213. Grinding and Polishing Machine for Lenses.

W. S. TANNER (Brit. Pat. No. 120827, Feb. 4th, 1918, No. 1985).

—In a machine for grinding and polishing lenses, etc., a number of grinding-heads are carried on a table, *m* (Fig. 92), mounted to turn about a central rotating shaft, *b*, from which is taken the drive both of the spindle, *o*, of the grinder, or lower tool, and that of the frames, 9, carrying the work-holders, or upper tools, the arrangement being such that, while the table normally is held stationary, it can be released and stepped round to bring the grinding-heads in succession in front of the operator. Each grinding-spindle is driven from the central shaft by friction wheels, *r*, *k*, *h*, of which the wheel *k* is mounted at the end of a hand-lever, *s*, pivoted at *u*, so that it may be swung upwards or downwards to engage with parts of different radii on the wheels, *r*, *h*, and thus to vary the speed transmitted. At the lower end of the wheel *h* is a plain loose ring, *i*; when the wheel *k* is brought into engagement with this ring, the drive ceases. The spindle of the wheel *k* works in a slot in the bent end of the lever *s*, and is drawn towards one end of the slot by a spring which pulls the wheel *k* into contact with the wheels *r*, *h*. Instead of the conoidal wheels shown, flat friction discs may be mounted on the shaft and on the spindle; the intermediate wheel then stands vertically, and is moved towards and from the centre of the shaft by a yoke actuated by a screw, and the disc on the spindle is pressed down by a spring, the drive being stopped when desired by lifting the disc by means of a cam on a spindle provided with a handle. The frames, 9, for the upper tools are mounted on arms, 6, which are connected by blade springs, 7, to a boss, 5, that is set in motion by an adjust-

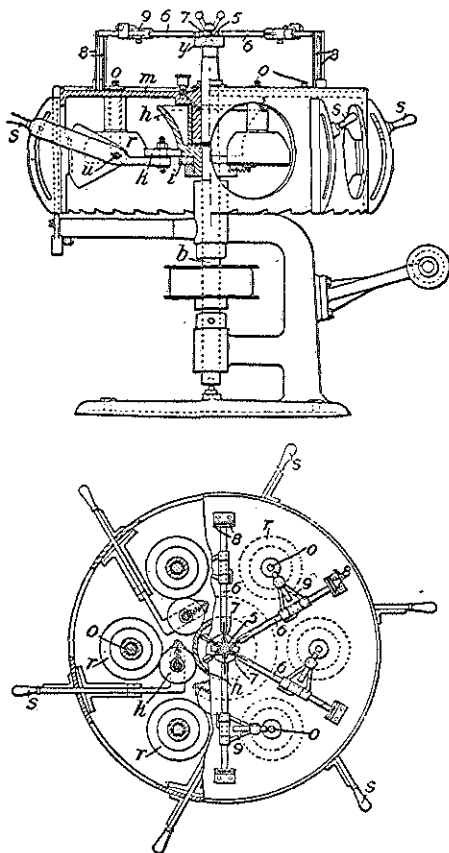


FIG. 92.

ment. The frames, 9, for the upper tools are mounted on arms, 6, which are connected by blade springs, 7, to a boss, 5, that is set in motion by an adjust-

able-throw crank-pin in the disc *y* at the top of the central shaft. The frames may be turned up on the rods to allow of access to the tools. The outer ends of the arms are supported by vertical blade springs, 8, or they may work through eyes in swivelling posts.

H. G. C.

214. Grinding and Polishing Glass. PILKINGTON BROS. and F. E. SLOCOMBE (Brit. Pat. No. 120697, October 10th, 1917, No. 6125/18).—A vacuum device for holding plate glass on to a table while grinding or polishing comprises a sucker adapted to adhere to the glass attached to a piston or cup of smaller area

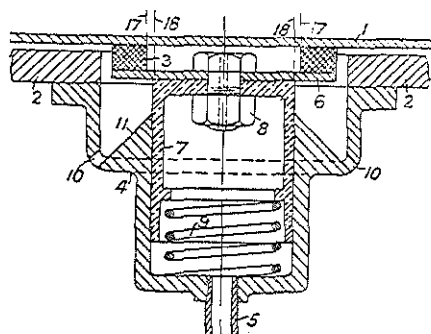


Fig. 93.

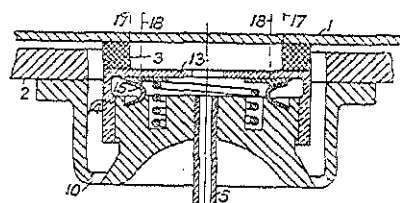


Fig. 94.

than the sucker and working in or on a cylinder carried by the table, the spaces within the sucker and the cylinder being connected together and to an exhausting means, with the result that the unbalanced atmospheric pressure on the glass is divided in a definite proportion, part operating to press the glass on to the table, the remainder pressing the glass on to the sucker rim.

Means are provided for preventing access of abrasive material to the sliding surfaces of the piston or cup. As shown in Fig. 93, the rubber ring, 3, of the sucker is carried by a disc, 6, secured by a perforated bolt, 8, to a piston, 7, sliding in a cylinder, 4, secured to the table, 2. The piston is

pressed upwards by a spring, 9, and the cylinder communicates by a pipe, 5, with an air-exhausting pump. When air is exhausted from the cylinder and sucker, the pressure between the glass plate, 1, and the sucker rim is proportional to the area between the dotted lines, 17. As the plate, 1, and the sucker and piston move inwards, the glass engages the table and the total pressure is divided between the table and the sucker rim in the proportion of the area between the lines, 18, to the annular area between the lines, 17, 18. Abrasive material is prevented from reaching the piston, 7, by the overlap of the disc, 6, and the cone or cylindrical surface, 11, by which the material is guided to apertures, 10. In the modification shown in Fig. 94 the sucker piston is replaced by a cap, 13, sliding externally on a boss, 14, secured to the table, 2. The cap is per-

forated and the vacuum space beneath it is enclosed by a rubber or like ring, 15. A series of suckers may be arranged on the surface of the table which may be horizontal, vertical, or inverted, and the suckers may be utilised to flatten slightly buckled plates.

H. G. C.

215. Glass Cutting or Dividing Machine. W. R. LYTLETON and TRIPLEX SAFETY GLASS Co. (Brit. Pat. No. 114462, March 31st, 1917, No. 4688).—Relates to cutting glass into oval or other curved shape, and consists of a construction of

machine in which the cutting edge of the tool is kept facing the direction of movement, and the holder is maintained in contact with a template by a link and spring arrangement. The figures show an apparatus in which the glass, *F* (Fig. 95), is stationary, and the tool, *L*, moves. The tool, *L*, is mounted in a bush, *K*¹ (Fig. 96), which is free to turn in a sleeve, *J*³, carried by a link, *J*, connected by a radius-bar, *I*, which can be turned by a crank-handle, *H*. The link carries an adjustable slide, *N*, the forward end, *N'*, of which is formed with two shoulders which bear on the edge of a fixed template, *F*, corresponding in shape with the design to be cut. A spring, *P*, keeps the shoulders against the template during the movement of the tool. The upper end of the tool engages the under-face of the template. The cutting apparatus is carried on links, *C*, *D*, pivoted to a fixed standard, *B*, and is normally kept raised by a spring, *Q*. In a modified arrangement, the glass turns with the template and the diamond-holder has no rotary movement.

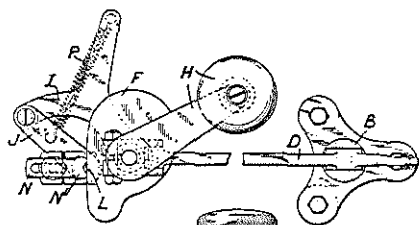


FIG. 95.

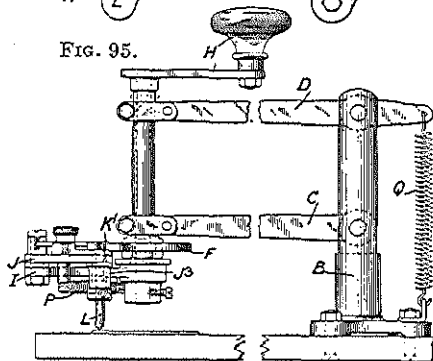


FIG. 96.

H. G. C.

216. Feeding Device for Bottle Machines. J. FORSTER (Brit. Pat. No. 113797, December 14th, 1916, No. 17970).—In apparatus for feeding bottle-making machines with molten glass, and of the kind in which a gathering head or carrier sucks up the glass from a furnace or tank and is then moved to the receiving part of the machine, where the charge of glass is discharged by air pressure, the gathering-head, 3 (Fig. 97), is arranged to be rocked

in the vertical plane. The tubular head, 3, is carried by an arm, 1, which is mounted on a horizontal pivot, 2, in a pedestal, 20, and fixed to or formed with a quadrant, 16, having a toothed endless rack, 15, with which the driving-wheel, 14, gears. Suitable mechanism is provided to move the wheel, 14, from one rack to the other at the ends of the oscillations of the head, 3. Links, 18, pivoted at one end, 19, below the pivot, 2, and at the other end to the head, 3,

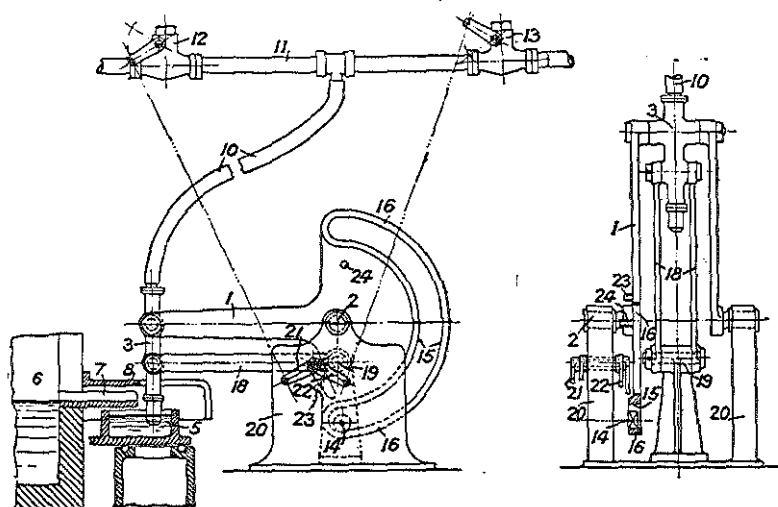


FIG. 97.

keep the head vertical during its movement. The tank, 5, which is fed by a runner, 7, from the furnace, 6, and provided with heating-means beneath its cover, 8, may be arranged to move both laterally and longitudinally so that the gathers are made from different parts of the tank. The vacuum and air valves, 12, 13, in the pipe, 11, to which the head, 3, is connected by a flexible pipe, 10, may be operated automatically by means of tappet levers, 21, 22, engaged by pins, 23, 24, situated on opposite sides of the quadrant, 16.

H. G. C.

I.—Glass-making Materials.

217. Drying Sand, etc. G. F. W. HOPE (Brit. Pat. No. 124244, February 20th, 1918, No. 3054).—Relates to rotary

drum apparatus for drying sand, etc. The material is fed from a hopper, 2 (Fig. 98), through a shoot, 12, into a rotating perforated or open-work drum, 1, provided internally with beaters, 5 (Fig. 99), and pivoted shelves, 10. The shelves are supported by chains, 17, so that they fall back as the drum revolves. The beaters, 5, have looped ends, 6, which engage the shaft, 4, and are thus free to move to a certain extent at right angles thereto. The beaters are lifted by angle-pieces, 9, carried by the drum, and, when raised sufficiently, slip inwards and clear the angle-pieces. Material escaping through the openings in the drum is received by one or more oscillating plates, 13, actuated by a cam, 14, and heated by gases from a furnace, 16. The material passes to another plate, 15, which may also be oscillated, and is delivered to a conveyor. The drum is driven through toothed gearing, 7, 8, or otherwise. The shoot, 12, is rocked by the passage of the trays over it. An adjustable gauge may be arranged between the plates, 13, 15.

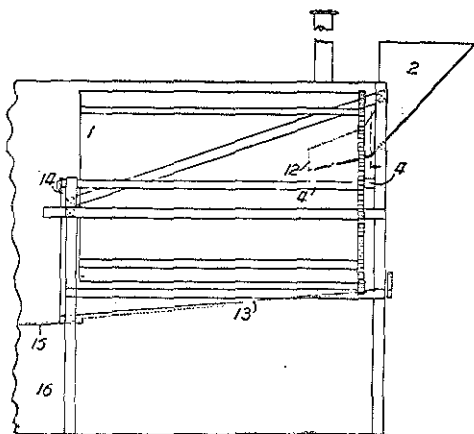


FIG. 98.

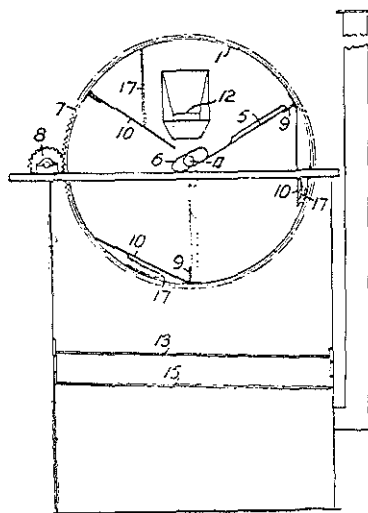


FIG. 99.

The drum is driven through toothed gearing, 7, 8, or otherwise. The shoot, 12, is rocked by the passage of the trays over it. An adjustable gauge may be arranged between the plates, 13, 15.

H. G. C.

218. Potash Recovery at Cement Plants. A. W. G. WILSON (*J. Soc. Chem. Ind.*, 1919, **38**, 314r).—During the production of 350 lb. of cement, from 2 to 7 lb. of potassium salts, together with sodium and lithium salts, were carried out in the flue dust and gases. These salts were derived from the alkaline silicates usually found in the clay or shale used as raw material. In contact with lime, these silicates were decomposed at the high temperatures (maximum about 1430°), and dust and volatile salts of the alkali metals, together with carbon and sulphur dioxides, were found in the flue gases. The main potassium salt obtained was the sulphate, though the thiosulphate, sulphide, and carbonate were also found.

Nineteen cement plants were known to have installed equipment for preventing escape of flue dust, and of those one disposed of the dust as a potash fertiliser, one merely collected the dust, whilst the other seventeen were for potash recovery from the dust. The electrical precipitation installations were to be found in nine cement plants in the U.S.A., and one each in Norway, Sweden, Spain, and Japan. Six plants in the U.S.A. used five different systems of water spraying.

The various systems of recovery were described in detail and the costs of the potash recovery discussed. F. W. H.

219. Separation of Potassium and Sodium Nitrates. F. A. FREETH and H. E. COOKSEGE (Brit. Pat. No. 124513, February 25th, 1916, No. 2847).—Potassium nitrate is recovered from commercial sodium nitrate by digesting the sodium nitrate with water or wash liquors at a temperature of about 80 – 100° , and, if the solution is not saturated with potassium nitrate, concentrating the solution until it is so saturated, the precipitated sodium nitrate being separated and washed; the solution, saturated with potassium nitrate, is then diluted with water until the ratio of the water to the sodium nitrate is the same as that which would obtain in a solution saturated with sodium and potassium nitrates at the temperature to which the solution is to be cooled, for instance, about 20° , and the solution is then cooled to that temperature. Potassium nitrate separates, and is removed and washed. The mother liquor, and, if desired, the washings of the sodium nitrate, may be concentrated until saturated with potassium nitrate at the temperature of concentration, and then treated as before to obtain more potassium nitrate. The washings of the potassium nitrate may be concentrated until saturated with potassium nitrate at the temperature of concentration, and then cooled to obtain a further separation of potassium nitrate.

H. G. C.

220. Potassium Carbonate. S. R. SCHOLES, U.S.A. (Brit. Pat. No. 117755, November 5th, 1917, No. 16157).—Minerals such as felspar are ground and mixed with a sodium or potassium compound, the carbonate, for example, in such quantity as to supply one equivalent of alkali metal oxide to each two equivalents of

silica in the mineral, and the mixture is fused. The melt is poured into water and ground, and is then boiled with water and treated with carbonic acid or gases rich in carbonic acid, for instance, cement kiln gases containing potash. The alkali carbonates are then formed in solution, leaving hydrated silica, alumina, etc., as a precipitate. The solution is filtered off and evaporated; a quantity equal to that extracted from the rock is withdrawn, and the remainder is used to treat the next batch of rock. If the operation is started with sodium carbonate, all the sodium carbonate may be thus withdrawn after a number of cycles, leaving only potassium compounds for subsequent cycles. Alternatively, when sodium carbonate is used to start the operation, the solution first obtained may be concentrated so as to precipitate most of the sodium carbonate which is separated, and the potassium carbonate remaining is then used with an appropriate quantity of rock for the next cycle.

H. G. C.

221. Potash Discovery in Sicily. (*J. Ind. Eng. Chem.*, 1919, 11, 246).—It is reported that in the province of Cattanissetta, in the Island of Sicily, immense deposits of potash have been discovered, and the preliminary investigations are said to establish these as the richest in the world, making it quite unnecessary to have recourse to German supplies.

C. M. M.

222. Potash from Kelp : The Experimental Plant of the United States Department of Agriculture. Preliminary Paper. J. W. TURRENTINE and PAUL S. SHOAF (*J. Ind. Eng. Chem.*, 1919, 11, 864).—The experimental kelp-potash plant of the United States Department of Agriculture at Summerland, California, was designed for the determination of the best methods of treating kelp for the extraction of potash salts and the simultaneous recovery of other valuable products. It was put into operation in the early autumn of 1917.

One hundred tons of raw kelp per day were subjected to a process involving drying, destructive distillation, lixiviation, evaporation, and fractional crystallisation for the preparation of high-grade potassium chloride. The by-products yielded in commercial quantities by this process consist of kelp oils, creosote, pitch, ammonia, bleaching carbons, salt, and iodine. At present the results obtained show that it will be possible to establish a new American chemical industry of considerable size and of importance and usefulness to the nation on kelp as the basic raw material.

C. M. M.

II.—Glass: Manufacture and Properties.

223. Procedures in the Manufacture of Optical Glass.

W. S. WILLIAMS and C. C. RAND (*J. Amer. Cer. Soc.*, 1919, 2, 422).—The stringent requirements for optical glass were set out. The faults likely to entail rejection were inhomogeneity, colour, devitrification or cloudiness, strain due to faulty annealing, hygroscopic tendency, and insufficient strength to withstand subsequent working operations. The necessity for the use of pure materials and intimate mixing of batch ingredients were emphasised, and the following table was given showing the percentages of impurities found in various materials examined:—

Material.	Fe ₂ O ₃ .		SO ₃ .		Cl.	
	Max.	Min.	Max.	Min.	Max.	Min.
Barium carbonate ...	0.009	0.0005	0.12	0.0774	0.13	0.01
Barium carbonate, C.P.	0.0067	0.004	0.08	0.018	0.069	0.0124
Red lead	0.0056	0.0015	0.055	0.01	0.13	0.017
Soda-ash	0.003	0.0014	0.03	0.0049	—	—
Lime, hydrated	0.048	0.026	0.167	0.06	—	—
Potash (K ₂ CO ₃)	0.01	0.004	0.07	0.018	0.31	0.11
Zinc oxide	0.006	0.0057	0.327	0.11	0.35	0.078
Saltpetre (KNO ₃)	0.0019	0.0007	0.0016	—	0.07	0.05
Borax	0.002	0.0004	0.034	0.018	0.005	0.0034
Alumina (Al ₂ O ₃)	0.0022	0.0022	0.15	0.15	—	—
Sand	0.02	0.0148	—	—	—	—

A single-pot furnace, fired by natural gas and compressed air, was used for the melts, and a number of working drawings of the furnace were given. The quality of pots necessary for the manufacture of optical glass was indicated, and drying and firing schedules were furnished.

Carefully selected cullet was first filled on, and then a mixture of batch and cullet at intervals of one and a-half hours until the pot was full. The amount of cullet used for the first filling was 200 lb., and for subsequent fillings from 150 to 200 lb., the melts being such as to produce about 1000 lb. of glass.

Thorough regulation of temperature during the whole of the melting and fining period was necessary, and typical time-temperature curves were given. The elimination of seeds was accomplished by the substitution of nitrates for carbonates in the batch or by "blocking" with ammonium nitrate. Stirring operations were fully described, and a diagram of the stirring machine was shown. To prevent striae from re-forming after stirring was stopped, the metal was cooled as quickly as possible to about 700° by tilting back the pot, supporting it by a firebrick, and directing a stream of compressed air against the bottom of the pot for three hours.

Various methods of moulding were tried. In all cases the glass was first heated to the softening temperature. Following this preliminary heating, the most satisfactory method was to place the heated glass on a furnace floor covered with mineral powder, such

as alumina, flint, mica, kaolin, or lime, and as the glass softened it was worked into a block to fit the iron mould of a press. On account of the lack of skilled workmen for this process, another method was adopted. The glass, on a punty, was softened in a glory hole, shaped at a bench, and sheared into the press mould.

The annealing was carefully conducted, schedules being drawn up for each kind of glass. All glasses were heated to 200° in the first four hours, to 300° in eight hours, and to 400° in twelve hours. Then, to reach the final temperature, three and a-half hours were taken, the final temperatures being as follows:—

Flint	480°
Light crown	520
Borosilicate	550
Light barium crown	610
Dense barium crown	625

The rate of cooling was 5° per hour.

In the authors' experience, the optical properties of glass did not depend entirely on chemical composition, but varied from melt to melt even when all conditions were apparently the same. Consequently, the optical constants for any particular composition could not be determined accurately by one melt. The following table was given indicating the variation of indices obtained with the same composition and other conditions apparently equal:—

Theoretical composition.	N_D .	ν
—	1.6282	36.7
SiO ₂ , 44.4	1.6283	36.7
PbO, 46.0	1.6268	36.7
K ₂ O, 4.1	1.6278	36.8
Na ₂ O, 3.5	1.6288	36.5
CaO, 2.0	1.6248	36.6
As ₂ O ₃ , 0.4	1.6242	37.2
—	1.6221	37.4
—	1.6285	36.6
—	1.6265	36.7

Tables were also given showing the batch composition, time of melting, type of pot used, percentage of cullet used, and optical constants for about 180 melts.

F. W. H.

224. Discussion of an Article by G. W. Morey, entitled, "An Improved Method of Optical Glass Manufacture."

C. N. FENNER (*J. Amer. Cer. Soc.*, 1919, 2, 373; see *J. Amer. Cer. Soc.*, 1919, 2, 146; this JOURNAL, 1919, Abs., p. 100).—A note of warning regarding the restriction of time allowed for fining in the method of manufacture suggested by Mr. Morey. The author considered that shortening the fining period was practicable only when the raw materials were free from certain impurities. Opalescent glass might be obtained when the batch materials used contained sulphates or chlorides, and, in that case, a longer period of fining was advisable. The use of potash containing more than 0.30 per cent. of SO₂, or more than 2.0 per cent. of Cl was liable to cause this trouble, and rendered it desirable to have a fining period of several hours at a high temperature.

F. W. H.

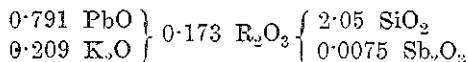
225. The Development of Improved Gold Ruby Glass.

H. T. BELLAMY (*J. Amer. Cer. Soc.*, 1919, 2, 313).—The work which supplied the information for this paper was undertaken in order to reproduce a ruby glass purchased in France before the war. It was necessary that the glass fulfilled the following conditions:—it must not shatter when introduced into a glass-blower's flame; it must not become discoloured when heated to a very soft condition; it should be of such a nature that small lenses can be formed from heated rods without subsequent annealing—the lenses should match an accepted standard, be of uniform colour, free from surface cracks and other visible defects, and when mounted in a brass shell should withstand impacts of 3 lb. applied at the rate of 115 per min.

A chemical analysis was made of the imported ruby glass, and the molecular formula calculated as follows:—

SiO ₂	38.35
PbO	54.48
K ₂ O	6.17
Sb ₂ O ₃	0.67
R ₂ O	0.70
Gold	Present.
B ₂ O ₃	Not determined.

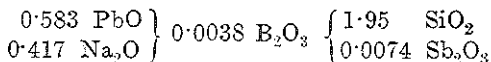
Calculated formula:—



The imported glass was made with potash, but owing to the scarcity of this material it was decided to substitute soda, and the glass was equally as satisfactory.

After making a few trial melts, a glass of the following formula was developed:—

Ruby No. 1.

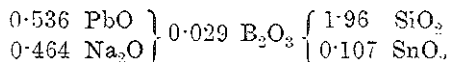


The gold, which was not included in the formula, was prepared by dissolving 10 carat gold in aqua regia, separating the base metals, and diluting the gold chloride so that 10 c.c. contained 1 gram of metallic gold. The requisite volume of gold chloride was added to the sand of the batch and evaporated to dryness.

With this glass, the consecutive layers of a gather were frequently of different colours, changing to blue, purple, or brown under certain conditions, and the lenses appeared streaked.

A second ruby was consequently developed.

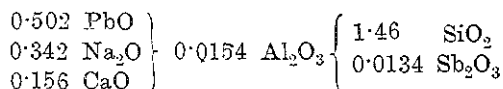
Ruby No. 2.



The author claimed that the tin oxide added in sufficient quantity to a properly proportioned batch gives a ruby glass which does not become discoloured, but only exists in the colourless and ruby states; in any case, the rods and lenses made from Ruby No. 2 were always of a uniform ruby colour.

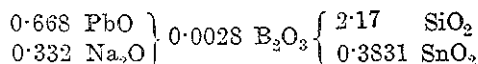
Simultaneously, attempts were made to produce an opalescent red, and the following formula was tried:—

Opalescent Red No. 1.



Rods of this glass shattered in the glassblower's flame, and lenses shattered under the impact test mentioned above. The brittleness was attributed to cryolite, which was used as an opacifier, and it was decided to substitute tin oxide.

Opalescent Red No. 2.



This glass melted well, was readily worked into rods, and lenses formed from the softened rods fulfilled the requirements specified above. With the tin oxide, a smaller amount of gold could be used to produce the same shade of ruby.

A red glass enamel was also produced by mixing finely powdered Ruby No. 2 with other suitable constituents. It was necessary to treble the amount of gold in order to secure sufficient intensity of colour in the thin layers used.

The fact that the glasses containing tin oxide could only exist in two colours was criticised by various writers; in particular, R. L. Frink pointed out that the statement was not compatible with the results as found by Zsigmondy and others, who stated that gold when existing in colloidal or aqueous solution may produce colours ranging from red to blue.

A. M. J.

226. Batch Mixtures for Opal and Violet Opal Glass. (*Sprechsaal*, 1906, 39, 53).—Three batches were recommended for an opal glass to be melted in a covered pot. They are—

	100 kg.	100 kg.	100 kg.
Sand	22	10	18
Fluorspar	20	35	25
Felspar	20	20	33
Soda	—	12	5
Potash	20	10	6
Red lead	4	6	2
Saltpetre	—	5	12
Cryolite	—	8	—
Calcespar	1	—	0.5
Arsenic			

Two batches stated to produce good violet opal glasses are—

Sand	100 kg.	Sand	100 kg.
Fluorspar	12	Potash.....	15
Felspar	10	Lime	6
Cryolite	6	Cryolite	14
Soda	15	Borax	4
Potash.....	10	Red lead	10
Saltpetre	5	Copper sulphate ..	6
Red lead	10	Smalt	0.2
Alumina	5		
Zinc white	8		
MnO ₂	8		

J. R. C.

227. Deposits on the Crowns of Glass Furnaces. W. H. ZIMMER (*Sprechsaal*, 1905, **38**, 1913, 2077).—In a Siemens' pot furnace a deposit about 6 cm. thick was formed on the crown after it had been working a few weeks. The crown itself was not attacked. The deposit was a pale yellow, crystalline mass insoluble in water and mineral acids, soluble with difficulty in hydrofluoric acid. Analysis showed it to have the following percentage composition:—

SiO ₂	94.62	PbO	0.14
Al ₂ O ₃	0.33	CaO	1.93
Fe ₂ O ₃	1.08	MgO	0.07
Na ₂ O	1.42	K ₂ O	0.51
Cl	Trace		

Neither fluorine nor sulphur was present, even in traces. It was at first thought that it was due to some of the sand used having been deposited on the crown, the excess of alkali and lead resulting from volatilisation of these constituents of the batch. Examination, however, of the structure of the layer led to the conclusion that the silica was originally amorphous, and heat had converted it into tridymite. It appeared therefore probable that volatile silica compounds were formed which, coming into contact with the roof, deposited silica thereon. None of the pots were used for fluorspar batches, so silicon fluoride was out of the question, and it was not likely that enough silicon tetrachloride would be formed to produce such a large deposit, though this would account for the trace of chlorine. The author cited a case of a similar deposit which Seger encountered in the flue of a Horn's generator. This was explained on the assumption that, as the coal used was of poor quality, silicon fluoride and chloride were formed in the generator and decomposed in the flue. This explanation was considered to hold good also for the deposit in question. Thus the remedy when such a phenomenon occurred was to change the coal used in the producer.

J. R. C.

228. Decolorisers and their Effect. H. SCHNURPFEL (*Sprechsaal*, 1905, **38**, 1331).—Experiments were made with a glass of the following batch composition:—

Sand	188 kilos.
Potash	28 ..
Soda	27 ..
Limespar	25 ..

This batch melted in about eleven hours under the furnace conditions employed, yielding a brilliant glass. It was slightly green owing to the presence of iron in the raw materials.

Nickel oxide was found to be very uniform in its effect, but must be free from cobalt. Owing to its high melting point, it acted at the end of the melt. The normal quantity required was 2·5 grams to every 100 kilos of sand. Antimony oxide attacked the furnace, so was not recommended. Cobalt oxide was also uniform in its effect. Very little was needed, 0·5 to 0·75 gram being sufficient for 100 kilos of sand. Manganese was better suited for use with a potash glass than with soda. In the former case it gave a violet colour and in the latter purple. The objection to it was the tendency of a glass thus decolorised to be coloured by sunlight. Usually 250 to 300 grams of MnO_2 were required for 100 kilos of sand. Arsenic was more useful for removing small bubbles than for decolorising, as it volatilised at 412° . In the author's view, the uncertainty attending the use of selenium militated against its employment. The quantity required must be ascertained accurately or an uneven red coloration would result. When correctly used, it produced a very brilliant glass. An example was given of the use of selenium with the batch quoted at the beginning of the abstract.

Quantity.	Furnace.	Remarks.	Nature of result.
3 gr.	Normal.	—	Good.
3 gr.	Cold.	Adverse wind and wet coal.	Very faint green.
3½ gr.	Normal.	—	Slightly red.

Stress was laid on the fact that a hot furnace was one of the best decolorisers.

J. R. C.

229. The Theory of Making Copper Aventurine Glass.

V. AUGER (*Compt. rend.*, 1907, 144, 422).—Copper aventurine consists of a greenish, transparent mass containing innumerable small, red crystals in suspension, which impart a golden-yellow tint to the glass.

Two views are held as to the nature of these crystals. According to the first, they are of metallic copper; according to the second, of cuprous oxide or silicate. By the former theory it is difficult, according to the author, to explain how the copper enters into solution in order to crystallise out on slow cooling, as the metal is scarcely soluble at all in the fused mass.

The author studied the behaviour of cuprous phosphate when fused and then cooled, and found that when fused and cooled rapidly a colourless, transparent mass was produced, but on reheating copper separated out. Copper aventurine behaves in just the same way when treated similarly.

Since, then, copper aventurine contains a cuprous silicate which behaves as the phosphate, being stable at a red heat, but splitting up on slow cooling into metallic copper and a blue cupric silicate, but on rapid cooling remaining unchanged, this would explain the

behaviour of the glass, and this view was supported by results of analysis. This theory requires that the cupric silicate be present in quantity at least equivalent to the amount of free copper, and in order to test this, the author isolated a small quantity of copper by treating the powdered glass with dilute hydrofluoric acid in the cold. After washing with water and alcohol, this isolated substance was found to possess the properties of metallic copper. Four grams of the sample furnished 0.052 gram of copper, 0.034 gram being extracted by an alcoholic solution of silver nitrate, and a further 0.018 gram being obtained by the action of dilute nitric acid. A microscopic examination of the residue showed no further trace of metallic crystals, but on treatment with hydrofluoric acid a further 0.08 gram of copper was found present as cupric silicate.

Hence the author concluded that copper aventurine consists, in the fused state, of cuprous silicate, which on slow cooling yields metallic copper and cupric silicate, the latter producing a greenish tint by its blending with the yellow of the ferric silicate in the glass.

V. D.

230. Notes on the Welding of Glass. M. LÉON APPERT (*Bull. Soc. d'encouragement pour l'ind. nationale*, Jan.—Feb., 1919).—The author stated that it was now possible to make glasses to satisfy the conditions necessary for successful welding, either with other glasses or with metals. The conditions were:—(a) The glasses must have the same coefficients of thermal expansion over the range of temperature to which the finished articles are likely to be submitted. (b) The diathermancies, or power of transmitting heat, must be equal. (c) The glasses must be inert and sustain no change whatever during the heating necessary in welding.

The first condition was most important and applied to all cases, while the other two were only of secondary importance.

Since the actual determination of the coefficients of linear and cubical expansion is long and tedious, the author advocates the use of methods which aim at determining the state of tension existing between the two glasses. If the coefficients of expansion were equal this is zero, whilst it was very great if the values differed very much.

Assuming that a "compound" glass behaved as would a piece of any one of the constituent glasses alone if the union be perfect, a piece of one glass was blown into a bulb or any convenient shape and used as a standard for future comparison. Thus, let V_1 be the glass chosen as standard and V_2 be a glass to be experimented upon. Two bulbs are blown: (1) of a layer of V_1 covered with a layer of V_2 , and (2) of a layer of V_2 covered with a layer of V_1 , and the thickness of these bulbs is made the same as that of the standard bulb (see Figs. 100 and 101).

Although alike in appearance, these bulbs behave very differently, and if the coefficients of expansion differ very much, one will burst violently, while the other cannot be broken except by severe blows. In the first bulb the glass, V_1 , forming the inner layer

is the more expansible, and it creates a strain of extension in the outer layer, V_2 , while in the second bulb the outer layer, V_1 , is strained by compression.

In order to test this state of tension, if it exists at all, a small cut is made on the bulb, and, on tapping gently, this crack spreads regularly, cutting the bulb into two almost equal parts if the union be perfect, the bulb behaving as the standard bulb would when treated similarly (Fig. 102). If the welding is unsatisfactory, the bulb is split into more or less numerous parts, each piece having a very irregular and indented outline (Fig. 103).

The second bulb, blown in the inverse order, will break under these conditions with more or less violence; the pieces being very irregular, but with rounded edges, the cracks not being rectilinear.

Further, let the inner surface of a piece of each bulb be cut; thus, in the first bulb glass V_1 is cut, while in the second bulb

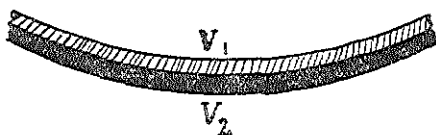


FIG. 100.

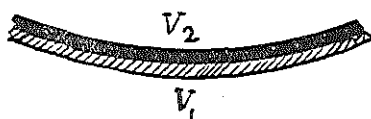


FIG. 101.

glass V_2 is used, and several more or less convergent lines are made. Two cases then arise: (1) if union be perfect, each of the pieces will crack along the marks made, as will also a piece of the standard bulb if treated in like manner; (2) if union be imperfect, it will be found impossible to make the slightest scratch on the fragment of the first bulb without shattering the piece, recalling the behaviour of the thick-walled "Bologne Vases." Considering the second bulb, it will be found impossible to make the slightest scratch on V_2 . Thus, if the more expansible glass be blown on the outside of a vessel, it exhibits a durability equal to that of tempered or hardened glass. By means of these tests, the order of expansion is tested.

Although by welding a glass of greater expansion on to one of lesser expansion, and by a careful choice of thicknesses and arrangement of the layers a glass of very great mechanical resistance is obtainable, yet the success of the operation is not so assured as when glasses of equal expansions are used.

Little is known of the athermancy of glass. On the one hand, glasses coloured by metallic oxides are athermanous, that is, intercept and store up heat rays, and, on the other, only optical and special glasses are diathermanous, that is, able to transmit heat rays. In "doublets," where the thickness of the layers may vary considerably, the storing of heat in the coloured layer may result

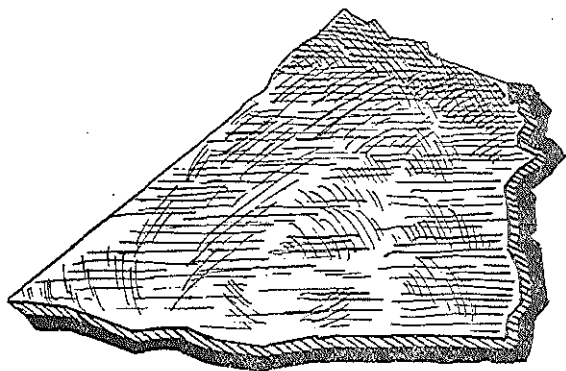


FIG. 102.

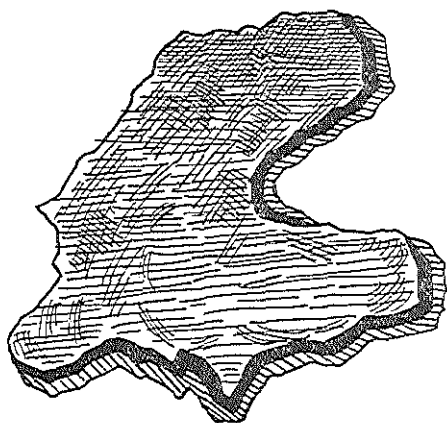


FIG. 103.

in a great rise in temperature, and the welding of thick coloured layers to colourless layers is not satisfactory.

Although alum solutions absorb infra-red rays, glasses of varying alumina content have not been found to do so.

Glasses are more or less resistant to change, according to their composition, and glasses rich in bases are far from stable when heated. The stability of a glass is tested by heating it to the

temperature employed in welding, when any change renders it useless. The chemical inactivity of the glass surface is tested by leaving it in contact with a sensitive liquid, for example, phenolphthalein or morphine hydrochloride.

The flame used in welding should be uniform and combustion should be complete, for oxidising or reducing conditions may affect the glass surface.

The author referred to the different methods of welding different types of glass to one another and to metals. In the welding of glass with metals, the surfaces must be well cleaned, so as to remove all traces of foreign matter, especially organic material, which, on heating, would be likely to generate bubbles of gas, and thus prevent good contact. The processes employed are of three types: (a) the embodiment of the metal in glass; (b) the deposition of metal on the glass surface; and (c) the deposition of glass on a metal, generally termed enamelling.

The first process is very important, being used in the manufacture of lamps of the Edison type, and of "wire-glass." The wire that is welded to the glass must possess the same coefficient of expansion as the glass, which often is of the composition of common window-glass. In the U.S.A. a special steel is used which resists oxidation and possesses a high polish even after welding.

Gold and platinum leaf will adhere to glass on heating; then a thin layer of glass fused over the whole preserves the lustre of the metal.

The second process in its true sense can only be brought about with platinum, though silver and copper can be deposited on glass by the reduction of their salts. Oxidation of the metal is prevented by covering it with a thin layer of glass. The deposition of silver and copper can also be accomplished electrolytically.

Ancient decorative enamels have been found to contain silica, potash, soda, and lead, the lead rendering them easily opaque.

A satisfactory enamel must possess the following properties:— (i) a melting point much lower than that of the metal to be enamelled; (ii) ability to attack the metal at its melting point and form a strong union; (iii) the same coefficient of thermal expansion as the metal over the range of temperature to which the articles are likely to be submitted; (iv) resistance to attack by liquids likely to be placed in the vessels.

The second condition is easily satisfied, and rather than sacrifice certain physical properties of the enamel, an intermediate glass or "flux" is used, and this has the power to attack the metal.

Gold and platinum are not readily attacked, silver is less resistant, but iron and copper are easily attacked.

When it is found necessary to alter the composition of an enamel or metal, the latter is chosen, the desired expansion being obtained by a combination of metals, as in the case of Demet, composed of one layer of nickel and two of copper.

The thermal conductivity of an enamel always differs from that of the metal, and renders cracking on sudden changes of tempera-

ture very easy, but this is remedied by coating the other side of the metal with the same mordant.

Whether applied to a cold or hot surface, enamels must be heated in a muffle to bring about fusion and form a perfect union. They should also be applied in successive layers, the thickness being very small in the case of transparent enamels to allow the play of light in them to bring out the colour, whilst on articles in common use a greater thickness is desired to give greater mechanical resistance.

V. D.

231. Devitrification of Glass. N. L. BOWEN (*J. Amer. Cer. Soc.*, 1919, 2, 261).—The devitrification of glass, in the author's view, is the result of the tendency of glass to reach the stable crystalline condition, and takes place whenever the glass is maintained for a sufficiently long period of time within the range of temperature where the crystallising power is great. The author discussed crystallisation from the fundamental principles of physical chemistry, and then applied these principles to the devitrification of glass.

Definite chemical compounds almost invariably had definite melting points, and a solid crystalline substance when raised to the melting temperature usually passed promptly to the liquid condition. If the liquid was then allowed to cool and the conditions were such that equilibrium was attained, crystallisation would take place at the temperature of the melting point. It was frequently possible to lower the temperature below melting point without the incidence of crystallisation, when the liquid was said to be under-cooled.

Usually only a certain amount of undercooling could be accomplished, and when this had been attained crystallisation occurred.

Certain substances might, however, be undercooled an indefinite amount, passing gradually and continuously from the state of fluent liquid through a condition of continuously increasing viscosity until, finally, a rigidity comparable with that of ordinary crystalline substances was attained, although the substance was still, from the point of view of the physical chemist, an undercooled liquid. The substance was then said to be in a vitreous condition, or simply a glass.

Compounds such as MgSiO_3 , Al_2SiO_5 , CaSiO_3 had a comparatively great crystallising power through a long range of undercooling, and could only be cooled to the vitreous state when the rate of cooling was very great. These silicates were poor conductors of heat, and could therefore be cooled to the glass condition only in a very small mass; they could not then be used as ordinary commercial glasses. A large number of silicates, particularly those of the alkalis, could be cooled quite slowly without crystallisation.

In mixtures the specific properties were modified. Thus, for example, the crystallisation temperature of pure CaSiO_3 under equilibrium conditions was 1540° , but only 1490° when mixed with 15 per cent. SiO_2 . Unlike the pure compound, this mixture did

not crystallise entirely at a definite temperature, but, as the temperature fell, crystallisation of CaSiO_3 continued, and the remaining liquid changed its composition until finally, at 1435° , when the liquid had the composition 78 per cent. CaSiO_3 , the silica began to crystallise and the whole mass solidified, giving a mixture of CaSiO_3 and silica.

The effect of the addition of silica was to lower the temperature of crystallisation of CaSiO_3 to a temperature at which the viscosity was much greater, and therefore the crystallisation power much decreased. At the same time the silica, in virtue of its own inherent properties, made a further addition to the viscosity of the liquid. Cooling to a glass was quite readily accomplished with this mixture, though so difficult with pure CaSiO_3 .

In cooling the mixture of CaSiO_3 and SiO_2 , the rate must be made such that the glass did not remain long within the temperature range where the crystallisation of the CaSiO_3 or SiO_2 or both was great.

With mixtures of more than two components, there was, on cooling, a certain temperature at which the liquid becomes saturated with one of the components, a lower temperature at which it became saturated with a second component, and so on for all the components.

Studying the theory of devitrification in the light of the foregoing, there were three distinct danger periods during which devitrification was likely to occur. The first was during the cooling, preparatory to working, that is, during gathering or final stirring (optical glass).

When devitrification or crystallisation did occur at this comparatively high temperature, it usually took the form of the separation of large individual crystals. Devitrification of this type was furnished during the manufacture of an optical glass known as a light barium crown, when crystals formed during the final stirring. From considerations of the fluidity of the glass it was not advisable to stop the stirring at a higher temperature; hence the composition of the glass had to be altered. By determination of optical properties the crystals were identified as BaSi_2O_5 . The melting point of pure BaSi_2O_5 is 1426° , whilst the temperature at which the light barium crown became just saturated with BaSi_2O_5 was 1100° . The glass then contained 57 per cent. BaSi_2O_5 . A change of composition so as to reduce the BaSi_2O_5 about 5 per cent. (with a corresponding decrease in saturation temperature) was made, when no further trouble was experienced owing to devitrification.

The author had had submitted to him a sample of plate glass containing crystals of *wollastonite* (CaSiO_3) up to 4 mm. in length formed in the pot during the "hold over" immediately preceding the casting of the plate.

In a communicated discussion, W. S. Williams, of the Bureau of Standards, stated that he had not experienced devitrification of a light barium crown, but a dense barium crown exhibited

12 inches of dense, pure white opal on the surface on cooling, whilst the rest of the glass was clear.

The analyses were as follows:—

	Clear glass.	Opal glass.
SiO ₂	37.88	44.67
BaO	42.36	38.02
ZnO	10.52	9.25
B ₂ O ₃	9.31	8.46

In reply, Dr. Bowen stated that he had seen a scum formed on a barium glass. Under the microscope it was found to consist of glass with a cloud of minute crystals of silica in one of its low refracting forms, *tridymite* or *cristobalite*. Evidently Mr. Williams's scum was identical, for calculation showed that if he took 9 grams of material corresponding in composition to his "clear glass" and added 1 gram of silica, he would obtain a material of the composition of his "opal glass." Whether the formation of these crystals was a true sample of devitrification was questionable; it seemed probable they represented silica that had never completely dissolved because the melt was too slow.

The second danger period was during the cooling from its final temperature in the furnace or tank, when it was plastic, to lower temperatures at which it was rigid. During this period it was usually worked into form by blowing, drawing, casting, etc. (in the case of optical glass the metal was usually cooled in the pot itself). Under these conditions the devitrification appeared in the form of spherulites or in that of very small crystals evenly disseminated. In the author's experience the crystals were apparently in nearly all cases one of the low refracting forms of silica (*tridymite* or *cristobalite*).

Substances such as SO₃, Cl, arsenic, or fluorine seem to exert an influence in promoting this form of crystallisation. The type of barium crown glass the devitrification of which at high temperature had already been described might undergo further devitrification during the cooling stage, with separation of spherulites of BaSi₃O₅.

Spherulites of *wollastonite* sometimes separated from an ordinary crown glass which had an excess of lime as compared with fluxes. The final danger period for devitrification was the period during which it was reheated, whether for working into a desired form or for annealing. In this case the inter-relation of time, temperature, composition, and power of crystallisation must be carefully considered.

Shaping or moulding should be conducted at such a temperature that absolute freedom from devitrification was guaranteed.

The choice of annealing temperature was not so easily made, for at low temperatures devitrification was induced in a certain time at a certain temperature, in a shorter time at a higher temperature, and so on. A foreknowledge of both rates of devitrification and of rates of annealing for various glasses was requisite, so as to determine whether devitrification would be induced at any given

temperature in a period of time which was long enough to give adequate annealing at that temperature. (A table of results for certain optical glasses was given.) There were glasses in which fine annealing and freedom from devitrification were mutually incompatible. Certain opaque (devitrified) glasses used for ornamental purposes were clear when first cooled, and became opaque only on reheating.

Frequently devitrification took place only at the free surface of a piece of glass, but the reason for this greater freedom of devitrification at the surface was unknown. A. M. J.

232. The Hardness of Glass. S. LECRENIER (*Sprechsaal*, 1905, 38, 1665, 1705).—The author commented on the lack of a suitable method of measuring hardness, and reviewed the attempts made to supply the need, commencing with the introduction of Moh's scale. For his investigations on the hardness of glass he decided to follow Auerbach and measure the extent to which a sphere of sandstone could be pressed into a glass block without permanent deformation of the sphere or block.

Both Auerbach and the author attempted to find some relation between the chemical composition. The results obtained by the former, using fourteen glasses, the composition of which was stated, were given. An attempt was made by Auerbach to express the hardness in terms of the percentage analyses, and though not very successful in obtaining coefficients which satisfied the equation $H = a_1w_1 + a_2w_2$. . . , w_1, w_2 . . . being percentages of constituent oxides, derived the following values:—

Al_2O_3	ZnO	K_2O	SiO_2	BaO	PbO	P_2O_5	B_2O_3	Na_2O	CaO
10.1	7.1	3.9	3.32	1.95	1.45	1.32	0.75	-2.65	-6.3

These coefficients were not at all suitable for the values of hardness obtained by the author. In the experiments now described great care was taken to remove all strain from the glasses, which had well polished surfaces. The results are tabulated below. In addition to the hardness of the specimens examined, the density and the coefficients of resistance to tension and pressure were determined. The values obtained for the densities did not agree at all well with those calculated from Winkelmann and Schott's linear coefficients (see p. 176). The author concluded that the influence of the chemical constitution of the glass on the hardness thereof can thus be summarised:—(1) Soda glasses are, as a rule, harder than potash glasses containing an equal volume of silica. (2) With the pure lime-soda glasses, the hardness increases with the increase of lime and decrease of soda. (3) Boric acid imparts great hardness to glass. (4) The addition of soda and lime to lead glasses increases the hardness.

No. of Glass.	Percentage composition.									Coefficient of			
	SiO ₂ .	Na ₂ O.	K ₂ O.	CaO.	BaO.	PbO.	Al ₂ O ₃ and Fe ₂ O ₃ .	As ₂ O ₃ .	B ₂ O ₃ .	Density.	Resistance to tension.	Resistance to pressure.	Hard- ness.
1	55.20	—	9.92	—	—	34.81	0.25	Trace	—	3.227	5.93	85.34	265
2	49.17	—	9.39	—	—	41.17	0.25	Trace	—	3.342	5.55	80.96	262
3	58.35	7.87	3.91	—	—	29.42	0.30	0.15	—	3.006	6.18	86.68	233
4	61.74	7.40	1.38	3.73	—	25.00	0.60	0.15	—	2.971	7.08	89.65	202
5	61.00	11.24	—	—	28.91	—	0.60	0.15	—	2.876	7.06	77.35	231
6	71.66	13.85	—	11.48	—	2.41	0.50	0.10	—	2.541	9.08	91.66	133
7	67.91	—	20.52	10.82	—	—	0.60	0.15	—	2.497	9.37	87.45	243
8	72.04	17.02	—	10.19	—	—	0.60	0.15	—	2.521	8.88	91.73	134
9	73.08	15.84	—	10.33	—	—	0.60	0.15	—	2.504	8.98	93.00	141
10	72.19	15.62	—	11.55	—	—	0.50	0.14	—	2.547	9.18	92.05	130
11	73.26	14.43	—	11.71	—	—	0.45	0.15	—	2.513	9.24	93.34	131
12	68.43	15.83	3.40	8.03	—	—	0.65	0.15	2.51	2.503	8.18	89.54	226

233. The Determination of Young's Modulus (Adiabatic) for Glass. C. A. BELL (*Phil. Mag.*, 1905, 9, 413).—The acoustical method was adopted, and the error due to the lack of uniformity in the diameters of the rods available was eliminated by applying an empirical correction. The number of vibrations per second executed by the rod when emitting its characteristic note was obtained by observation of the beats produced when a steel rod of nearly equal and known pitch was caused to vibrate simultaneously. The following results were obtained:—

Glass.	Density.	E at 0° .
Soft German <i>a</i>	2.508	6.95×10^9 dynes/sq. cm.
" " <i>b</i>	2.507	6.91×10^9 ..
" " <i>c</i>	2.488	6.91×10^9 ..
Bohemian glass	2.394	6.38×10^9 ..
Gauge-tube	2.525	7.36×10^9 ..
Soft Jena	2.499	7.16×10^9 ..
Flint glass <i>a</i>	3.164	5.30×10^9 ..
" " <i>b</i>	3.136	5.39×10^9 ..

In the case of the soft German glass *a* there was a diminution in E of 1.12 per cent. from 5° to 100° , but flint glass *a* showed no change in this range of temperature. If the rods could not be obtained exactly uniform in diameter, uniform tapering was preferable to small, irregular variations.

In an appendix to the paper, C. Chree showed that the empirical correction applied had a theoretical explanation. J. R. C.

III.—Lamp-worked and General Scientific Apparatus.

234. A Simple Weighing Burette. D. W. MACARDLE (*J. Ind. Eng. Chem.*, 1919, 11, 670).—In order to avoid certain disadvantages in the use of ordinary burettes, such as inaccuracy of bore, temperature variation, drainage, and difficulty of reading accurately, a simple form of weighing burette could be used, thus obviating all corrections and allowing nearly as rapid work as the ordinary method with a degree of accuracy only limited by the sensitiveness of the end-point.

The author's apparatus consists of a glass stopcock and a bent capillary tube passed through a rubber stopper fitted into the neck of a conical flask which is nearly filled with standard solution. The stopcock is closed, and the flask turned up so that the capillary is inverted over the titrating vessel, and the heat of the hand is made to force the solution into the capillary. Then, when the stopcock is opened, the solution will flow out freely, and there is no danger of loss through the stopcock. Near the end-point the

cock may be closed and the solution forced out in drops by the heat of the hand. S. E.

235. A New Form of Distilling Tube. J. S. MCHARGUE (*J. Ind. Eng. Chem.*, 1919, 11, 670).—The author's form of

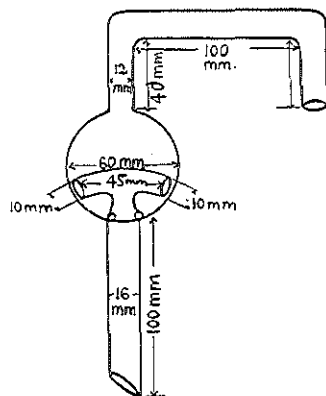


FIG. 104.

distilling bulb is shown in Fig. 104. The stem of the T that connects with the distilling flask is of sufficient size to allow the steam to pass into the distilling bulb and the condensed liquid to flow back into the flask without the latter being caught in a column and held in the tube by the escaping steam. The two small holes in the stem of the T within the bulb allow condensed water to return to the flask as fast as formed. The arms of the T prevent any bubbles of liquid being thrown forward into the condensing tube. Steam flowing out of the two ends of the T keeps the bulb at a uniform temperature, thus lessening

condensation in the bulb and hastening distillation.

S. E.

236. Blowpipe Burners. J. KEITH and G. KEITH (*Brit. Pat. No. 117101*, May 29th, 1917, No. 7661).—In a method of producing a high-temperature flame, more particularly for glass working, the combustible mixture is preheated whilst flowing through a straight passage with a smooth surface and of such form and dimensions that it is delivered in a non-turbulent condition. The pre-heating may be effected by a burner supplied with a portion of the combustible mixture or otherwise, or by electrical or other means. In the form shown in Fig. 105, air and gas supplied through *B* and *C* are mixed in a body, *D*, and heated in long, narrow outlet tubes, *E*, which may be of heat-resisting alloy, by annular burners, *H*, surrounding the tubes and supplied with a portion of the mixture. Regulating screws, *G*, control the supplies to the burners, *H*, and the tubes, *E*, are provided with enlarged outlets in heads, *F*, screwed in a plate, *K*, which prevent combustion products from the burners, *H*, reaching the main burner

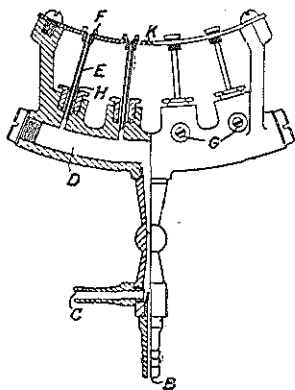


FIG. 105.

flames. The tubes, *E*, may be bent to secure a fine adjustment of the position of the flame. Fig. 106 shows a unit adapted to be fitted into any form of burner. The preheating burner comprises a bush, *J*, extended to form a lantern carrying a disk, *L*, which replaces the plate, *K* (Fig. 105). In a modification, the preheating burner is a perforated tube parallel to the heated tube, and the latter is composed mainly of refractory material or is enclosed in a refractory tube. The heated tube may be $1\frac{1}{4}$ in. long and $3/64$ to $1/16$ in. bore.

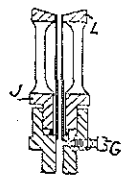


FIG. 106.

H. G. C.

IV.—Decorated Glass.

237. Platinising Pottery, etc. F. J. KETTEL, A. GASCH, and T. A. DEAN (Brit. Pat. No. 117432, May 13th, 1918, No. 8003).—The article is covered with a solution or emulsion consisting of platinum chloride, glycerol, and phenylhydrazine, heated to $850-900^{\circ}$ to reduce the platinum to the metallic state, and subsequently cooled gradually under ordinary atmospheric conditions. The ingredients are used substantially in the proportions of 3 grams of platinum chloride to 12 cubic centimetres of glycerol and 7 drops of phenylhydrazine. In preparing the solution or emulsion, the platinum chloride is dissolved in the least possible quantity of water, the glycerol is added, and the mixture is heated on a water-bath until it reaches the temperature of boiling water, at which it is maintained for one and a-half hours; the phenylhydrazine is then added slowly drop by drop, and the mixture stirred. Heating is continued until frothing ceases, that is, in about three hours, or the liquid may be poured away from the froth.

H. G. C.

V.—Optics and Optical Instruments.

238. Deposits on Glass Surfaces in Instruments. L. C. MARTIN and (MRS.) C. H. GRIFFITHS (*Trans. Optical Soc.*, 1919, 20, 135).—In general, films were most likely to form on surfaces enclosing the smaller spaces in an instrument. In binoculars, deposits were most frequent on the graticules, and no deposit had been found on the object-glass. The authors traced the stages in the formation of a film, it being assumed that the agents contributing to the formation were grease on the lenses, dust nuclei,

water vapour, grease vapour from the lubricants, and heat. The effects of these agents were separately investigated. To remove traces of grease from the lenses, two methods of cleaning were employed, one of which was complicated (*A*) and the other (*B*) consisted of cleaning the surface with methylated spirits and wiping with silk. This latter method was found to be as efficient as the former. If the lenses were boiled in distilled water prior to cleaning, they showed a greater resistance to attack by moisture. Neither moisture nor the presence of lubricants produced a globular deposit, though the former caused disintegration of the surface; but when both these agents were present, such a deposit was observed. The presence of residual vapour of the solution in which the metallic parts had been pickled had a decided action in forming globular deposits.

The nature of the glass had a great influence, and the following table was given. The glasses were heated to 34° in an oven and allowed to cool once during each day.

Glass.	Method of cleaning.	12 days in oven.	35 days in oven.
Crown	A	Definite disintegration.	Considerable uneven disintegration.
"	B	Little effect.	Some disintegration.
Baryta crown... ..	A	Minute pits in surface.	Action continued.
Heavy flint.....	A	"	"
Optical plate	B	Surface beginning to disintegrate.	"
"	B	Little effect.	Definite disintegration.
Barium light flint ...	B	Surface covered with pits	Action continued.
" " ...	B	(pits smaller).	"
" " ...	B	Some disintegration.	"
" " ...	B	Fewer pits, but larger and more irregular.	"

In general, the surfaces were fixed at the ends of a brass tube 1 cm. long, but in the second and fourth tests with B.L.F., the tubes were 0.5 and 4.0 cm. long respectively. The order in which the glasses could be arranged in view of their tendency to disintegrate under the action of warmth showed no agreement with Kohlrausch's order of solubility of similar glasses, nor with the order in which they were placed by an autoclave test. J. R. C.

239. The Possible Disturbance of a Range Finder by Atmospheric Refraction due to the Motion of the Ship.

RAYLEIGH, LORD (*Trans. Optical Soc.*, 1919, 20, 125).—A mathematical treatment of the subject, the conclusion arrived at being that the error due to refraction was so small as to be negligible. This view was controverted by T. Y. BAKER in the discussion following the paper. It was asserted that the magnitude of the variation calculated was greater than the probable observational error.

J. R. C.

VI.—Illumination and Illuminating Ware.

240. Thorium Salts. LINDSAY LIGHT CO., U.S.A. (Brit. Pat. No. 117438. November 26th, 1917, No. 17468).—Thorium pyrophosphate.—Monazite sand is heated with strong sulphuric acid, a temperature of 175° being mentioned, to convert the thorium and rare earths into soluble form, and the heating is then raised to 250 — 300° until the thorium alone has become insoluble. The mass is then cooled and stirred with water, and the insoluble thorium pyrophosphate in crystalline form is filtered off, and may be further treated to obtain pure thorium compounds. Pure thorium pyrophosphate in this form may be made by heating thorium sulphate and phosphoric acid at 280° .
H. G. C.

241. The Reduction of Tungstic Oxide. C. W. DAVIS (*J. Ind. Eng. Chem.*, 1919, 11, 201).—Several industrial concerns at the present time produce powdered metallic tungsten for use in the manufacture of alloys. Although extensive, the available literature on the reduction of tungstic oxide to the metal failed to give definite information concerning the conditions involved. Hence the following work was undertaken by the author to supplement existing data.

The tungstic oxide used for reduction must be pure, dry, in a state of fine division, and should be thoroughly mixed with carbon. A blue or purple oxide was obtained at 650 — 850° , a chocolate-coloured material at 900 — 1050° , and at temperatures above 1050° grey, powdered metallic tungsten resulted.

As the tungsten was easily oxidised, the reduced material must be cooled in a reducing atmosphere. Excess carbon could be partially removed by washing, and the ratio of tungstic oxide to carbon varied from 10:1 to 10:1.6, depending on the process used, the temperature of reduction, and the time involved.

Fireclay crucibles or iron tubes gave satisfactory reduction with a product of more than 98 per cent. of tungsten, but under the conditions of the test some oxides were formed at the portions nearest the crucible cover and the ends of the tube. It was found that fireclay was not attacked by the change at the temperatures used, but that iron tubes suffered considerable oxidation on the outside.

To obtain tungsten powder free from oxides, a continuous process could be arranged, the time for reduction of small samples at 1100° being less than one hour. The temperature of reduction with hydrogen at ordinary pressures was much the same as with carbon, a yield of more than 98 per cent. of tungsten being realised.
C. M. M.

VII. Fuels, Refractories, and Furnaces.

242. Problems in the Utilisation of Fuels. R. F. BACON and W. A. HAMOR (*J. Soc. Chem. Ind.*, 1919, **38**, 161 τ).—Some of the most important engineering problems in the utilisation of fuels were discussed. The last twenty years had seen improvements in the development of water power, in the concentration of the production of power from fuel in central stations, where the most economical methods could be used, and in the distribution of power electrically. There remained, however, a great deal to be done in the direction of replacement of inefficient and isolated power plants of various types with electric power, and from the point of fuel conservation, the largest field open at present was on the railways. The fuel supply was still abundant, and manufacturers had found it a more convenient policy to use high-grade rather than low-grade fuels. However, the supply of high-grade fuels, such as anthracite and coking coal, might soon be exhausted, possibly during this century, and consequently the conservation of all classes of fuel became increasingly necessary. The reasons for lack of development and utilisation of low-grade fuels were the cheapness with which the high-grade fuels could, in the past, be mined and transported to the markets, and the need of basic experimental and development work which was required in order to utilise the full thermal efficiencies of the low-grade fuels.

Low-grade coal and lignite could probably be utilised to better advantage in the pulverised form. In this form it required 25 to 30 per cent. of excess air, whereas in lump form, burned in "hand-fired" furnaces, it usually required 100 per cent. of excess air. The resulting temperature of the fire was, of course, a limiting factor. Bearing on this problem were other factors, such as the construction of the furnace, the proportion of heat radiated directly to the tubes, and the fusibility of the ash. Where the fuel was rich in combined nitrogen, the by-product gas producer became of value for large installations. The utilisation of waste from coal-washers was discussed at length, and the authors considered that the oil-flotation process for the recovery of the coal in most low-grade fuels would be a means of combating fuel problems of the future. Another problem which was arising was the effective development of the shale-oil industry, owing to the necessity for finding suitable substitutes for petroleum products. The various aspects of the possible development of the industry in America were considered in detail.

Engineering problems were extensive, and included the many difficulties encountered in securing perfect combustion, such as furnace volumes, rates of combustion, loss due to clinkering, scale, flue dust, etc. With pulverised coal there were the problems of crushing and drying, explosibility and storage, injection into the fire-box and erosion of the refractories, and the

relative value on a heat and cost basis of pulverised coal, fuel oil, and producer gas.

The smoke evil led consideration in three directions, namely, the wider extension of the use of gaseous and powdered fuels, the adoption of electricity as a motive power, and the manufacturing of some form of semi-carbonised coal as a domestic fuel at a price which would not exceed that of raw coal.

The use of gaseous fuel from producers raised the following problems:—

(1) In the case of fixed type producers, the troubles arising from clinkering, incomplete burning of the coal, and air-holes and pressure; (2) the most economical size and shape of producers for gas to be used for heating purposes; (3) economical use of the tar by-product; (4) automatic, separate control of steam and air blasts; and (5) practical automatic check and regulation to maintain a regular quality of producer gas.

With fuel oil there were the problems of explosibility, storage, burning for perfect combustion, and action on furnace refractories.

In the refractories industry, the most important problems arose in the development of the necessary heat, and might be enumerated as follows:—

(1) Regular and even heating in the kilns; (2) effective and economic conduction of gas from producers to kilns without great loss of heat from the gas; (3) in the use of pulverised fuel, the prevention of deposition of ash dust, and development of a feeding arrangement giving combustion even at low temperatures; (4) maintenance of a good draught; and (5) avoidance of defects due to clinkering, *e.g.*, loss of temperature in kilns owing to inrush of cold air during the cleaning of fire-boxes.

The effective use of the heat developed then depended on decreasing radiation, stack, and kiln losses.

The glass industry required a cheap and continuous supply of fuel. Coal was, from the economic point of view, the most suitable fuel; fuel oil was too expensive, whilst the use of electricity in glass-making was exceedingly problematic, both from the engineering and the economic sides. Direct burning of coal in pot furnaces was inefficient, and was not applicable to tank furnaces. Improvements in producer design and the extension of the use of lower grades of fuel would be of benefit. Pulverised coal, though perhaps applicable to pot furnaces and certain types of lehrs and kilns, had not, so far, been successful for glass melting owing to the choking of flues and contamination of the glass by ash, etc. If it was used, some gaseous fuel would be necessary for "glory holes," etc.

Heat economy was one of the most important problems in the glass industry. In the case of a plate-glass furnace, only 17 per cent. of the total heat supplied was required to melt the glass, whilst 56 per cent. was lost through radiation, conduction, and in the flue gases. Many improvements were necessary in the

standardisation of furnaces, arrangements of ports and baffles, regulation of air supply and gas pressure, and in the efficient construction of regenerators. As regarded furnaces for closed pots, in particular, heating of the pots evenly on all sides would reduce the heat loss. In lehrs there was need for more accurate regulation of temperature and a greater uniformity of heating in order to avoid breakage due to improper annealing and the necessity, in many cases, of a second annealing.

The fuel problems in the iron and steel industry were also dealt with. F. W. H.

243. Refractories. J. W. MELLOR (*J. Soc. Chem. Ind.*, 1919, 38, 180R).—The first effects of heat on clay were the removal of hygroscopic moisture and the dehydration of the colloidal silicic acid; at 500°, the clay was decomposed into free silica, free alumina, and water; about 800°, the alumina began to polymerise; above 1000°, *sillimanite*, $\text{Al}_2\text{O}_3 \cdot \text{SiO}_2$, was formed; at 1500°, the clay sintered to a stone-like mass; at 1650°, the clay softened, and at 1700° formed a brown or grey, viscid liquid.

About 500°, clay goods, during firing, absorbed heat without rise of temperature; at about 900° they became hotter than the kiln, and afterwards cooled to the kiln temperature. Clay expanded during dehydration and then contracted when the temperature rose above 600°, due to vitrification and the change of the products of decomposition to a mixture with a higher specific gravity. The specific gravity of alumina increased on heating from about 2.8 at 600° to about 3.9 at 1200°, corresponding with a contraction of nearly 30 per cent. This contraction, under ordinary firing conditions, was slow and took a long time for completion. Hence serious difficulties arose through subsequent contraction, and alumina or bauxite bricks were condemned. The author considered that these bricks had not had a fair trial. Ferric oxide, chromic oxide, and magnesia underwent analogous changes, but in a less degree, whilst with zirconia the changes were even more pronounced than with alumina.

Tests on the penetration of firebricks by dust showed that dusts consisting of oxide of iron, copper, or zinc penetrated the refractory as vapours, owing to their volatilisation at comparatively low temperatures in a reducing atmosphere. Ferruginous dusts in reducing atmospheres caused rapid slagging. Salt vapour from coal also produced a very fusible slag with silica and fireclay refractories. The best resistance to this action was given by bricks in which the ratio of alumina to silica molecules was less than 1 to 3.5. F. W. H.

244. Refractory Substances. G. W. MOTTRAM (Brit. Pat. No. 123116, November 7th, 1917, No. 16229).—Refractory bricks and the like are made by first dry-grinding the base material and saturating it with water, then wet-grinding the binder or flux to the consistency of a slip varying in fineness from 30—200

meshes to the linear inch with 1—4 times its weight of the base and mixing the product with the remainder of the saturated base material. After the mixture has been allowed to stiffen and mature and excess of water is removed, it is pressed, dried, and burnt at a sintering temperature. As base material, silica, fire-clay, and other old or new refractory material may be employed ground to a fineness of 8—40 meshes to the linear inch, and the clay binding material may be made more plastic by the addition of peat-water or the slime deposited from the effluent from sewage purification or the refuse liquid from tanneries. Lime or other basic oxide or iron oxide or salts to the extent of 1.5 to 4 per cent. may also be added with or without 5 to 15 per cent. of fireclay.

H. G. C.

245. A Study of some Light-weight Clay Refractories.

M. F. BEECHER (*J. Amer. Cer. Soc.*, 1919, 2, 336).—The author described a study on bricks of twelve different compositions, namely:

No.	Refractory clay.	Kaolin.	Regular. grog.	Kaolin grog.	Sawdust.
1	19	38	24	—	19
2	10	30	13½	—	46½
3	50	10	—	10	30
4	50	10	10	—	30
5	50	10	20	—	20
6	50	20	—	—	30
7	25½	24½	—	—	50
8	Norton special clay brick.				
9	A good quality silicious clay brick.				
10	A flint-clay brick (Pennsylvania).				
11	A flint-clay brick (Missouri).				
12	A flint-clay brick (Kentucky).				

The sawdust in these bricks contained no hard woods. It had a weight of 14 lb. per cubic foot when shaken down slightly, and was sized to pass an 8-mesh screen.

The major results of the study are summed up in the following table:—

		Load test		Resistance to spalling.		Cone of fusion.	Thermal insulation.	
Weight.		Deformation.		Behaviour.				
No.	Rank.	Standard 2½" × 4½" × 9".	Rank.	Per cent.	Rank.		Rank.	
1	6	5.51	4	2.66	10	fair	31—32	10
2	2	4.01	9	10.57	12	poor	31—32	3
3	4	5.43	12	Shear	5	good	31—32	5
4	5	5.50	6	5.54	9	fair	31—32	6
5	7	5.84	3	2.37	1	good	31—32	2
6	3	5.35	5	4.56	8	fair	32	4
7	1	3.93	11	23.80	11	poor	32	8
8	9	6.76	2	2.19	2	good	32	11
9	8	6.58	1	1.33	6	fair	29—30	9
10	10	6.87	7	7.06	7	fair	32	7
11	12	7.92	8	8.43	4	good	31—32	12
12	11	7.43	10	18.40	3	good	—	1

The results show that, except for Nos. 2 and 7, the load-carrying capacities of light-weight bricks (made with a percentage of sawdust) compare very favourably with the standard full-weight bricks.

In resistance to spalling, the light-weight bricks again show up very well. In thermal insulation they are practically equal to or superior to all the commercial brands except No. 12. Sawdust additions (to relatively open-burning clay mixtures) appear to increase the porosity by an amount equal to the actual volume of the addition.

The author drew a number of valuable conclusions concerning sawdust mixtures with fireclay, and several writers in communicated discussions pointed out that there is much scope for the development of light-weight refractories. A. M. J.

246. The Volatilisation of Iron from Optical Glass Pots by Chlorine at High Temperatures. J. C. HOSTETTER, H. S. ROBERTS, and J. B. FERGUSON (*J. Amer. Cer. Soc.*, 1919, 2, 356).

—Chlorides and chlorine have previously been used to volatilise iron; for example, (1) Bole and Howe have used various chlorides to volatilise iron from enamels (*Trans. Amer. Cer. Soc.*, 1915, 17, 125); (2) sand has been purified by igniting with 2.5 per cent. of sodium chloride (J. G. A. Rhodin, Brit. Pat. No. 8495, 1914); (3) chlorine at high temperature has been used to purify zirconia from iron (A. J. Phillips, *J. Amer. Cer. Soc.*, 1918, 1, 791). In order to test if chlorine could be used to free glass pots from iron, experiments were first conducted on a laboratory scale to determine the best conditions.

Portions of previously burned pot-shell, held in a porcelain or alundum boat, were placed in a silica glass (or, at higher temperatures, a porcelain) tube, through which a stream of chlorine was forced. The tube was heated in an electric furnace, the temperature of which was measured by a platinum-platinum-rhodium thermocouple. The first experiments showed that chlorine at 800° would remove some portion of the iron, but that better results were obtained at higher temperatures.

The details of several runs under different conditions are shown in the following table:—

Minutes to reach max. temp.	Max. temp.	Minutes held at max. temp.	Per cent. of Fe_2O_3 in pot.		Per cent. of Fe_2O_3 removed by Cl.
			Initial.	Final.	
—	1100°	120	2.19	1.03	53.0
155	1214	195	2.19	0.78	64.3
—	1225	105	2.19	1.20	45.2
185	1365	125	2.19	0.49	77.6

The results show that the chlorine treatment should be conducted at the highest attainable temperature, and should continue for at least two hours. The treated pot samples after these runs were nearly white in colour with occasional yellow spots. The

colour was uniform throughout, showing that the gas penetrated to the centre.

Some pieces of ordinary red brick placed in the boat along with the pot-shell were beautifully white after treatment.

The effect of moisture and hydrochloric acid vapour with the chlorine was tried; some results are shown in the following table:—

Chlorine.	Time at max. temp.	Temp.	Iron content of pot.		Iron removed, per cent.
			Initial.	Final.	
Dry	30 min.	1265°	1.94	0.74	61.8
Bubbled through water at 69°	30 min.	1265	1.94	0.88	54.7
Bubbled through conc. HCl at 17°...	30 min.	1265	1.94	0.84	56.7

There is, therefore, no advantage to be gained by the use of moisture or hydrochloric acid vapour along with the chlorine.

Large-scale experiments were next tried at the glass works of

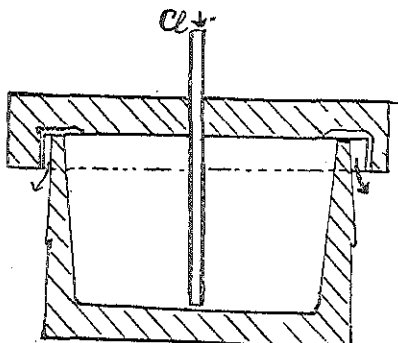


FIG. 107.—Diagram illustrating the most effective method of introducing the chlorine and covering the pot.

the Bausch and Lomb Optical Co. The equipment consisted of a cylinder of liquefied chlorine, to which was connected a wash-bottle containing concentrated sulphuric acid to show the rate of flow of the gas, whilst a rubber tube connected the wash-bottle to a 15 mm. fused silica glass tube about 200 cm. long, which served to carry the gas down into the pot. Fig. 107.)

Some of the pots were treated in a recuperative furnace, others in pot arches, and one in a regenerative furnace.

In all cases the pots appear to have been of the open type. It was found best to introduce the chlorine stream so that it first impinged on the bottom of the pot (where the greatest corrosion takes place during melting), and also to control the direction of the effluent gas so that the precipitation of the ferric oxide formed by the interaction of the ferric chloride with the furnace gases would not occur within the pot.

Generally, it was found that glass made in treated pots con-

tained less iron than glass made in untreated pots. At the same time there was evidence that the removal of iron made the pots more porous and more readily attacked by the melted batch, and therefore a greater percentage of iron was found in the glass in some cases.

The physical condition of the pot played an all-important rôle in resistance to pot corrosion. If a dense surface has been made on the interior of the pot, and this has been thoroughly vitrified in the arching and burning processes, the pot becomes exceedingly resistant to the action of the batch. It is possible, therefore, that if after chlorination the pots had been burnt for several hours at a higher temperature, better results would have been obtained.

The experiments were regrettably discontinued owing to the imperative demand for the maximum production of glass.

A. M. J.

247. The Comparative Value of Kneading and Pugging in the Preparation of Porcelain Bodies. L. E. BARRINGER and CHESTER TREISCHER (*J. Amer. Cer. Soc.*, 1919, **2**, 306).—In the authors' opinion, the pug mill is an excellent mixer and works rapidly, but tends to leave laminations where the knives and augers pass through the putty-like mass. The rolling or kneading table does not mix as well as a pug mill, but should leave the mass more free from imperfections.

The authors measured the air content of the product obtained from different machines, using Spurrier's method (*J. Amer. Cer. Soc.*, 1918, **1**, 710; this JOURNAL, 1919, Abs. No. 174, p. 117), and it was ascertained that the kneading table is a more efficient air remover than the pug mill.

In a communicated discussion, C. E. Jackson, Warwick China Company, Wheeling, W. Va., stated that clay after it has been on a kneading machine is better in all respects than clay that is hand wedged.

The kneading machine also strengthened a weak body and produced a clay which worked more smoothly. Clay prepared by the kneading machine lent itself to the production of extremely delicate work. From the commercial point of view a pug mill has about six times the output of a kneading machine.

A. M. J.

248. Silica Bricks and their Manufacture. L. DAUPHIN (*Bull. Soc. de l'Ind. Min.*, 1918, **13**, 137; from *J. Soc. Chem. Ind.*, 1919, **38**, 136A).—The properties of typical silica bricks were described, and the effect of the presence of added ferric oxide, alumina, and lime on the refractoriness was discussed. Suggestions were made regarding the selection of raw materials and making and firing the best type of silica bricks. The following results of the tests on various bricks were quoted:—

	Source.	Refractori- ness.	True sp. gr.	Porosity. Per cent.	Composition,					Refractori- ness after addition of 6 per cent. of Fe ₂ O ₃ .
					SiO ₂ .	Al ₂ O ₃ .	Fe ₂ O ₃ .	CaO.	MgO.	
British bricks.	B.W.	1725°	2.44	24	94.3	1.40	1.66	2.30	—	—
	B.A.Y.D. ...	1733	2.36	28	95.0	0.87	2.03	2.00	—	—
	B.S.Y.D. ...	1710	2.33	26	95.0	1.17	1.33	2.20	—	—
	B.F.P.	1735	2.43	32	95.6	0.68	2.22	1.30	—	—
	B.B.	1725	2.53	28	93.9	0.86	1.84	3.0	—	—
Ger. man.	Zurbig	1728	2.30	23	95.1	1.53	0.97	2.0	—	—
	Stella	1730	2.47	20	95.9	0.41	1.87	1.7	—	—
French.	Loire	1725	2.34	31	95.48	1.86		1.78	traces	1715°
	"	1725	2.56	28	96.46	1.18		2.06	0.27	1700
	S.A.M.	1715	2.35	27	93.82	1.12	2.54	1.78	—	—
	C.F.D.	1750	2.35	17	96.15	0.37	1.24	1.75	0.18	1735
American "Star"		1730	2.31	30	97.8	0.9	0.85	0.10	0.15	1710

249. The Progress of Vitrification and Solution in some Porcelain Mixtures. A. S. WATTS (*J. Amer. Cer. Soc.*, 1919, 2, 400).—The author states that the industrial application of porcelain requires three questions to be answered:—(1) How may *sillimanite* be developed in a porcelain so that the highest grade of product will result? (2) To what extent can *sillimanite* be developed in a porcelain without the loss of any desirable physical property? (3) To what extent may the solution of quartz be carried to the benefit of the porcelain?

To study the progress of *sillimanite* development and quartz solution, a body was prepared containing 33 per cent. Canadian felspar, 17 per cent. flint, 25 per cent. American china clay, and 25 per cent. American ball clay. Three portions were taken, one fired to cone 9, one to cone 11, and one to cone 13. Microphotographs of these specimens were shown. It appears that the development of *sillimanite* starts in the felspar grains and progresses with fusion. The matrix of fused felspar saturated with clay substance and quartz permeates the mass.

The composition of the clay body was altered in order to determine the influence of the degree of viscosity of the solvent upon the *sillimanite* development. The introduction of calcium flux did not apparently add to the *sillimanite* development, although it undoubtedly increased the solution of the quartz grains at any given temperature. The substitution of soda-felspar for potash-felspar was accompanied by increase in size of the *sillimanite* crystals, but the amount of *sillimanite* did not apparently increase. The preliminary fusion of the felspar and calcium flux before incorporation in the body increased the fluxing action and tended to increase the size of the *sillimanite* crystals developed. It also aided the solution of the quartz grains, but the amount of *sillimanite* was not materially increased.

A study of natural rocks showed that those containing *sillimanite* are high in alumina and alkali content. The presence of alkaline earths is unfavourable to *sillimanite* development.

A. M. J.

250. The Effect of Time and Temperature on the Micro-structure of Porcelain. A. B. ПЕЧК (*J. Amer. Cer. Soc.*, 1919, 2, 175).—Petrographic microscopic examination showed that quite dissimilar bodies could be produced by maintaining porcelain at a constant temperature for lengths of time which lie within the variations of commercial practice. The clay passed into amorphous silica and *sillimanite*, which in turn passed into crystallised *sillimanite*, the solution of quartz taking place at the same time. The difference in structure became more marked the higher the burning temperature. The amount of *sillimanite* formed was greater the longer the burning at constant temperature was continued; also the larger and better developed did the crystals become and the greater the amount of quartz dissolved by the felspar.

Sillimanite crystals were formed, first, by the gradual change

from the amorphous to the crystalline state without the aid of a flux, and, secondly, with the aid of felspar as a flux through solution and recrystallisation of the amorphous *sillimanite*.

Bodies fired for longer periods at lower temperatures had been produced which simulated very closely those fired at higher temperatures for shorter periods, and therefore it was not possible to predict the temperature of burning of porcelain bodies without having some knowledge of composition and length of firing.

Several photomicrographs were shown in illustration.

A. M. J.

251. Glass Furnaces. A. F. PEETERS, HOLLAND (Brit. Pat. No. 116477, February 11th, 1918, No. 2439).—In a tank glass-melting furnace having melting and working compartments, the burner or inlet for the heating gases is situated at the end of the working compartment, and the outlet flue at the end of the melting compartment.

H. G. C.

252. Glass Furnaces. H. C. GHIJSEN and NAAMLIOOZE VENNOOTSCHAP VITRITE WORKS, HOLLAND (Brit. Pat. No. 124307, April 9th, 1918, No. 6057).—In a melting furnace, more particularly adapted for use in filling the bases of electric lamps with molten glass, a continuous stream of metal is maintained by heating a small part only of the raw material, and the quantity required for a filling operation is cut off by a pair of blades and led through a conduit into the base or mould to be charged. The raw material is fed down an inclined surface, 3, on to a floor, 4, where it is melted by the flame from a burner, 9. The stream of molten metal is further heated by a burner, 10, and flows to the discharge lip, 6, through a narrow channel formed by vertical wall, 7. Projections, 8, from the roof of the furnace prevent too rapid descent of the raw material, and an inspection opening, 12, is provided on the furnace wall opposite the lip, 6. The cutter blades, 17, 18, are carried by concentric shafts, 15, 16, and are operated at regular intervals from a rotating shaft, 28, of the lamp-making machine through a cam groove, 27, lever, 23, links, 21, 22, and arms, 19, 20. In their open position, the blades are withdrawn into cooling chambers, 30. The lamp bases, 31, are carried

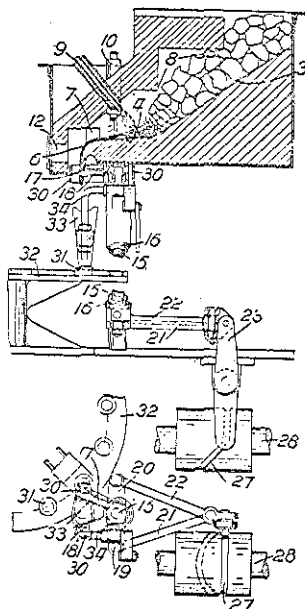


FIG. 108.

by a rotating table, 32, and the cut-off portions of glass are fed thereto by a guide conduit, 33, carried by a pivoted arm, 34, connected to a treadle, operation of which moves the delivery end of the conduit out of the path of the lamp bases. H. G. C.

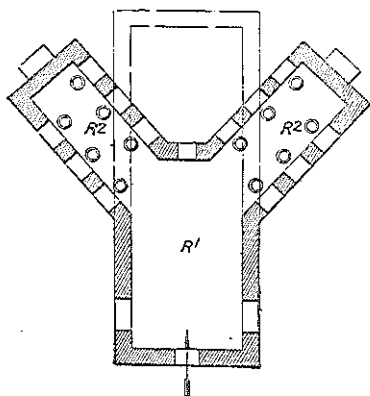


FIG. 109.

253. Glass Furnaces. A. F. PEETERS, HOLLAND (Brit. Pat. No. 123146, February 11th, 1918, No. 2440).—Two or more working spaces, R^2 , are connected with a single melting space, R^1 , the total cross-sectional area of the working spaces being in excess of that of the melting space. The heating gases pass from the melting space through the working spaces, or *vice versa*.

H. G. C.

254. Reverberatory Furnaces for Glass Manufacture, etc.

T. B. KITSON (Brit. Pat. No. 122672, December 27th, 1917, No. 19116).—The air for combustion is heated in an intermediate chamber or flue arranged between the furnace crown and an upper waste flue, without previously passing through a regenerator, the air and waste gas flues being straight and unobstructed, and the air and waste



FIG. 110.

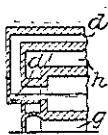


FIG. 111.

gases passing through them in the same direction. The exhaust ports, or outlets, for the waste gases also serve as troughs, or spouts, for the discharge of molten glass, etc. Fig. 110 is a vertical section of a gas-fired furnace. The air for combustion passes first through a series of parallel passages, g , beneath the furnace, and then through a chamber or flue, h , between the furnace crown and the waste-gas flue, d , being finally delivered to the furnace chamber through ports alternating with gas-supply ports, j . Fig. 111 shows the arrangement whereby the waste-gas outlets are formed by the outflow spouts, d^1 , for the molten glass. H. G. C.

255. Glass-annealing Lehrs. J. KEITH and G. KEITH (Brit. Pat. No. 123254, June 13th, 1918, No. 9727).—A glass-annealing lehr, through which goods are carried by an endless conveyer, consists of a long tunnel with a portion inclined upwards from the feeding end, A , Fig. 112, a gas-fired heating chamber, C , at the highest point, and a long, downwardly inclined discharge part,

the end of which is at a slightly higher level than the inlet to the tunnel. The heating chamber is formed as a muffle, and the products of combustion from high-pressure burners, *H*, Fig. 113, pass from the surrounding flues to the discharge part of the

FIG. 112.

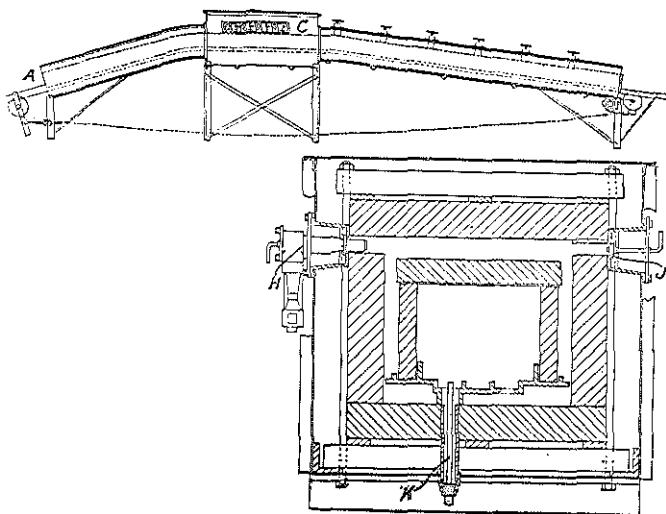


FIG. 113.

tunnel, from which they escape at the end, and through dampered openings about its length. Pyrometers, *K*, are fitted in the heating chamber and along the discharge part, and observation openings, *J*, are provided opposite the burners.

H. G. C.

256. Glass Furnaces. E.

ROIRANT, FRANCE (Brit. Pat. No. 117452, June 27th, 1918, No.

10572. Convention date, July 12th, 1917. Not yet accepted. Abridged as open to inspection

under Sec. 91 of the Act).—Discharging.—Glass is discharged from a melting furnace into a receptacle, 11 (Fig. 114), which can be moved from its receiving position within a chamber, 2, adjoining the furnace to the gathering point.

As shown, the receptacle 11 is mounted between arms, 9, pivoted on a shaft, 8, and passes to and from the chamber, 2, through an opening, 5, in the front wall. The

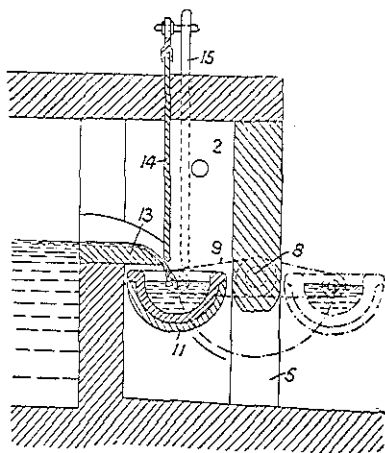


FIG. 114.

delivery of glass over the lip, 13, is controlled by a gate, 14, which may be automatically operated by the movement of the receptacle through a rod, 15. The chamber, 2, may be heated either by gases from the melting furnace or by separate burners.

H. G. C.

257. Electric Furnaces. H. A. GREAVES and H. ETHELLS (Brit. Pat. No. 115866, April 11th, 1917, No. 5072).—Resistance furnace.—Granular resistance material is contained in ducts, *d*, looped around the furnace chamber, *b* (Fig. 115), and separated by material which, when hot, allows a certain amount of current leakage between the ducts. Suitable materials for the loose resistance are ground coke, retort carbon, kryptol, carborundum, siloxicon, silundum, or a mixture of minerals, such

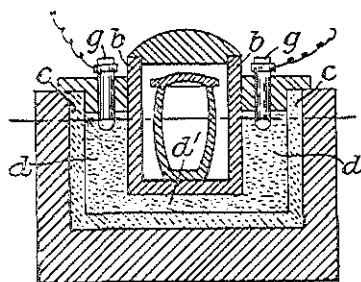


FIG. 115.

as cryolite and chromite. The partitions between the ducts may be of chromite, magnesite, carborundum, or silundum. A layer of resistance material, *d*¹, beneath the furnace chamber connects the material in the ducts. Passages may be provided for replenishing the ducts with resistance material. Electrodes, *g*, entering the ducts, preferably from above, are arranged in groups of two or three for polyphase currents, or are alternately of opposite polarities

when single-phase or direct current is used. Supply transformers may be arranged for alternative series or parallel connection, for use at starting and in normal working respectively. Further regulation may be effected by auto-transformers in the primary circuits. The furnace may be used for melting, refining, heating, annealing, etc.

H. G. C.

258. Gaseous-fuel Furnaces. H. N. DAVIS and W. R. TWIGG (Brit. Pat. No. 122673, December 28th, 1917, No. 19189).—

Furnaces specially adapted to be fired by coal gas as supplied by gas companies are provided with reversible regenerators formed entirely within the furnace structure, to which air is supplied under pressure. Fig. 116 is a diagrammatic section of such a furnace, gas

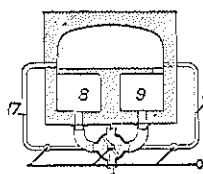


FIG. 116.

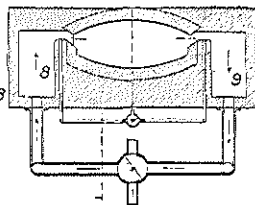


FIG. 117.

being supplied by the pipes 17 and 18 alternately, and air under

pressure through the regenerators 8, 9, alternately, the regenerators being arranged beneath the floor of the furnace chamber. Fig. 117 is a similar view of a furnace with the regenerators at the ends of the furnace. Figs. 118 and 119 are more detailed sectional views of a furnace heated by a row of gas burners on each side, gas being supplied at either side alternately from pipes 36, 38, while

FIG. 118.

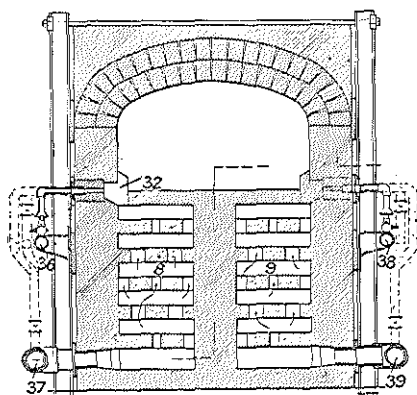
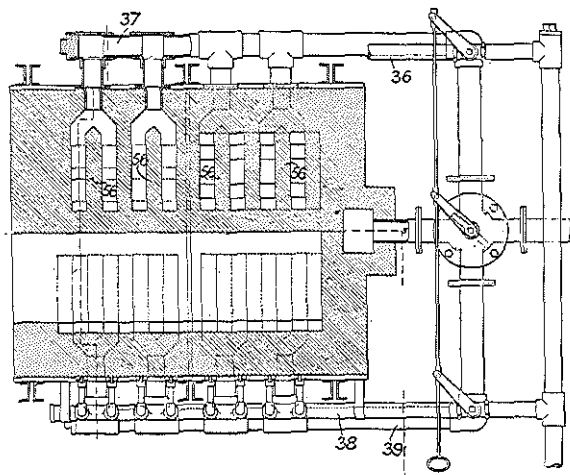


FIG. 119.

air is supplied under pressure through the regenerators 8, 9, alternately, from pipes 37, 39, by means of reversing valves. The burners deliver into spaces 32 at the level of the floor of the furnace chamber, into which the heated air from the regenerators is delivered. The waste products of combustion pass through the regenerator which is not in use for heating the air. The regenerators are divided into sections independently supplied with

air, as shown in the sectional plan view, Fig. 118, and each section is further divided into two by a partition, 56. Unheated air may be supplied to the burners by connections from the air-supply pipes, as indicated by dotted lines in Fig. 119. H. G. C.

259. Muffle Kiln for Firing Pottery, etc. W. BENNETT

(Brit. Pat. No. 117147, July 16th, 1917, No. 10257).—A combustion chamber, *c* (Fig. 120) is arranged longitudinally beneath the floor of the kiln about midway of its breadth, and is supplied with gas and air through passages, *b*, *e*, extending from one side, the gas being admitted to the passages, *e*, from a side-main, *a*. The gas and air passages are preferably grouped in, say, four sets, each having an air passage, *e*, between two gas passages, *b*, and the combustion chamber may be divided by transverse partitions. The supplies of gas and air to the passages, *b*, *e*, are controlled by suitable valves. In a modification, the air passages are divided into two parts, one above the other, by a partition, one part leading direct to the combustion chamber, and the other passing to the opposite side of the kiln and returning to the combustion chamber. H. G. C.

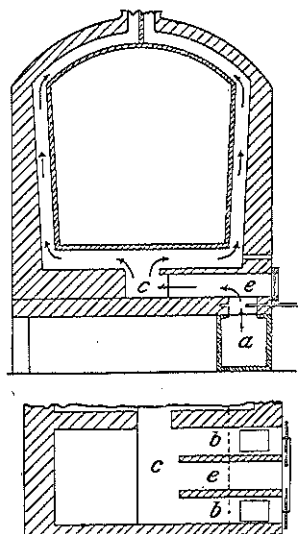


FIG. 120

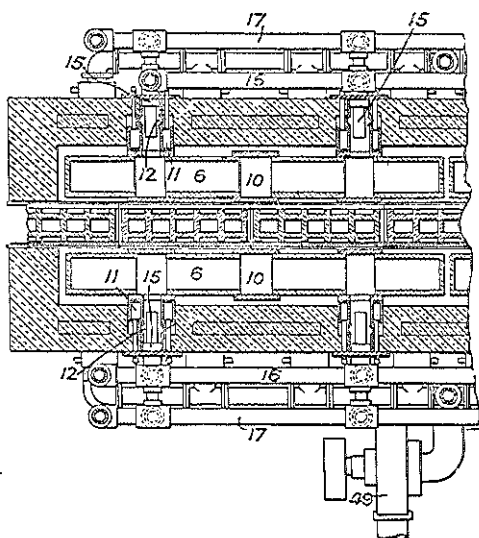


FIG. 121.

260. Tunnel Kilns.

G. H. BENJAMIN, U.S.A. (Brit. Pat. No. 117383, November 12th, 1917, No. 16592).—A continuous tunnel kiln for use in the manufacture of tiles, pottery, and the like consists of a main chamber or tunnel heated by closed combustion chambers arranged in line along its sides in which gas is burnt, and by the circulation through the main chamber, and through the goods, of hot air which, after

exhaustion from the goods chamber, may be in part used for combustion. Fig. 121 shows a sectional plan of one end of the kiln, and Figs. 122 and 123 show transverse sections through different parts of it. Gas and air are supplied by pipes, 16, 17, and burners, 15, to each combustion chamber, 6, at two points as shown, or at one point only, through a corrugated section, 12, and a water-cooled sleeve, 11, and the combustion products pass away at 10 through arched flues, 26 (Fig. 123), to a multitubular air-heater, 35, and thence to a chimney. In the arrangement shown, the outlet portion, 10, of each combustion chamber is situated between two burners, 15. In a modification, each combustion chamber has one burner only, the outlet portion being at one end. Some of the hot air from the air-heater, 35, is drawn off by a pump for combustion in the burners, gas being supplied by another pump. The gas and air are supplied preferably at pressures of one and one quarter lb. per sq. in. respectively. The remainder of the hot air from the heater, 35, is led by pipes, 38, to flues, 39, beneath the combustion chambers, 6, and circulates through the goods, 41, passing away through flues, 44, 45, formed in the trucks conveying the goods through the kiln, and through flues, 46, 47, in the base

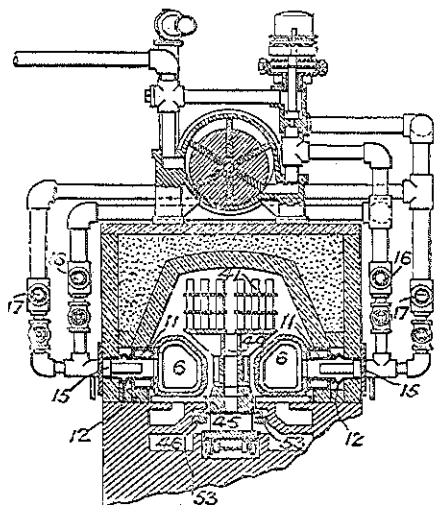


FIG. 122.

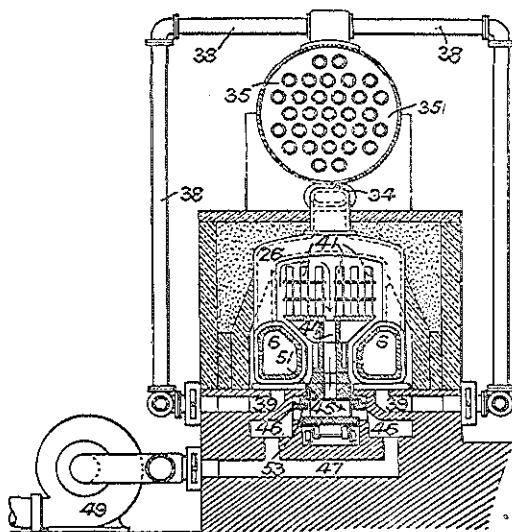


FIG. 123.

of the kiln to the exhaust fan, 49. The passages, 45, are sealed from the interior of the kiln by sand seals, 53, in which move the down-turned edges of a plate on the truck. Cold or tempered air may be admitted to the kiln by shutting a valve on a pipe connecting the air-heater and the air pump, and opening another inlet on the air pump. The fan, 49, may deliver the air withdrawn from the kiln to the inlet, 34, of the air-heater for use again.

H. G. C.

261. Furnaces and Kilns for Metal Heating or for Pottery. H. FRANCAERT (Brit. Pat. No. 122742, March 21st, 1918, No. 5027).—A furnace or kiln for metal heating or for use in the manufacture of pottery, etc., comprises combustion and heating chambers arranged side by side and connected at top and bottom so that a continuous circulation of combustion products will take place from the combustion chamber, down through the heating chamber, and back again to the combustion chamber. In the kiln

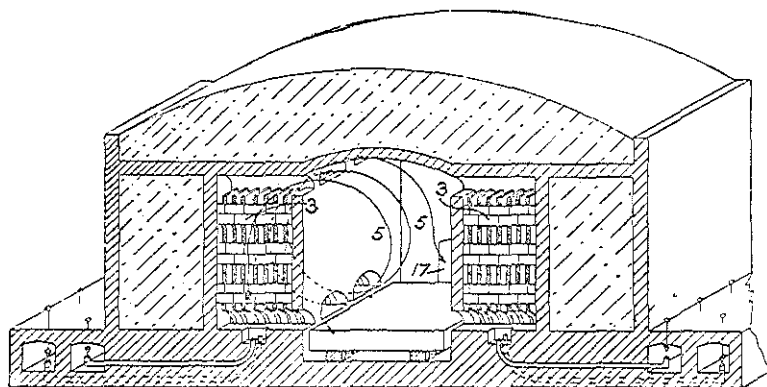


FIG. 124.

shown, a number of combustion chambers, 3, are arranged at the two sides of the heating chamber, 5, with which they are in communication by openings at the top and bottom respectively. Gas and air are burnt at the lower ends of the combustion chambers, and the products circulate through the heating chamber as shown by the arrows, finally escaping by an end flue, 17. The combustion chambers may be filled with chequer brickwork, which acts as a heat accumulator.

H. G. C.

262. Coke Ovens. E. HUREZ, FRANCE (Brit. Pat. No. 123099, February 6th, 1919, No. 2974. Convention date, January 20th, 1918. Addition to 107178. Not yet accepted. Abridged as open to inspection under Sec. 91 of the Act).—A coke oven of the type described in the parent specification is modified so that it can be

heated by crude gas direct from the ovens, by the oven gas after the removal of by-products, or by a poor gas, such as blast-furnace or producer gas. When working with crude gas, dampers *B* in passages connecting the ovens, *G*, with the heating-flues, *D*, are opened, and the damper *I* is closed. Air is supplied either through plugs inserted in place of the stoppers, *R*, or through the chamber, *V*, and channels, *Z*, and the products pass down through the

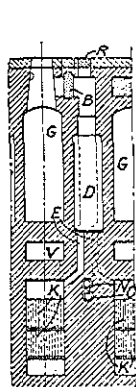


FIG. 125.

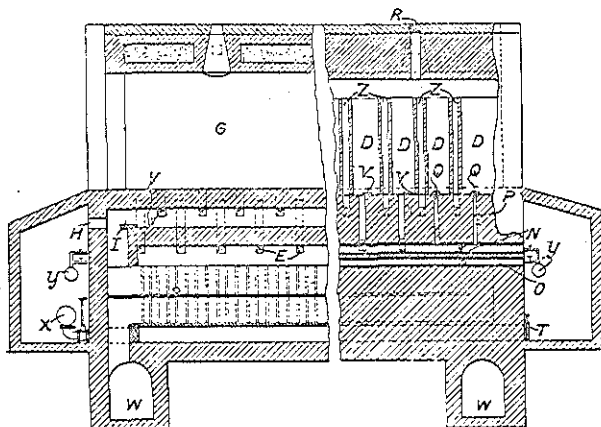


FIG. 126

heating flues, *D*, passages, *E*, and the vertical channels of the recuperator, *K*, to the chimney flues, *W*. In the second method of operation, washed oven gas from the mains "*y*" is supplied to two superposed flues, *N*, *O*, and passes thence through passages, *P*, to burner nozzles, *Q*, at the base of the flues, *D*. Air enters at the damper, *T*, passes through the vertical channels of the recuperator, and enters the flues, *D*, through the passages, *E*. The products of combustion pass downwards through the flues, 2, to the chamber, *V*, and pass thence along the horizontal passages of the recuperator to the chimney flue, *W*. The third method of working, the poor gas from a main, *X*, is supplied to alternate recuperators, and enters the heating-flues through the corresponding passages, *E*, of which there are two for each heating flue. The air is supplied as in the second method through the remaining recuperators and the corresponding passages, *E*, in connection with which damper blocks, *v*, are provided. The form of recuperator block used is shown in Fig. 127.

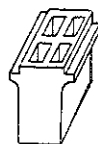


FIG. 127.

H. G. C.

263. Heat Regulator for Ovens and Kilns. A. TILSTONE and T. TILSTONE (Brit. Pat. No. 125486. March 14th, 1918, No. 4493).—A heat regulator for ovens and kilns for firing pottery and the like consists of a detachable "grid" or perforated block

or set of blocks which are fitted to the outlet and other flues of the kiln, etc., to check the flow of gases. Fig. 128 shows such a perforated block. It may be mounted in a metal ring, *c*, and may be raised about a pivot, *d*, by a cord, *f*. Two or more such blocks may be fitted one above another, so that by rotating the upper block the ring of apertures, *b*, may be partly closed.

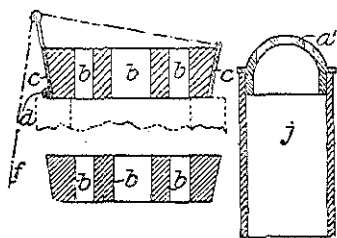


FIG. 128.

FIG. 129.

Fig. 129 shows a modification, particularly for an enamel kiln, consisting of a hollow, perforated dome, *a'*, fitted upon a tube, *j*, which is fitted into the flue in the upper part of a kiln. The block shown in Fig. 128 is adapted to the inlets and outlets of an up-draught oven and to the outlet of a down-draught oven. The devices may also be used for ventilating the heating and cooling chambers of tunnel ovens and other heating apparatus.

H. G. C.

264. Indicator for Furnaces. G. ALLIATA, SWITZERLAND (Brit. Pat. No. 115423, April 11th, 1918, No. 6175. Convention date, May 3rd, 1917. Not yet accepted. Abridged as open to inspection under Sec. 91 of the Act).—An indicating device for use in connection with furnaces comprises a pointer or pointers controlled by pressure differences between, or the pressures in, two chambers, through which flow gaseous fluids used in combustion, for example, primary and secondary air or gas and air. Variations in combustion are indicated by deflection of the pointers, and by suitably adjusting the supply valves of the two fluids normal conditions can be re-established. In one form of apparatus, shown diagrammatically in Fig. 130, the primary air for the combustion of coke

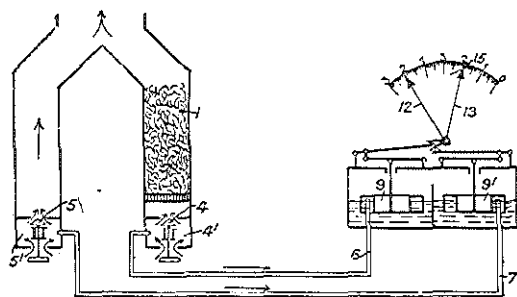


FIG. 130.

in a furnace, 1, is supplied under control of a valve, 4, through a chamber, 4', while secondary air is supplied through a similar chamber, 5', under control of a valve, 5. From the chambers, 4', 5', pipes, 6, 7, lead to bell floats, 9, 9', which operate, through suitable levers, pointers, 12, 13, moving over scales, 15. The apparatus is so adjusted that, when combustion conditions are normal, the pointers will stand at the same gradua-

tion on the two scales. When variations occur, for example, owing to clinkering of the grate, the pointers will be deflected in opposite directions, and the valves, 4, 5, can then be operated until the pointers indicate that balanced conditions are re-established. In a modification, the two pointers are connected by a rod pivoted about a knife-edge, and in a further modification, the two bell floats are controlled by the pressure-differences between two points in the supply conduits. The bell floats may be replaced by a diaphragm operating a single needle.

H. G. C.

265. Reversing Valves for Regenerative Furnaces. H. N.

DAVIS and W. R. TWIGG (Brit. Pat. No. 122674,

December 28th, 1917, No. 19190).

—The gas and air reversing valves are simultaneously operated by rigid connections. As shown in Fig. 131, which is a plan view, the air valve, 3, and the gas valves, 13, 14, are arranged with their axes vertical in the same vertical plane, and their actuating levers are connected together by a common actuating rod, 20. A similar arrangement is described in which the valves have their

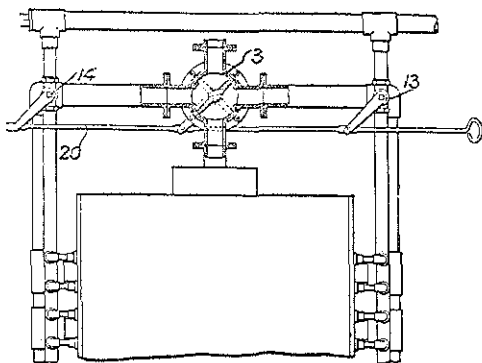


FIG. 131.

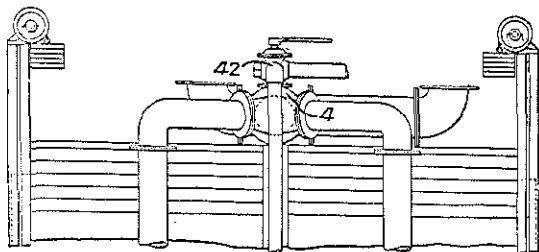


FIG. 132.

axes horizontal. Fig. 132 shows in elevation an arrangement in which the gas valve, 42, and the air valve, 4, are co-axially arranged with a common spindle. Three such sets of valves may be connected together by chain gearing so as to be operated simultaneously. Valves arranged at the rear of the furnace may be operated by a spindle extending to the front, and weights may be fitted to retain the valves in their operative positions. Valves for admitting compressed air to the burners may be arranged to be operated by the same means as the reversing valves.

H. G. C.

VIII.—Chemical Analysis.

266. The Gravimetric Determination of Calcium and Separation of Calcium from Magnesium. L. W. WINKLER (*Zeitsch. angew. Chem.*, 1918, 31, 187, 203, 214).—An examination was made of the method of estimating calcium as oxalate or carbonate. The following conclusions were drawn:—Calcium, as oxalate, was best precipitated by addition of ammonium oxalate to a boiling solution containing acetic acid and excess of ammonium chloride. The oxalate was filtered off after standing twenty-four hours, washed, dried at 100°, and weighed as such rather than as oxide after ignition. This reduced the liability to error when sulphate was present, since the oxalate and sulphate of calcium have about the same molecular weight. High results were obtained when sodium salts were present. Potassium salts and chromates did not affect the determination. Calcium was most successfully precipitated as carbonate in the absence of ammonium salts and also of chromates.

The separation of calcium from magnesium was made by precipitation of calcium as oxalate as indicated above and the subsequent precipitation and weighing of magnesium as ammonium magnesium phosphate.

F. W. H.

267. The Alkalimetric Determination of Small Amounts of Magnesium. P. L. HIBBARD (*J. Ind. Eng. Chem.*, 1919, 11, 753).—This method, with various modifications, is based on Bruckmüller's estimation of magnesium by titration of ammonium magnesium phosphate. The author found that with his modifications the method was convenient and exact for the determination of quantities of between 5 mg. and 0.1 mg. The principal changes introduced were: (1) Use of the Gooch crucible for filtration, whereby it is possible to wash the precipitate in the most efficient manner with the least quantity of solution. (2) Use of neutralised alcohol, followed by water solution of ammonium magnesium phosphate for washing. (3) Use of methyl-red instead of methyl-orange as indicator.

The method is alkalimetric, depending for success on obtaining the magnesium in a definite compound, ammonium magnesium phosphate, the alkalinity of which may be accurately determined by means of standard acid. The solution must be free from other bases precipitable by the phosphate ion in alkaline solution. It was convenient, in most cases, to use the solution from which the calcium had been separated as oxalate. The volume should be small. For amounts less than 1 mg., 5 c.c.; 1 to 3 mg., 10 c.c.; in excess of 5 mg., 20 c.c. Other soluble salts increased the solubility of the precipitate, and hence should be absent. Ammonium salts should be removed by evaporation and ignition, or by evaporation with nitric and hydrochloric acids. The quantity of

ammonium salts formed in making the separation of calcium as oxalate ordinarily did not interfere with precipitation of the phosphate.

The author gave two methods of precipitation, one in the cold and Schmitz's method for hot precipitation if the solution contains much ammonium salts which are not convenient to remove. (a) *Cold precipitation*. The solution should contain one-tenth to two-tenths of 1 per cent. ammonium chloride and enough free ammonia to give a distinct odour. One c.c. of a $1\frac{1}{2}$ per cent. solution of ammonium sodium hydrogen phosphate is added for each 1 mg. of magnesium present, and the mixture shaken well. After ten minutes, one-third of the volume of strong ammonia is added and allowed to stand for at least two hours. (b) *Hot precipitation*. The solution is acidified slightly with hydrochloric acid, heated to boiling, the necessary amount of ammonium sodium hydrogen phosphate added, then one-third of the volume of strong ammonia, and allowed to stand for two hours or more.

A Gooch crucible with a moderate thickness of paper pulp is used, and the precipitate filtered with moderate suction, washed two or three times with 95 per cent. neutral alcohol, and then four times with 5 c.c. portions of a saturated aqueous solution of ammonium magnesium phosphate. The paper pulp with the precipitate is returned to the flask with water and titrated.

For the titration a few drops of 1 per cent. alcoholic solution of methyl-red as indicator are added, then acid until there is about 5 c.c. in excess. After complete solution of the precipitate, the acid is titrated back with alkali of the same strength.

One c.c. of $N/50$ -acid $\equiv 0.24$ mg. magnesium. When more than 2 mg. of magnesium were present, the colour change was not sharp.

C. M. M.

268. The Gravimetric Determination of Arsenic Acid.

L. W. WINKLER (*Zeitsch. angew. Chem.*, 1919, 32, 122).—The arsenic acid was reduced by means of potassium thiocyanate in the presence of hydrochloric acid. To a quantity of the solution of arsenic acid containing about 0.01 to 0.15 gram of As_2O_5 was added 10 c.c. of hydrochloric acid and 5 c.c. of 20 per cent. solution of potassium thiocyanate. Sulphuretted hydrogen was then passed into the solution for about one hour and the latter allowed to stand. After about eighteen hours the precipitate, consisting of a mixture of arsenic sulphide and sulphur, was filtered off, washed, dried at 100° , and weighed. The arsenic sulphide might then be dissolved in ammonia, oxidised with hydrogen peroxide, precipitated as ammonium magnesium arsenate, and weighed as such, or, after ignition, as magnesium pyro-arsenate.

F. W. H.

269. The Gravimetric Determination of Phosphoric Acid.

L. W. WINKLER (*Zeitsch. angew. Chem.*, 1919, 32, 99).—To 100 c.c. of the phosphate solution, containing about 0.1 gram of P_2O_5 , were added 2.5 grams of ammonium chloride. The solution was then

boiled and 10 c.c. of 10 per cent. ammonia solution added. For precipitation of the phosphoric acid 0.5 c.c. of a solution was added containing 10 grams of magnesium sulphate and 5 grams of ammonium chloride to 100 c.c. of water. The mixture, while still hot, was stirred until the precipitate became crystalline, and then a further 9.5 c.c. of the magnesium sulphate solution were added slowly. When quite cold, the precipitate was filtered off, washed with 1 per cent. ammonia solution, dried, and then weighed as ammonium magnesium phosphate or ignited and weighed as magnesium pyrophosphate.

When the phosphoric acid was previously precipitated as ammonium phosphomolybdate the final figures were found to be slightly high to the extent of about 0.3 milligram on amounts from 0.05 gram to 0.25 gram. Sodium and potassium chlorides did not affect the results when the precipitate was weighed as ammonium magnesium phosphate, but potassium chloride caused high results when the precipitate was weighed as magnesium pyrophosphate.

F. W. H.

270. A Convenient Method of Analysis of Fluorspar and of Basic Slags containing Fluorine. G. R. DOYLE (*Chem. News*, 1919, 118, 304).—The finely ground sample was extracted by repeated evaporations with glacial acetic acid, and the excess acid finally expelled by heating in a steam oven. The heated material was then dissolved out in water, boiled, and filtered. The residue contained all the lime existing as calcium fluoride, all iron and alumina, and the greater part of the silica. The filtrate contained soluble lime and silica, manganese, magnesia, and lead. The silica in the residue was determined by using hydrofluoric acid, and the remainder was converted to sulphates by treatment with sulphuric acid, ignited, and weighed. The iron and alumina were determined, deducted from the weight of the sulphates, and the remaining calcium sulphate calculated to calcium fluoride.

The filtrate was evaporated to dryness with 5 c.c. of hydrochloric acid and a few drops of nitric acid, baked, and taken up in 5 c.c. of hydrochloric acid, diluted, and filtered. The silica so obtained was determined and added to the amount from the residue. Manganese was precipitated by bromine and ammonia, estimated as usual, and calculated as MnO. Lime was precipitated as oxalate, ignited to oxide, and weighed. Magnesia was estimated as pyrophosphate.

F. W. H.

271. The Estimation of Zinc and Calcium in the Presence of Lead. E. NYMAN (*Chem. News*, 1919, 119, 75).—Ammonia was added to an acid solution containing the zinc, calcium, and lead until the solution was strongly alkaline. The solution was then acidified with acetic acid. Any precipitate formed at this stage was dissolved by addition of ammonium acetate. The solution was then rendered slightly alkaline with ammonia and titrated, at a temperature from 70° to 80°, with potassium ferro-

cyanide solution, an acid solution of uranium acetate being used as external indicator.

For the estimation of calcium, the solution was prepared in the same way as for zinc up to the slightly alkaline stage. The calcium was then precipitated as oxalate by addition of excess of ammonium oxalate.

F. W. H.

272. The Estimation of Zirconium. P. NICOLARDOT and A. REGLADE (*Compt. rend.*, 1919, **168**, 348).—The solution of zirconium was rendered either neutral or acid with sulphuric acid. The zirconium was precipitated by the addition of ammonium phosphate, filtered, washed, ignited, and weighed as pyrophosphate. This method gave complete separation of zirconium from aluminium provided that the acidity was equivalent to 10 per cent. sulphuric acid, and from iron and chromium if 20 per cent. of acid were present. The authors used the factor 0.487 for the conversion of the weight of pyrophosphate to oxide of zirconium.

F. W. H.

273. The Solubility of Aluminium Hydroxide. E. H. ARCHIBALD and Y. HABASIAN (*Trans. Roy. Soc. Canada*, 1917–1918, **iii**, 11, 1).—The authors determined the solubility of aluminium hydroxide in solutions of ammonia of different strengths and in ammoniacal solutions of ammonium nitrate or potassium nitrate. Freshly precipitated aluminium hydroxide was shaken with the particular solvent in sealed tubes for twelve hours in a thermostat at 20°, and also at 30°. The contents of the tubes were filtered and certain weights of the filtrates evaporated to dryness in platinum crucibles and the residues ignited and weighed. It was found that the solubility of aluminium hydroxide increased with the concentration of ammonia until a solution of semi-normal strength was reached; the solubility then decreased as the ammonia concentration increased. The presence of ammonium nitrate decreased the solubility of aluminium hydroxide in ammonia, whilst presence of potassium nitrate considerably increased the solubility.

It was recommended that aluminium hydrate should be precipitated in a solution containing a very slight excess of ammonia and should be washed with a 10 per cent. solution of ammonium nitrate.

F. W. H.

274. The Technical Analysis of Auckland Clays. A. B. JAMESON (*N.Z. J. Sci. and Tech.*, 1919, **2**, 209).—The author adapted the method of analysis used by Zschokke, a method which combined certain details of the elutriation process of separation, or "mechanical analysis," and Seger's "rational analysis." Elutriation alone could not separate colloidal clay matter completely, and failed entirely with certain calcareous clays. Seger's method alone was unsatisfactory, since sulphuric acid decomposed, not only the actual clay, but also many minerals frequently associated with a plastic clay.

The "combined method" used consisted, first, in the elutriation

of the clay into a clay fraction, *A*, and a sand fraction, *B*, these two portions then being separately extracted with 10 per cent. hydrochloric acid. The material after elutriation was dried, and a known weight rubbed gently with a pestle in a porcelain dish containing about 100 c.c. of the 10 per cent. hydrochloric acid until disintegrated. After digesting for thirty minutes on a steam-bath, the contents of the dish were filtered, and the residue washed, dried, and weighed. A known weight (about 3 grams) of the residue was then taken to the fuming stage with 10 c.c. of 50 per cent. sulphuric acid. After cooling and diluting with water, the residue was filtered off, washed, dried, and weighed. The results were indicated thus:—

$A. \begin{cases} (a) \text{ Insol. in HCl, treated with H}_2\text{SO}_4. \\ (b) \text{ Soluble in HCl.} \end{cases}$	$\begin{cases} (c) \text{ Insoluble in H}_2\text{SO}_4: \text{ Quartz, felspar, mica, etc., determined by microscopic investigation.} \\ (d) \text{ Soluble in H}_2\text{SO}_4: \text{ Clay, reckoned by difference.} \\ \text{Estimated by difference: CaCO}_3, \text{ CaSO}_4, \text{ MgCO}_3, \text{ MgSO}_4, \text{ and FeO, determined by microscopic investigation.} \end{cases}$
$B. \begin{cases} (e) \text{ Insoluble in HCl.} \\ (f) \text{ Soluble in HCl.} \end{cases}$	$\begin{cases} \text{Coarser grains of (c).} \\ \text{Estimated by difference, coarser grains of (b)} \end{cases}$

Thus fraction *A*, the "clay fraction," gave actual clay, fine sand, etc., and fine carbonate, etc., whilst *B*, the "sand fraction," gave coarse sand, etc., and coarse carbonates, etc. The results obtained for any particular clay therefore indicated the means of modifying composition where necessary.

The results of analyses of various Auckland clays were given. The shrinkage of moulded samples on drying and firing was also determined. The clays were separated by elutriation into two fractions, the "clay fraction" and the "sand fraction," and then new samples were made by mixing together various proportions of the two fractions. The new products were then fired, and contractions and porosities were determined. An attempt was made to show how the firing properties of the clays could be interpreted from the analytical data.

F. W. H.

275. Precautions Necessary in Grinding Samples of Coke for Analysis. A. E. FINDLEY (*J. Soc. Chem. Ind.*, 1919, 38, 93r).—Experiments were undertaken in order to investigate the widely different results obtained in the determination of ash in coke. All samples ground in an iron mill were magnetic, but one sample of coke was itself magnetic, probably owing to reduction of the pyrites in the coal during coking. Samples of coal yielding different types of ash were ground in agate or glass mortars and coked in platinum or silica crucibles. The samples of coke obtained were then ground in agate, iron, or glass mortars, and the ash determined. Coke samples ground in either agate or iron mortars were magnetic if obtained from coal rich in iron. The difference between determinations of ash in coke ground in agate and iron

mortars was roughly 0.2 per cent. The results justified the conclusions that no very appreciable error in the determination of ash was caused by grinding coarsely-powdered coke to a fine powder in an iron mortar, and that contamination must have occurred during the conversion of small pieces to a coarse powder.

Further experiments on a very hard type of coke confirmed the above conclusions. A large piece of this coke was broken into four approximately equal pieces, and after treatment gave the following results:—

No.	Coarsely powdered.	Finely powdered.	Ash, per cent.	Iron as Fe_2O_3 , per cent.
1	In cloth, by hammering.	In agate mortar.	7.0	1.875
2	In iron mill.	In iron mortar.	8.2; 8.4	2.915; 3.125
3	In hardware mortar.	In hardware mortar.	8.5	1.885
4	In agate mortar.	In agate mortar.	7.15	1.885

All portions were magnetic.

The high ash in portion (2) was evidently due to iron, whilst that in portion (3) was due to extraneous matter derived from the hardware mortar. The final conclusions were:—

(1) The largest amount of abrasion occurred during the breaking down of small pieces to coarse powder.

(2) The grinding of coarse powder to fine powder did not appreciably increase the percentage of ash.

(3) The use of a linen bag for breaking down offered a satisfactory solution of the difficulty, since the effect of abrasion of the linen on the percentage of ash was negligible.

F. W. H.

276. Comparative Tests of Palan and Rhotanium Ware as Substitutes for Platinum Laboratory Utensils. L. J. GUREVICH and E. WICHES (J. Ind. Eng. Chem., 1919, 11, 570).—The authors dealt with a series of tests carried out to determine the suitability of the alloys of gold and palladium, known as "rhotanium" and "palan," as substitutes for platinum in laboratory ware. The tests were of two types, the aim being to determine the resistance of the materials to chemical reagents and their behaviour upon heating. Tables were given of the observed changes in weight of the crucibles tested when treated with various reagents, namely, boiling hydrochloric, nitric, and hydrofluoric acids, cold sulphuric acid, boiling solutions of ferric chloride and of 20 per cent. sodium hydroxide, and fused sodium hydroxide, sodium carbonate, and potassium pyrosulphate.

The tests showed that rhotanium-4 ware was superior to platinum both of high (2.4 per cent.) and low (0.6 per cent.) iridium content in respect to its resistance to loss on heating. The losses on treatment with acid, after heating, were about equal. In most tests it appeared to be superior to platinum, except when treated with nitric acid, boiling 10 per cent. ferric chloride solution, and for fusions with sodium hydroxide. The only objection

raised to its use was the rather low melting point of the alloy, making it impossible to blast or heat strongly without melting it. Palan and rhotanium-*C* behaved towards reagents in much the same way as rhotanium-*A*, except that they were not suitable for potassium pyrosulphate fusions and were inferior to grade *A* for sodium hydroxide fusions. The only striking distinction between rhotanium-*C* and palan was the latter's slight superiority in the case of potassium pyrosulphate fusions.

Palan and both grades of rhotanium* could all be used to advantage in the electrolysis of chemical solutions, but only as cathodes. As anodes, the alloys are worthless.

The solubility of platinum is recognised and allowed for in exact methods of analysis. With palan and rhotanium, both gold and palladium may pass into solution, requiring somewhat different treatment for their elimination.

C. M. M.

277. Sodium Pyrogallate Solution as an Absorbent for Oxygen. G. W. JONES and M. H. MEIGHAN (*J. Ind. Eng. Chem.*, 1919, 11, 311).—Experiments were made by the authors for the purpose of determining the feasibility of using sodium hydroxide to replace the more expensive potassium hydroxide in pyrogallate solutions for the absorption of oxygen.

Tests made over a wide range of concentrations of the various reagents showed that the rate of oxygen absorption in sodium pyrogallate solutions increased with the dilution of the sodium hydroxide, and for any given concentration the rate of absorption was proportional to the concentration of the pyrogallic acid.

It was found that sodium pyrogallate solutions made by using sodium hydroxide solutions of less than 1.30 specific gravity gave off carbon monoxide, which increased with the dilution; also all sodium pyrogallate solutions gave off carbon monoxide when analysing oxygen samples containing more than 95 per cent. of oxygen.

The following sodium pyrogallate solution was recommended by the authors. Stick sodium hydroxide is dissolved in an equal weight of water, and constitutes the stock sodium hydroxide solution. Stock pyrogallate solution is made up in the proportion of 1 gram of pyrogallic acid to 3 c.c. of water. When ready for use, 5 parts of the sodium hydroxide solution are mixed with 2 parts of pyro.

The authors devised a new apparatus for testing the relative absorption with different solutions, an illustration and description being included in the paper.

C. M. M.

278. The Analysis of Natural Gas and the Calculation and Application of Results. R. P. ANDERSON (*J. Ind. Eng. Chem.*, 1919, 11, 299).—In brief, the method of analysis of natural gas by the combustion method consisted in passing a sample of natural gas slowly into oxygen in which an electrically heated platinum spiral was flowing, the calculations being made from an

observation of the contraction in volume resulting from the combustion and of the volume of carbon dioxide formed.

The author described two modifications of the apparatus generally used for the analysis of natural gas. One is a simple device which indicates when no further contraction takes place, that is, when combustion is complete, and the other is the substitution of Pyrex glass for the glass ordinarily employed in the combustion pipette. The necessity for accuracy in the measurement of gas volumes was emphasised.

The calculation of results of natural gas combustions according to the theoretical equations was discussed. A statement of the average number of carbon atoms per molecule of paraffin hydrocarbon in the natural gas was recommended as being more logical than a statement of the percentages of two hydrocarbons forming a mixture equivalent, as regards combustion data, to the one actually burned.

The paper included tables of correction and a description of methods for computing the specific gravity and calorific power of the gas.

C. M. M.

IX.—Machinery for the Working of Glass.

279. Bottle-stoppers. BEATSON, CLARK & Co., and F. TWEEDDALE (Brit. Pat. No. 117403, January 11th, 1918, No. 701).—The head, *A*, of a ground-glass bottle-stopper, *D*, is formed so as to extend beyond the bottle rim, *B*, and is provided with a downwardly-directed annular flange, *C*, adapted to overlap the rim, *B*, when the stopper is inserted in the neck, *E*, of the bottle, so as to exclude dust, etc., from the mouth, rim, and lip of the bottle. A ring of cork, rubber, or other padding may be placed within the flange, *C*, or around the rim, *B*. The flange may be arranged to fit the rim, *B*, accurately, and the engaging surfaces may be ground together. The operations of grinding the plug to fit into the neck, *E*, and grinding the flange, *C*, to fit the rim, *B*, may be performed simultaneously.

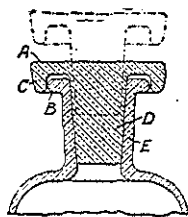


FIG. 133.

H. G. C.

280. Bottle-making Machines. H. WADE (Z. V. LOCKWOOD, U.S.A.) (Brit. Pat. No. 123236, April 26th, 1918, No. 7091).—Consists

of mechanism for forming a bottle-neck with an internal groove of the form described in Specification 25440/11. The invention is described as applied to a rotary machine in which a series of five parison moulds are mounted on a table which receives an intermittent movement. Fig. 134 shows in part one of the moulds, *C*, with the groove-forming mechanism in its operative position. The groove

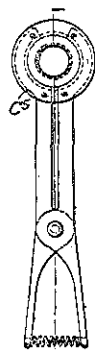


FIG. 135.

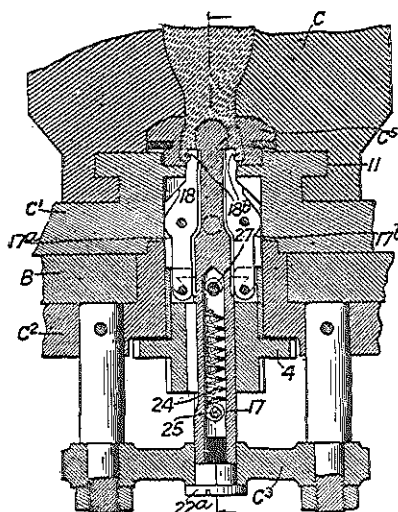


FIG. 134.

is formed by the rotation of bits, 18^b , formed on the upper part of pivoted levers, 18, carried by a block, 17^a , adapted to slide in an opening formed in the adjacent parts of the table, *B*, the fixed mould base-plate, C^1 , and an under plate, C^2 . The block, 17^a , is mounted on a spindle, 17, sliding in a cross-piece, C^3 , and provided with a head, 22^a , to limit its movement. A pinion, 4, is splined to the spindle, 17, but is free to slide thereon. The boss of the pinion carries a cross-pin, 27, passing through a slot in the spindle and connected by a spring, 24, to a pin, 25, fixed to the spindle. The mould, *C*, is shaped to engage the flanged upper part, 11, of the base-plate, C^1 , and is adapted to receive the head, C^5 , of tongs, shown in Fig. 135, which form the outer part of the neck and serve for the removal of the bottle. The operation of the machine is as follows. Molten metal having been placed in the closed mould, the table is moved forward, and at the next stage a cap is brought down on the mould and compressed air is admitted to force the glass into the neck-forming parts, which are in the position shown in Fig. 134. The mould is held close by a forked piece actuated by a piston and engaging lugs on the mould halves and the gear, 4, which has been raised by a stationary cam, engages a supporting lever, and also gears with a pinion actuated by an electric motor. The levers, 18, are thus revolved, and the groove is formed by the bits, 18^b , which have been moved outwards by the raising of the gear, 4. During the next movement of the table, the bits, 18^b , are moved inwards and the block, 17^b , is lowered. The descent of the block opens communication with a conduit, through which compressed air is admitted to blow the parison. The blowing is effected while the table is at rest, and the mould is locked by a

device similar to that used at the neck-forming stage. Further movement of the table causes the mould to be opened and allows the parison to be removed in the tongs. The moulds are opened and closed by sliding blocks actuated by a central stationary cam and connected by links to the pivoted mould sections. The table is actuated by a reciprocating piston, and is fitted with locking mechanism as usual.

H. G. C.

281. Making Glass Bottles, etc. SYKES & SUGDEN and T. JACKSON (Brit. Pat. No. 124118, June 8th, 1918, No. 9462).—Relates to the type of turnover machines in which both parison

and finishing moulds rotate about a central column, and consists of means for controlling the valves through which suction acts to draw the glass into the neck ring. In the arrangement shown, three turnover heads and three corresponding finishing moulds are employed. The column, 1 (Fig. 136), has a chamber, 8, connected by a pipe, 9, to a pump or other suction apparatus. The chamber, 8, communicates through three sets of pipes, 10, 16 (one only being shown), with the parison moulds, 5, the pipes being fitted with joints, 14, 15, to allow the turnover action. The turnover axis is provided with a valve, which is only open when the parison is upright, and each pipe, 10, is fitted with a valve, 11, the arm, 20, of which is connected by a link, 21, and post, 22, to a slide, 6, carrying the opposite finishing mould. When the parison is being charged, the valve, 11, is open, but it is closed when the slide is pushed inwards at the next station to bring the finishing mould under the turnover head. At the third station, the slide is drawn out to allow removal of the bottle, etc., and thus reopens the valve, 11. Fig. 137 shows the nozzle connected with the parison mould. The air is drawn through recesses, 23, in a liner, 24, fitting in the nozzle, 19, and surrounding the punch, 25.

FIG. 137.

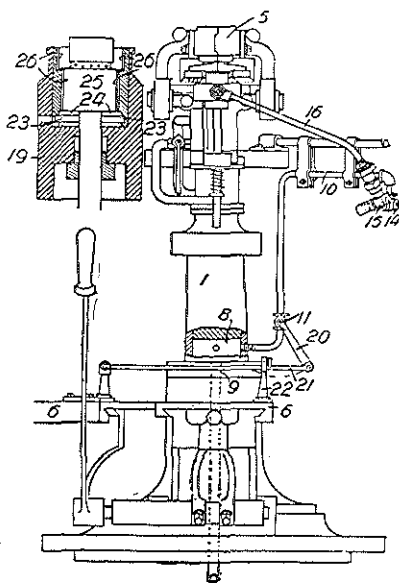


FIG. 136.

H. G. C.

282. Glass-making Machinery. A. E. CLEGG (Brit. Pat. No. 124356, July 12th, 1918, No. 11420).—In a machine for

pressing jam-jar blanks intended to be blown subsequently in another mould, the usual spring cover-plate, 9 (Fig. 138), through which the plunger, 1, works, is operated by a cam, 11, by means of levers, 5, the ends of which press upon sliding rods, 7. The hand-lever, 13, is mounted on the same shaft, 12, as the cam, 11,

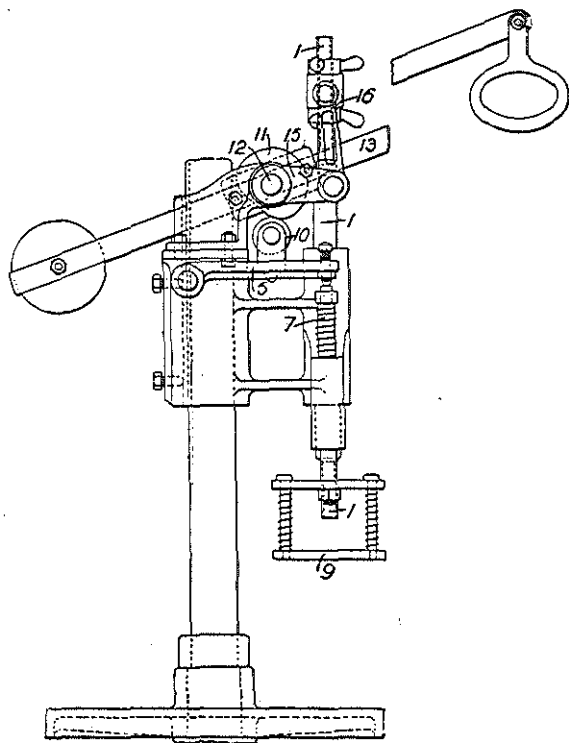


FIG. 138.

and operates the plunger, 1, through arms, 15, and links, 16. By this arrangement, the springs no longer oppose the motion of the plunger when once the roller, 10, rides on the concentric part of the cam, 11, and, in consequence, this motion is easier and more sensitive.

H. G. C.

283. Washing and Stoppering Bottles. H. TOMSON and J. CLAYTON (Brit. Pat. No. 117208, November 22nd, 1917, No. 17205).—Relates to apparatus for externally rinsing screw-stoppered bottles after they have been filled, and also to a device

for screwing the stoppers tight. The filled bottles, with the stoppers lightly screwed therein, are placed on a rotary table, *e*, arranged in a tank, *d* (Fig. 139). The table is divided into four sections, and is rotated by a crown wheel, *n*, and worm, *m*, from a pulley, *g*¹, driven from a shaft, *h*. On the underside of the table are four cams, *s*, which, by means of a roller, *t*, on the lever, *t*¹, actuate a spring valve, *t*², in a pipe, *t*³, leading to a sprayer above the bottles. The table is mounted on its shaft, *o*, Fig. 140,

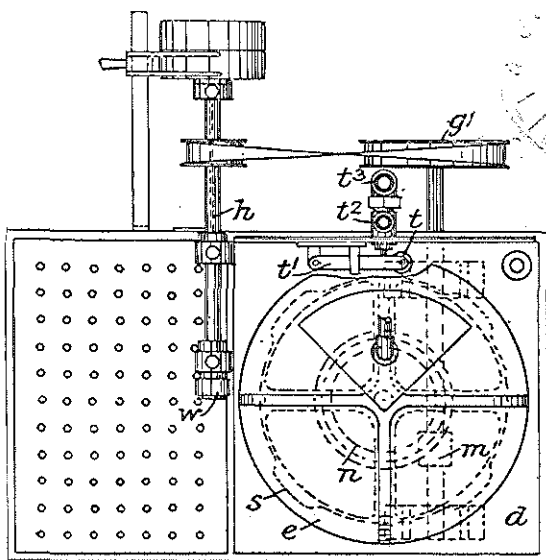


FIG. 139.

by a recess engaging a cross-pin, *g*, in the shaft, so as to be easily removable. The bottles, after being rinsed, are removed to a draining tray, *f*, where the stoppers are screwed up tight by being pressed

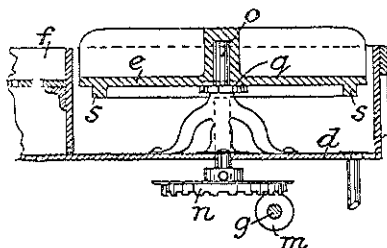


FIG. 140.

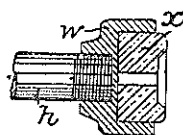


FIG. 141.

against a socket, *w*, on the end of the shaft, *h*. This socket carries a recessed rubber block, *x* (Fig. 141), the friction of which against the head of the stopper is sufficient to screw the stopper home, whereupon it slips on the stopper without damaging it.

H. G. C.

284. Sheet Glass. T. J. McCox, U.S.A. (Brit. Pat. No. 117194, October 29th, 1917, No. 15735).—Relates to apparatus

for forming sheet glass in which the metal is delivered from the furnace in the form of a sheet which, whilst still plastic, is received by a conveyer, which carries it away. The glass from

FIG. 142.

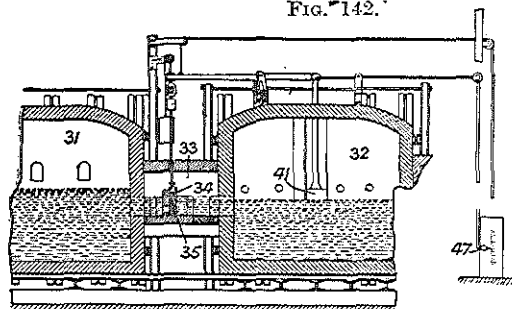
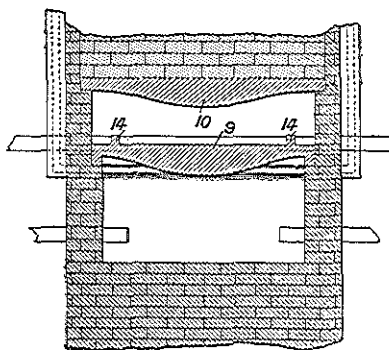
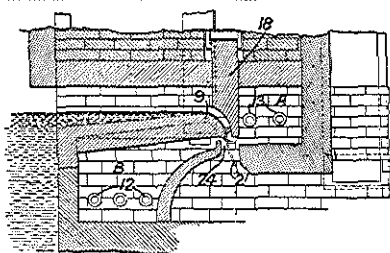
FIG.
143.

FIG. 144.

the chamber, 31 (Fig. 142), of the glass-melting tank passes through a channel, 33, fitted with a valve formed of refractory blocks, 34, 35, the movable block, 35, being connected to a float, 41, in the second compartment, 32, so as to keep the level of the glass constant. The valve can be operated by hand when required, and an indicator, 47, is provided to show the level of the glass in the tank. From the chamber, 32, the glass flows over an inclined refractory block, 9 (Fig. 143), in the form of a sheet, 21. The block, 9, forms the top of a chamber, B, heated by gas burners, 12, and having an opening, 24, in front. A second chamber, A, forms an extension of the glass tank, and is partly closed

by an adjustable refractory block, 18, which is brought into close proximity with the glass sheet. The chamber, A, is heated by gas burners, 13, and is provided with an opening close to the issuing glass. The block, 9, is reduced in thickness at the sides, as shown in Fig. 144, and is formed with upstanding sides, 14. The capstone, 10, of the tank above the block, 9, is formed of reduced thickness at the sides. Lateral air discharge flues are provided to the tank and extension to regulate the temperature,

and windows are fitted through which the outflow of the glass can be observed. The blocks, 34, 35, may slide in grooves in refractory blocks arranged at the sides of the channel, 33, and the blocks may be provided with additional grooves to receive a solid block for cutting off the glass when the sliding block requires repairing.

H. G. C.

285. Glass-bulb Cutting Machines. BRITISH THOMSON-HOUSTON CO. (GENERAL ELECTRIC CO., U.S.A.) (Brit. Pat. No. 125278, June 15th, 1918, No. 9887).—Consists of a

machine for cutting off the necks of miniature lamp-bulbs. The bulbs are delivered to the machine down a curved shoot, 29 (Fig. 145), provided with a longitudinal opening at the bottom, 30, through which the necks project. A disc, 20, is formed with a series of recesses, 21, to receive the bulbs, and is rotated by gearing so as to carry them past a carborundum wheel, 16, which forms a nick in the neck. A spring-arm, 23, normally holds the bulb in the recess, but is raised by cams, 25 and 26, at the receiving and delivering positions. A second spring-arm, 27, presses the neck of the bulb inwards during the cutting operation, so as to ensure fracture. The wheel, 16, is driven by an electric motor, 11, which also actuates the disc through gearing.

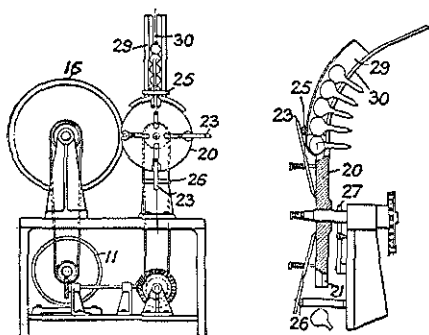


FIG. 145.

H. G. C.

286. Grinding and Polishing. F. COTTERELL, AUSTRALIA (Brit. Pat. No. 115661, May 4th, 1917, No. 6367).—In a glass-polishing machine, tables, 4, 5, are pivoted at adjacent edges so that they may be set horizontal, as shown in full lines, for polishing flat surfaces, or inclined in opposite directions, as shown in dotted lines, for simultaneously polishing the bevelled edges of two sheets. The brackets, 6, in which the tables are pivoted are mounted on a frame formed of a pair of bars, 11, which, by means of a hand-wheel, 21, pinions, and racks, are adjustable along rails, 17, supported on the side members, 2, of the main frame. Each rail is composed of two bars placed face to face and toothed on their lower edges to engage pinions operated by the hand-wheel, 38, whereby they may be moved longitudinally in opposite directions to extend the supporting surface for the bars, 11. The table, 5, is pivoted on an eccentric spindle which may be turned by a handle, 51, to adjust the position of the axis. The angular posi-

tion of the tables is adjusted by racks, 57, 59, engaged by pinions actuated, through worm gear, by hand-wheels, 72. The spindles, 91, of the polishing tools, 100, are carried by a transverse support, 73, which is moved to and fro in the direction of its length by

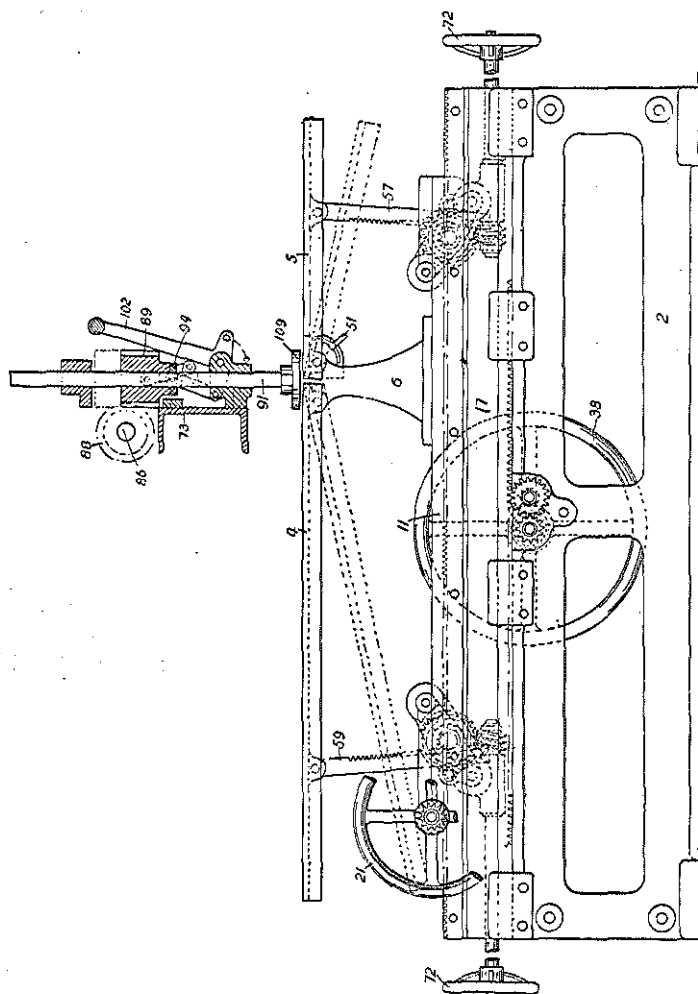


FIG. 146.

worm gear and crank and link. The spindles are driven by worm-wheels, 89, 88, from a shaft, 86, carried by the support, 73, and driven by belt; the tools may be lifted off the work by means of hand-levers, 102, and links coupled to cross-heads, 94, secured to

the spindles. The tools may be of disk or of hour-glass shape, and, for the supply of the abrading material, they may be formed with annular gutters communicating by passages with the working faces.

H. G. C.

287. Grinding and Polishing. C. ZEISS, GERMANY (Brit. Pat. No. 115632, April 25th, 1918, No. 6973. Convention date, May 5th, 1917. Not yet accepted. Abridged as open to inspection under Sec. 91 of the Act).—Disk and wheel apparatus; bevelling. The rims of spectacle glasses, particularly non-circular glasses, the opposite faces of which are dissimilar, are bevelled in the machine shown in plan in Fig. 147. The glass, l^2 , is mounted on the end of a spindle, l , which carries a former disk, l^3 , working against a stop-plate, m^1 , and runs in a bearing, i , movable in a segmental guideway on the slide, h . The spindle is driven by an electric motor, k , on the bearing, i , and the bearing may be swung round on the segmental guideway to bevel first one edge of the glass and then the other. The slide, h , is drawn towards the grinding wheel, g^4 , by weighted cords, n , and the line of its movement forms an angle differing from a right angle with the axis of the spindle. The stop-plate is set at an angle which is adjustable; it is movable along a guideway into the position shown in dotted lines for bevelling the second edge of the glass. By fixing the former disk, l^3 , to the bearing, i , the machine may be used for bevelling circular glasses.

H. G. C.

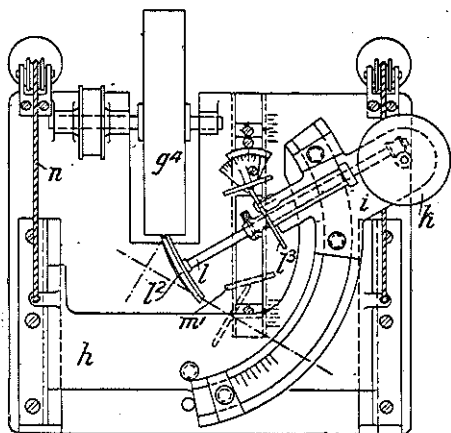


FIG. 147.

288. Grinding Lenses, etc. W. TAYLOR (Brit. Pat. No. 116397, July 21st, 1917, No. 10507).—Lenses which have been rough ground are smoothed by a lap shaped to fit the curve of the lenses, the lap and the lens-holder being mounted upon spindles arranged at an angle to one another. The lap is adapted to seat itself upon the lenses without constraint, except that due to the feeding force, which is in the direction of the axis of the lap. The detritus is washed away continuously by a supply of water, and the smoothing abrasive may be supplied in suspension in the water.

or may be fixed in the lap. The lap, *D*, is mounted upon a hollow spindle, *C*, mounted in fixed bearings, *C*₁, *C*₂, and rotated by the pulley, *C*⁴. The liquid, or liquid and abrasive, are supplied through the hollow spindle, and are led through grooves, *I*, in the lap surface, or through the spaces between a number of lenses, to all parts of the surface to wash away the detritus. The grooves in the face of the lap are arranged in such a manner that the liquid has to traverse substantially the whole of them before it escapes. The lens or lenses, *F*₄, *F*₅, are mounted on a holder, *F*₂, secured by a chuck, *F*₃, to a spindle, *F*, carried in a frame, *F*₁. The frame is secured to a bar, *F*₆, mounted to slide in the direction of the axis of the lap spindle, *C*, in bearings, *F*₇, *F*₈, and is counterweighted. The spindle, *F*, is driven by a belt, *G*, passing round guide-pulleys, *G*₁, *G*₂, on a fixed bracket, and a pulley,

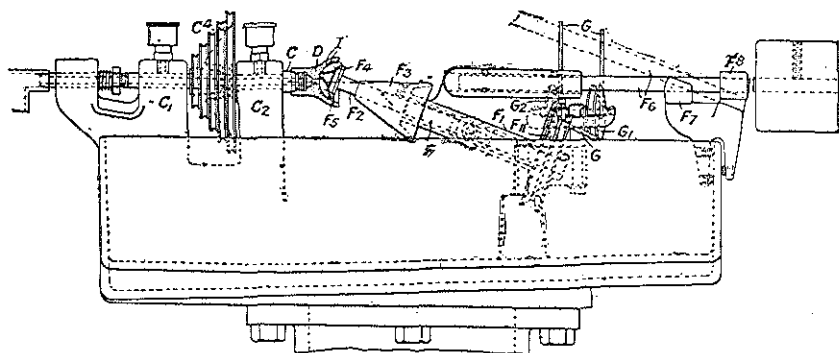


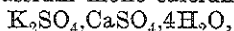
FIG. 148.

*F*₁₁, on the spindle. A strut is interposed between the frame, *F*₁, and the axle carrying the pulleys, *G*₁, *G*₂, to take any strain due to the tension in the driving belt and to prevent any constraint being put upon the frame. The spindles are set at an angle to one another—about 20 degrees if the surface to be smoothed is approximately hemispherical—and the feed is obtained by pushing the bar, *F*₆, through its bearings. The angle between the spindles may be adjusted by mounting the spindle, *F*, in a frame carried in circular slides on a part secured to the bar, *F*₆. The bearings, *F*₇, *F*₈, are open at the top and the bottom respectively to allow the bar, *F*₆, to be tilted to facilitate attachment or removal of the work.

H. G. C.

I.—Glass-making Materials.

289. Double Salts of Calcium and Potassium and their Occurrence in Leaching Cement Mill Flue Dust. E. ANDERSON (*J. Ind. Eng. Chem.*, 1919, 11, 327).—Owing to the recent development of the cement potash industry, attention had been directed to certain double salts of potassium and calcium. Of these, *syngenite*, or potassium mono-calcium sulphate,



was perhaps the most familiar, but potassium penta-calcium sulphate, $\text{K}_2\text{SO}_4 \cdot 5\text{CaSO}_4 \cdot \text{H}_2\text{O}$, was equally important. These salts occurred in natural potash deposits, and the fact that they could be easily made artificially indicated the possibility of the formation of such compounds in solution from potash-bearing flue dust, since calcium sulphate was often found in such dust.

The author gave a *résumé* of the data already available concerning these compounds, and discussed the possibility of their production by leaching cement mill flue dust. C. M. M.

290. Some Chemical Aspects of the Potash Industry in Great Britain. E. C. ROSSITER and C. S. DINGLEY (*J. Soc. Chem. Ind.*, 1919, 38, 3757).—An account was given of investigations regarding the possibility of potash production from blast furnaces. The sources considered were the raw materials used in the blast-furnace charge, the flue dust, and the blast-furnace products. Unless the addition of salt to the charge was made and efficient methods of cleaning the flue gases were used, it was improbable that potash recovery could be made profitable.

The limestones and cokes did not, as a rule, contain more than 0.1 per cent. of potash calculated as KCl, the chief source of potash being the iron ore. Of the ores examined, the following particulars were given:—

Ores.	Percentage content K ₂ O.
Ferro-manganese (7 samples)	0.526
Northamptonshire (37 samples)	0.420
Cleveland (13 samples)	0.366
North Lincolnshire (13 samples).....	0.358
Oxfordshire (4 samples)	0.303
Foreign (22 samples)	0.158
North-west coast (18 samples)	0.153

A clean ore contained less potash than an ore not clean; hæmatite iron ore contained less potash than inferior ore. Strata adjacent to certain ores often contained a higher percentage of potash than the ore itself. The sand next the ore at Scunthorpe, for example, contained potassium compounds amounting to 1.5 per

cent. calculated as KCl. The possible potash production per ton of pig iron from ores was given as follows:—

Ores.	Pounds KCl.
Ferro-manganese	37
Northamptonshire	38.5
Cleveland	46
North Lincolnshire	49
Foreign	10
North-west coast	10.5

The flue dust from blast furnaces could be used directly as a fertiliser. The heavy dust contained little potash, but the soluble potash content of dust from the stoves and boiler settings varied from 3 per cent. K_2SO_4 with 4 per cent. KCl to 30.5 per cent. K_2SO_4 , and the insoluble potash from 3.6 per cent. to 11.4 per cent. calculated as KCl. The amount of potash obtainable from the dust averaged about 2.5 lb. of KCl per ton of iron, or less than 10 per cent. of the potash contained in the furnace charge, and hence most of the dust could only be suitable for local use as a fertiliser.

The major portion of the potash in the charge came out either in the slag, probably combined as silicates, and in the exit gases, which might contain, after cooling, potassium as carbonate, bicarbonate, formate, cyanide, thiocyanate, sulphate, and chloride, with small quantities of bromides and iodides. Only the potash in the gases was available for the manufacture of potassium salts, and it was essential that as much potash as possible should be present in the gases and as little as possible in the slag. A highly basic charge treated in the furnace at high temperatures would suffer volatilisation of the whole of the potash. The addition of salt to the furnace charge was found to increase the volatilisation of the potash, and as much as 80 per cent. was recovered in certain cases. The authors estimated that potassium salts equivalent to 60,000 or even 80,000 tons of potassium chloride per annum were recoverable from the blast furnaces of England and Wales, an amount approximately double the pre-war consumption of this country.

Thirteen tables of detailed data relating to potash recovery from blast furnaces were also given.

F. W. H.

II.—Glass: Manufacture and Properties.

291. Yellow Glass Produced by Coal. L. SPRINGER (*Sprechsaal*, 1919, 52, 88).—The production of a yellow colour in glass by carbon is already well known, the use of coke, anthracite, graphite, and carbonaceous substances for the purpose being common. Antique glasses of a yellow or brown colour are

known in which heavy metals are absent, so that carbon must be the responsible colouring agent in some form, in conjunction with sulphate-containing impurities. Kunkel appeared to be the first to recognise that the direct addition of carbon to the glass batch produced a yellow glass. At first the view held was that the carbon itself produced the colour. Splitgerber, however, in 1839 recognised that glass coloured yellow by carbon also contained sulphur, and showed that with two carbon-containing batches, one with 1.75 per cent. of sodium sulphate and the other without any, only the former developed a yellow colour. Pelouze in 1865, who independently discovered the same fact, found also that other substances, such as sulphur, silicon, boron, and phosphorus, which had the power of reducing sulphates, gave rise to a yellow colour. Further, hydrogen at incipient red heat produced a similar colour with sulphate-containing glass, whilst selenium gave colours analogous to sulphur.

From these facts, the author stated, a general belief had arisen that carbon alone, without sulphur-containing materials, could not give rise to a yellow colour in glass, and in support of this view he quoted statements by Dralle, Schnurpfel, Hohlbaum, and Müller. The author shared this view until some experiments with graphite added to batch materials of high quality led him to doubt its validity. Hence a series of tests was undertaken with purified batch materials melted in small covered crucibles with the object of excluding possible sulphur dioxide arising from the coke-fired furnace employed. The following mixtures were tested:—

1. Sand 100, soda 30, potash 30, calcium carbonate 20, together with (a) 0.7 graphite in one test, and (b) 0.3 graphite in a second. With (a) the glass was a yellowish-brown; (b) bright yellow.

2. (a) as in 1 (a), but with 2.1 parts of powdered brown coal. Again a bright yellow colour was obtained.

(b) as in (1), but 60 soda instead of 30 soda and 30 potash, and 2.1 parts of powdered coke. The coke appeared to have sunk to the bottom, since the upper portion of the glass was almost colourless, but the lower was yellow.

(c) as in (1), but using 60 parts commercial soda containing approximately 6 per cent. of sodium sulphate. The glass was yellowish-brown in colour.

Five further series of experiments on very similar lines were carried out to test the effect of different forms of carbon, soot, and sugar-charcoal, of sulphate-free mixtures of soda and lime, of the addition of sulphate, and of the effect of using all potash instead of soda. The general conclusion was that carbon alone has the power of imparting a yellow colour, even in the absence of sulphur-containing substances, although the presence of the latter may emphasise the colour.

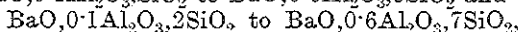
Samples of the glass coloured by carbon were treated by hydrofluoric acid, and a black deposit of insoluble carbon obtained. One

sample, for the preparation of which 2.67 per cent. of carbon had been used in the batch, contained approximately 1 per cent., the remainder having obviously been volatilised after oxidation. The author expressed the view that the yellow colour imparted by carbon is due to the presence of the latter in the colloidal condition.

W. E. S. T.

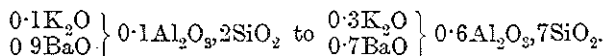
292. Experiments on Barium Glasses. H. FRITZ (*Sprechsaal*, 1918, 51, 51).—A series of tests carried out to determine the mixtures of baryta, silica, alumina, zinc oxide, and the alkalis with which ready melting could be accomplished at a temperature SK 4a—6a (1160—1200°) in small crucibles. The alumina was added as kaolin or, where practicable, as felspar.

No fusion was found possible with baryta and silica mixtures between BaO, SiO_2 and $\text{BaO}, 6\text{SiO}_2$. On the introduction of alumina, also, the following mixtures remained completely unmelted: $\text{BaO}, 0.1\text{Al}_2\text{O}_3, \text{SiO}_2$ to $\text{BaO}, 0.6\text{Al}_2\text{O}_3, 6\text{SiO}_2$ and



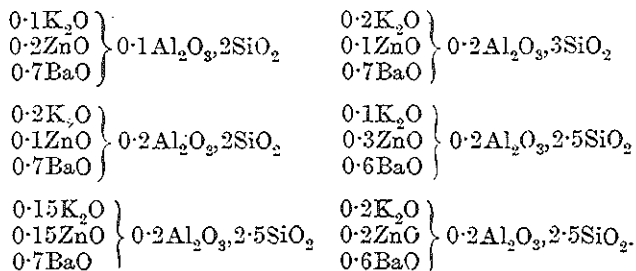
the alumina being increased in each case by 0.1 molecule at each stage and the silica by 1.0 molecule.

Potash was next added to the baryta, alumina, silica mixtures in such a manner as to replace the baryta in stages of 0.1 molecule K_2O for 0.1 BaO . The compositions ranged from

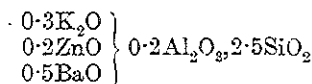


In all these cases sintering occurred, but not fusion.

On the addition of zinc oxide, replacing baryta to a certain degree, melting occurred in most cases with production of a clear glass. The mixtures which melted were:



A mixture containing



did not melt satisfactorily.

The author stated that the glasses produced had a bright blue colour.

W. E. S. T.

293. Behaviour of an Acid Glass in a Tank Furnace.

J. M. KNOTE (*Trans. Amer. Cer. Soc.*, 1912, **14**, 655).—The author described a case of devitrification of glass resulting in machine-made bottles exhibiting white streaks. These tails represented the glass adhering to the dipping rod after cutting off the metal for the previous bottle, the residue of one not blending perfectly with the next gathering of glass.

The trouble developed most in machines making large bottles. On a furnace delivering 12 tons per day, it was reduced by an increase in the gas pressure. A smaller furnace, delivering 8 tons, gave no trouble, and samples of glass taken from the two tanks had the following percentage composition:—

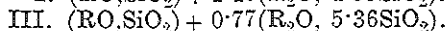
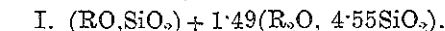
	Small tank.	Large tank.	Empirical molecular formula.	
Glass I.	Silica 77.0 Lime 4.62 Magnesia..... 3.26 Soda 15.10	77.3 4.52 3.24 15.94	Magnesi... 0.2 Lime 0.2 Soda 0.6	Silica 3.13

A three-year-old bottle had the following composition, II, whilst the glass made at another factory the results under III:—

Glass II.		Glass III.	
Silica	76.45	Silica	73.10
Lime	4.05	Lime	13.47
Magnesia	2.80	Magnesia	0.5
Soda	16.7	Soda	12.1

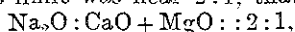
In discussing this trouble, Dr. Tillotson pointed out that a glass may be quickly cooled below its melting point without devitrifying, but on reheating to the softening point crystallisation might take place, causing the glass on the dipping rod to devitrify. The temperature attained during the melting and fining of the glass was a very important factor, and as the trouble was absent from the small furnace or when using higher gas pressure, a greater degree of chemical equilibrium and physical homogeneity were doubtless obtained, due to higher temperature.

Denoting the alkaline earth oxides by RO and the oxides of the alkalis by R_2O , glasses I and III may be expressed as:—

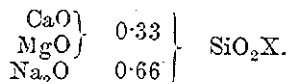


The ratios 1.49 and 0.77, representing $\frac{\text{equiv. } R_2O}{\text{equiv. RO}}$ were important in determining the physical properties of a glass, especially devitrification. The ratios 4.55 and 5.36, indices of the "acidity" of the glass, showed, in this case, that a glass with a lower percentage of SiO_2 might yet be the more "acid" glass.

Mr. Gelstharp expressed the view that, in using soda ash alone as the source of alkali, there was a minimum limit for the ratio of soda to lime and magnesia if a white scum or devitrification was to be avoided. This limit was near 2:1, that is,



and the empirical formula of this glass would be



In glass I the ratio $\frac{\text{Na}_2\text{O}}{\text{CaO} + \text{MgO}} = \frac{1.5}{1}$ and this glass, in his opinion, favoured devitrification under suitable conditions.

For glass II the ratio was 1.95:1, and this agreed with the desired ratio, 2:1, mentioned above, and this glass did not devitrify. Even after consideration of these ratios, trouble was likely to arise if a change occurred in the composition of the materials used, especially if burnt lime were used instead of limestone, or if dolomitic lime be used.

Using a properly proportioned glass, the reheating of the glass on the rod would only produce a cord at the worst. V. D.

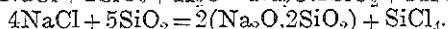
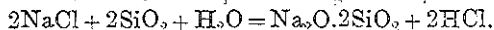
294. Some Chemical Reactions of Interest to the Plate Glass Chemist. F. GELSTHARP (*Trans. Amer. Cer. Soc.*, 1912, 14, 642; 1913, 15, 585).—A study of the properties of the raw materials concerned and of their reactions with one another. The main conclusions were:—

(1) *Saltcake* begins to dissociate at about 1300°, and the rate of dissociation increases rapidly with rise in temperature.

(2) *Sand + Soda Ash*.—In a mixture of soda ash and excess of sand, either $\text{Na}_2\text{O} \cdot \text{SiO}_2$ or $\text{Na}_2\text{O} \cdot 2\text{SiO}_2$, or a mixture of these, might be found depending on the intimacy of the sand and ash mixture. The disilicate would predominate, and on continued heating the silicates would dissolve the excess of sand.

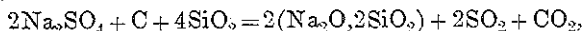
(3) *Sand + Saltcake*.— Na_2SO_4 (saltcake) begins to react with silica near its melting point, and the rate of the reaction depends on the temperature.

(4) *Sand + Common Salt*.—Using rather damp, coarse-grained salt and sand passing a 40-mesh sieve, but the bulk remaining on a 60-mesh, the proportions being 120 sand to 61.5 salt, and heating ultimately to 1400°, it was found that 1.92 grams of salt reacted with 100 of SiO_2 . The author believed the first of the following reactions to be the more probable, the sand grains becoming coated with silicate of soda in the presence of water vapour, and this surface film preventing further reaction:—

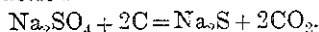


(5) *Saltcake + Limestone*.—According to the author, no reaction took place on heating to 1000°.

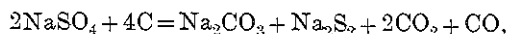
(6) *Sand + Saltcake + Charcoal*.—Used in correct proportions, sodium silicate was obtained thus:—



but if the C be in excess, some sodium sulphide may be produced, according to the reaction

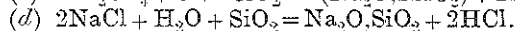
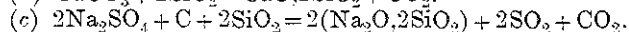
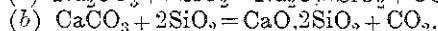
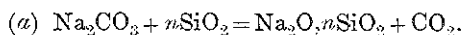


This reaction might be more complex, and a polysulphide of sodium being formed, colouring the sodium silicate yellow. Such a reaction would occur as follows:—



the Na_2CO_3 forming sodium silicate, which dissolves the polysulphide. A silicate had actually been obtained which, when dissolved in hydrofluoric acid, liberated free sulphur with evolution of H_2S .

(7) *Sand + Soda Ash + Saltcake + Common Salt + Limestone + Charcoal + White Arsenic*.—In proper proportions and intimately mixed, a homogeneous glass should be produced, the reactions usually being expressed as:—



(e) As_2O_3 might oxidise iron, and the resulting arsenic and residual white arsenic would volatilise.

These equations failed to explain many phenomena which arose in glass making. For instance, CaS might be formed to some extent, as in the old Le Blanc soda process, and this, along with possible Na_2S , Na_2S_2 , and impurities such as Fe_2O_3 , Al_2O_3 , and CaSO_4 complicated the reactions.

The presence of SiO_2 lowered the temperature of complete decomposition of CaSO_4 , and the reaction between CaSO_4 and SiO_2 took place more rapidly than the one between Na_2SO_4 and SiO_2 . CaSO_4 reacted with charcoal according to the following equations (H. O. Hofman and W. Mostowitsch, *Bull. Amer. Inst. Min. Eng.*, 47, 917):—

(1) $\text{CaSO}_4 + 4\text{C} = \text{CaS} + 4\text{CO}$, commencing at 700° and complete at 1000° . Below 800° CO_2 was formed, but above 800° CO , the CO reducing CaSO_4 more readily than C .

(2) $\text{CaSO}_4 + 4\text{C} = \text{CaS} + 4\text{CO}_2$, commencing at 680° and complete at 800° .

(3) $3\text{CaSO}_4 + \text{CaS} = 4\text{CaO} + 4\text{SO}_2$, beginning at 800° and energetic between 850° and 900° .

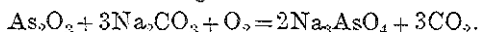
Ground glass, mixed with CaSO_4 and maintained at 1370° , showed that CaO was taken up by the glass. Na_2SO_4 separating on the surface, disappearing later by dissociation, part of the Na_2O being again taken up by the glass. All attempts to reduce Na_2SO_4 to Na_2SO_3 by C were unsuccessful.

(8) *Soda Ash + White Arsenic*.—Usually in a glass batch As_2O_3 was stated to act thus:—



The metallic As passed off, and As_2O_5 oxidised the materials, being reduced to As_2O_3 , the process being repeated until all the As has

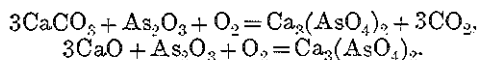
left the glass. However, from his experiments, the author believed the As_2O_3 to exert a reducing action, thus:—



This view was supported by the use of the oxide to remove black streaks in glass. The glass became seedy and green, due to the reducing action of the arsenic compound.

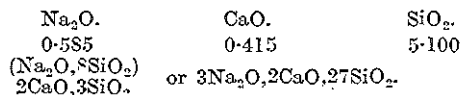
(9) *Saltcake + White Arsenic*.—After heating to 940° , the product was found to be neutral to litmus and contained As_2O_5 . Sulphur compounds were absent, but if formed by the reduction of the Na_2SO_4 , they would be immediately oxidised, leaving Na_3AsO_4 . Later, Na_3AsO_4 was found to produce no decomposition of Na_2SO_4 , probably because here the arsenic was not capable of further oxidation, but when Na_3AsO_3 was heated to 940° in a closed crucible with Na_2SO_4 , a decided action took place, sulphur compounds being produced, whilst the melt was strongly alkaline and brownish in colour. Treatment with acid precipitated sulphide of arsenic, and H_2S was liberated. Hence sodium sulphides, with sodium arsenate and sulpharsenate, must have been formed.

(10) *Limestone + White Arsenic*.—The experiments indicated that the reactions with CaCO_3 and CaO proceeded as follows when heated to 1090° :—



As_2O_3 in a glass batch was partly reduced by carbon, but the author had found as much as 56 per cent. of the original oxide left in the finished plate glass, not as As_2O_3 , but as As_2O_5 . Hence As_2O_3 acted as a reducing agent, and although volatile at 200 — 250° , it remained in the melt by combining with Na_2O or CaO , forming comparatively stable arsenates.

(11) *Sand + Soda Ash + Limestone*.—The results showed that when the ratio of Na_2O to CaO was less than 2:1, a uniform glass was not likely to be obtained. The thick, white scum which remained on the surface of the pot during the experiments, using the materials in varying proportions, was found to be a crystallised double silicate approximating to the composition:—



The addition of a little Na_2SO_4 decomposed it, and it became incorporated in the melt.

In conclusion, the author stated that he found in all cases considered that As_2O_3 acted as a reducing agent, and he failed to find Na_2SO_3 present in melting a glass batch. V. D.

295. Opal and Green Glasses. (*Sprechsall*, 1906, 39, 645).—The following formulæ for green and opal glasses which could be joined together were stated:—

Opal.

	I.	II.	III.
Sand	93 kg.	85 kg.	100 kg.
Soda	25	24	15
Cryolite	12	10	15
Lime	5	—	10
Fluorspar	5	10	—
Felspar	6	28	—
Saltpetre	1	500 gr.	5
Manganese oxide	200 gr.	100 „	—
Nickel oxide	4 „	3 „	—
Potash.....	—	3 kg.	10

Green.

	I.	II.	III.
Sand	42.5 kg.	55 kg.	100 kg.
Potash.....	5	20	12.5
Soda	10	—	20
Lime	5	7.5	15
Saltpetre	0.5	—	—
Red lead	1	7.5	—
Borax	500 gr.	—	—
Uranium oxide	375 „	—	—
Copper oxide	1,000 „	1.25	5
Chromic oxide	1,000 „	—	—
Potassium bichromate	—	1.5	0.5
Ferric oxide	—	—	2

J. R. C.

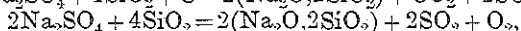
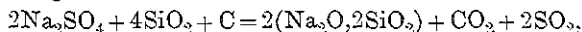
296. Emerald Green Glass. (*Sprechsaal*, 1906, 39, 473).—

The following batches were recommended for emerald green glass:—

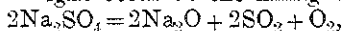
	I.	II.	III.	IV.
Sand	100 kg.	100 kg.	100 kg.	75 kg.
Soda	20	5	22	15
Potash.....	10	35	10	19
Borax	3	3	3—4	—
Saltpetre	6	—	2	—
Lime	20	22	18	12
Potassium bichromate.	1	0.5	1	0.35
Copper oxide	300 gr.	—	0.1	0.35
Iron oxide	200 „	—	—	—
Uranium oxide	—	1.3	—	0.03
Copper sulphate	—	5	—	—
Antimony oxide	—	—	0.25	—

J. R. C.

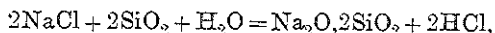
297. Solubility of some Salts in Glass. F. GELSTHARP (*Trans. Amer. Cer. Soc.*, 1912, 14, 665).—In the author's view the following reactions may take place under the conditions of glass melting:—



or simple dissociation might occur at the fusing temperature,



some of the alkali being volatilised and some absorbed by the glass. The decomposition of NaCl might also proceed, to some extent, according to the following equation:—



and any remaining NaCl would be volatilised, since the fining temperature of glass is about 530° above the volatilising temperature of the chloride.

Careful chemical analyses were made of plate glass made from SiO_2 , Na_2SO_4 , Na_2CO_3 , NaCl, CaCO_3 , C, and As_2O_3 . Although, according to the above reactions, no Na_2SO_4 or NaCl would be expected in the finished glass, yet they were both found present to a considerable extent.

Na_2SO_4 was found in varying amounts, ranging from 0.59 to 1.74 per cent. in different samples of plate glass. The absorption of SO_3 from furnace gases during melting would produce Na_2SO_4 in a glass otherwise not containing the salt, but in glasses made and tested under the same conditions this did not amount to more than 0.22 per cent.

NaCl was found present in samples to the extent of 0.91 to 1.48 per cent., while two samples tested for both sulphate and chloride contained:—(1) Na_2SO_4 0.85 per cent., NaCl 0.91 per cent.; (2) Na_2SO_4 0.64 per cent., NaCl 1.48 per cent.

Increase of temperature or increase of time at the same temperature caused a decrease in the amount of Na_2SO_4 present, and glass containing much NaCl continued to give off NaCl vapours.

The maximum amount of these two salts that could be retained by plate glass depended largely on the time of exposure to certain temperatures, but at the ordinary fining temperature the author found the maximum of Na_2SO_4 to be 1.74 per cent., while that of NaCl was 1.48 per cent. According to the author, plate glass containing these salts was less soluble in water than that not containing them, indicating that solubility depends on percentage of alkali silicate.

The depth of colour of opal glass depended largely on the solubility of fluorides in it, long-continued heating driving off most of the dissolved fluoride.

Large quantities of CaS or Na_2S might be retained by glass, but it was not clear whether such were cases of solubility, or chemical combination, or simple mixture.

The following method was used by the author for the estimation of SO_3 or Na_2SO_4 . Fuse 1 to 2 grams of the finely ground sample with Na_2CO_3 in a platinum crucible over an alcohol blast lamp. Digest the fused mass with water, and make slightly acid with HCl. Boil well, and add a small quantity of paper pulp. Filter off the SiO_2 , using a filter pump. To the boiling solution add just sufficient BaCl₂ for precipitation: boil for some time. Filter off the BaSO_4 , which contains some SiO_2 . Burn the filter paper at a low temperature. Treat the residue in the platinum crucible with HF and a few drops of H_2SO_4 . Heat to drive off SiF_4 and the excess of H_2SO_4 . Fuse the residue with Na_2CO_3 , take up with

water, add a drop of HCl in excess in order to make the liquid acid, and boil for some time. Filter and weigh the BaSO_4 , and calculate from it the percentage of SO_3 or Na_2SO_4 . V. D.

298. An Investigation of the Surface Devitrification of Glasses under Thermal After-treatment. C. J. BROCKBANK (*Trans. Amer. Cer. Soc.*, 1913, 15, 600).—The author described experiments made to determine the influence of chemical composition of a glass on its susceptibility to surface devitrification, and also the critical temperature required to induce the change rapidly. The soda-lime-silicates were studied, and melts of 5 lb. and 1500 lb. were made. The temperature probably reached 1600° on heating, and, after twelve hours' cooling, test-pieces of glass were ground and polished for experiment.

These pieces were heated in a gas muffle, and the softening and "dimming" temperatures determined by the aid of the reflections in the glass surface of a small steel rod, its point resting on the surface, the temperatures being recorded by a thermocouple. Care was taken to maintain uniform time of reheating in each case.

Details of the melts and temperatures were given, and the following conclusions were drawn from the results:—

(1) Substitution of potassium carbonate for sodium carbonate raised the dimming point and increased chemical and physical stability.

(2) Boric acid produced no marked improvement.

(3) Introduction of magnesia, and particularly alumina, into white sheet glass was very beneficial, making the glass more stable.

(4) The use of dolomite, particularly in conjunction with alumina, resulted in great improvement, even if the glass were more difficult to "fine."

(5) In flint glasses the substitution of soda for potash was detrimental, but a mixture of the two was still more so. V. D.

299. Note on the Solubility of Zinc Oxide in Fused Lead Silicate and Borate. A. D. HOLDCROFT (*Trans. Eng. Cer. Soc.* 1909-10, 9, 37).—The author first proved that there was practically no volatilisation of lead from the lead silicate at the temperature at which the experiments were made. The objects of further experiments were: (1) to determine the solubility of zinc oxide in lead monosilicate at 1000° . (2) To compare the solubility of zinc oxide with that of zinc silicate and willemite (natural zinc silicate) at 1000° . (3) To ascertain the solubility of zinc oxide in PbO, SiO_2 at 850° and in $\text{PbO}, \text{B}_2\text{O}_3$ at 1000° and 850° . The author gives the conclusions as follows:—

Grams of zinc oxide soluble in	1000° .	850° .
PbO, SiO_2	12—14	7—10
$\text{PbO}, \text{B}_2\text{O}_3$	60—70	50—60

These results may be of use in the making of crystalline glazes, using zinc oxide. C. M. M.

300. The Volatilisation of Lead Oxide from Lead Silicate Melts. OLAF ANDERSEN (*J. Amer. Cer. Soc.*, 1919, 2, 784).—The author made experiments on the amount of PbO volatilised from the surface of lead silicate glasses at temperatures from 900° to 1400°. The experiments were carried out in an electric furnace, and the losses were obtained by weighing the crucible at the beginning and at the close of the experiment. It was found that the rate of loss decreased with prolonged heating, but remained constant when stirring was applied, the reduction in loss from the unstirred samples being due undoubtedly to the formation of a surface layer relatively richer in silica. The results are tabulated as follows:

Volatilisation of PbO from Pure Lead Silicate Glasses.
Loss in mg. per sq. cm. per hour.

Percentage of PbO in glass	85	78.7	75	70	65	60
Temperature:—						
1400°	318	131	91	60	46	33
1300	100	40	30	23	16	13
1200	37	11	8	7	5	4
1100	13	4	2	2	1	1
1000	8	2	1	1	—	—
900	1	1	—	—	—	—

It was found that the volatilisation from an unstirred glass in fifteen minutes occurred at approximately the same rate as from a stirred glass heated for a longer period of time. The above results are based on a short heating without stirring of melt. Further, the author states that if the procedure is reasonably constant from melt to melt, variations in refractive index due to volatilisation are not to be expected; but if the melting schedule be changed the volatilisation may be large enough to cause considerable variations in refractive index.

C. M. M.

301. A Thermal Study of Boric Acid-Silica Mixtures. A. V. BLEININGER and P. TEETOR (*Trans. Amer. Cer. Soc.*, 1912, 14, 210).—Mixtures of silica and boric acid possessed the character of glasses or solid solutions, and their thermal study might indicate any possible chemical combination. The research dealt with (a) the determination of softening points of mixtures between the limits B_2O_3 — $B_2O_3 \cdot 3SiO_2$, (b) the determination of heating and cooling curves, and (c) an investigation of the solubility of the fused glasses in water. The reagents used were chemically pure hydrous boric acid and silica, and some fusions were made, using flint which passed a 200-mesh sieve.

In determining the softening points, the fused mixtures were ground to fine powders, made into cones with a little water, placed in an electric resistance furnace, and the temperature at which the cones bent was measured.

The deformation point of B_2O_3 was difficult to determine, due to evolution of steam, some anhydrous boric acid reverting to the hydrous form. The addition of $0.1SiO_2$ made the cones stand in

good shape. The addition of water to the mixture $B_2O_3, 1.5SiO_2$ resulted in considerable heat being given off, but little was evolved by $B_2O_3, 1.4SiO_2$ and the mixture $B_2O_3, 1.6SiO_2$. The mixture $B_2O_3, 1.5SiO_2$ became pink on fusing.

The glasses were quite viscous, and on repeating the tests the results varied, more beyond $B_2O_3, 2SiO_2$ than below, and even more varied were the results obtained by using rods drawn from the fusions. The internal molecular friction would retard any reaction taking place in these mixtures, which were typical glasses, having no definite deformation temperatures.

In the determination of the heating and cooling curves no temperature acceleration or lag was observed.

In order to investigate the solubility of the mixtures in water,

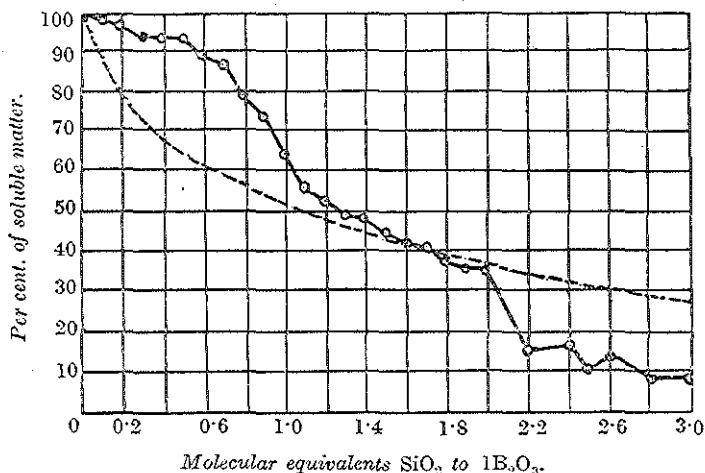


FIG. 149.

they were pulverised, and the portion passing the 80- but remaining on the 150-mesh sieve, was used. Samples were shaken in distilled water for ten hours, allowed to stand overnight, then the residue was filtered and washed, dried, ignited, and weighed.

The results are set out in Fig. 149, from which it is seen that in the lower part of the series all the boric acid, and some silica, were dissolved, but at about the composition $B_2O_3, 1.8SiO_2$ some B_2O_3 had become insoluble. The amount of soluble matter decreased more rapidly than the B_2O_3 content, and between 2 and $2.2SiO_2$ a decided fall in solubility indicated that a chemical combination might have taken place at this point, and the formation of some of this compound earlier in the series might explain the gradual decrease in solubility that was found.

V. D.

302. Some Chemical Characters of Borate Glasses.
BURGESS and HOLT (*Trans. Eng. Cer. Soc.*, 1905-6, 5, 163).—The

addition of a metallic oxide to fused boric anhydride results in one of three things: (1) the oxide is insoluble, (2) or it forms an almost insoluble borate; (3) or it forms a soluble borate. The first case included the oxides of gold, the platinum metals, and probably the oxides of aluminium, tin, thorium, and other rare earths. The oxides of gold and platinum were decomposed, the finely divided metal being suspended in the fused mass. Lead oxide, though forming a borate, was easily reduced, rendering the mass opaque.

In the second case studied by Guertler (*Zeitsch. anorg. Chem.*, 1902, 40, 225, 268, 337) the anhydride dissolved a little of the borate, and the borate dissolved some 3 or 4 per cent. of the anhydride, so that, if only a little of the oxide were used, two non-miscible liquids were formed. The resulting mass presented a milky appearance when a very small quantity of oxide was used, and further addition of the oxide produced a clear, homogeneous glass consisting of the most acid borate; but later an opaque mass was formed.

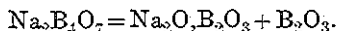
The oxides of the alkalis and thallium constituted case (3), though the behaviour of arsenic, antimony, and mercury was uncertain. Results of previous work on mixtures of sodium carbonate and boric anhydride were referred to, and it appeared that some of these mixtures formed a less fusible, crystalline modification when heated for some time at a temperature just below their melting points.

Mixtures containing boric anhydride and sodium oxide in the ratio 8:5, or with the anhydride in greater proportion, were glasses, while a greater oxide content produced crystalline substances, which could only be obtained as glasses by sudden cooling. Glasses could not be obtained at all if the ratio $B_2O_3 : Na_2O$ was less than 2:3. Glasses that were prepared with difficulty could easily be devitrified, one of composition $3Na_2O, 2B_2O_3$ devitrifying when heated in a Bunsen flame, while one of composition $Na_2O, 4B_2O_3$ resisted devitrification for days at this temperature. Complete devitrification was impossible when the ratio $B_2O_3 : Na_2O$ exceeded 4:1, the crystalline portion of composition $Na_2O, 4B_2O_3$ decreasing as the proportion of anhydride increased.

Vitreous and crystalline mixtures of B_2O_3 and Na_2CO_3 consisted of two borates, $Na_2O, 4B_2O_3$ and Na_2O, B_2O_3 , intermediate crystals being regarded as solid solutions of these two, and mixtures varying from pure B_2O_3 to $Na_2O, 4B_2O_3$ were probably solutions of the borate in the anhydride.

Lithium borates gave analogous results, but only one compound, $Li_2O, 2B_2O_3$, appeared to be formed. The borates of the alkaline earths formed three distinct compounds.

The colouring properties of the metallic oxides when added to glasses could, according to one theory, be explained by the decomposition of sodium pyroborate into the metaborate, and boric anhydride, the latter combining with the oxide to give a coloured borate:—



Since almost all these colouring oxides were insoluble in the anhydride, but dissolved on the addition of alkali, the idea that the oxides acted as an alkali, combining with the excess silica in a glaze, must be discarded. Alkali was essential in coloured glasses, which contained a complex salt of it with the metallic oxide and B_2O_3 , as, for instance, sodium-copper borate in copper glass.

Attempts to crystallise cobalt and copper glasses resulted in the separation of almost colourless crystals, with ejection of the colouring matter, showing the glasses to be in a metastable condition. Similarly, the crystallisation of borax, and the separation of some of the dissolved thoria, prevented any regularity in results when attempt was made to determine the amount of ignited thoria that could be dissolved in borax.

The colour imparted to a glaze by an oxide was influenced by the quantity of alkali present; copper oxide imparted a green colour to a borax glass of low sodium content, but the colour changed to blue with increased alkali content. The colour changed, too, with rise in temperature, the change being the inverse of that brought about by an increase of the alkali present, and a comparison with the behaviour of strong aqueous solutions of a copper and cobalt chloride suggested that the colour of the glass might depend on its degree of ionisation.

Boric anhydride did not conduct electricity, but a glass containing a small amount of sodium and copper conducted it readily, the ions produced by the decomposition of the complex sodium-copper borate and the sodium borate carrying the current. If the undissociated molecules were blue, and the ions green, the addition of sodium would cause the glass to appear blue, due to decreased ionisation; and the green colour exhibited at higher temperatures would be due to increased ionisation.

Again, supposing that the complex could combine with more solvent, producing an unstable compound, different in colour, say, blue, then the formation of this blue compound would be helped by the addition of sodium, but at higher temperatures it would give place to the more stable, green compound.

The depression of the melting point of borax by the addition of copper oxide was greatest when one-twelfth equivalent of copper was added; hence an infusible network appeared to be formed by the oxide and copper borates when the glass became saturated. The oxide produced no lowering of the melting point of B_2O_3 , as copper borate was insoluble in the anhydride.

The colour of gold and copper ruby glasses was held to be due to entirely different causes.

V. D.

303. The Chemical Rôle of Boron in Glazes. R. C. PURDY (*Trans. Amer. Cer. Soc.*, 1912, 14, 731).—The author reviewed much work previously done on the effect of B_2O_3 on glazes, and questioned the views expressed of similarity in function of Al_2O_3 and B_2O_3 .

Evidence showed that in respect to both crazing and devitrifi-

cation, B_2O_3 and Al_2O_3 had opposite effects in glazes of low oxygen ratio, but the same effect in glazes of higher oxygen ratio; yet this did not prove that in the former case B_2O_3 functioned as an acid and in the latter case as a base.

Studies on colour effects indicated a similarity in action of Al_2O_3 and B_2O_3 , but did not prove the actual chemical rôle of B_2O_3 .

V. D.

304. The Thermal Conductivity of some Solid Insulators.

W. M. THORNTON (*Phil. Mag.*, 1919, 38, 705).—From inspection of the recorded values of the physical constants of some heat insulators, including glasses, it was observed that the thermal conductivity is equal to the product of the elasticity and density, so that $k = E\rho = V^2\rho^2$, where V is the velocity of sound in the substance. A table of the most probable values of the constants and the products is given, and the very good agreement between k , $E\rho$, and $V^2\rho^2$ indicates that there is some fundamental process, a consequence, possibly, of the electrical structure of matter, beneath these phenomena. As a practical outcome of this relationship, the author holds that a heat insulator should be light and inelastic.

J. R. C.

305. The Spreading of Fluids on Glass.

W. B. HARDY (*Phil. Mag.*, 1919, 38, 49).—When a drop of some fluids is placed on a water surface on which a few dust particles rest, a film of insensible thickness rapidly spreads from it in all directions, pushing the dust particles before it. The drop may then spread to form a layer of sensible thickness. If the fluid is pure, the phenomenon finishes at the first stage. The same was found to hold true for a glass surface, but here the presence of a very small amount of water vapour caused the second stage to take place.

J. R. C.

306. Adsorption of Metals from Drinking Water by Glass.

K. SCHERINGA (*Pharm. Weekblad*, 1919, 56, 8).—Glass vessels were thoroughly cleaned, and solutions containing known quantities of various salts poured into them. After standing for two days, the metallic content of the solution was determined, and it was found that no diminution had occurred.

Since the proportion of lead in drinking water often decreased in the course of a few hours, it would appear that this decrease was due, not to adsorption by the glass, but to chemical action. The decrease, it was suggested, might be caused by the precipitation of finely divided lead carbonate or by the disturbance of an equilibrium when the water was removed from contact with lead.

F. W. H.

307. Researches in the Chemistry of the Silicates.

F. M. JÄGER and H. S. VAN KLOOSTER (*Spreksaal*, 1919, 52, 256).—The silicates were prepared by first heating a mixture of quartz and the metal carbonate or oxide to the sintering point in an iridium-

VOL. III.	Substance.	Melting point.	Specific gravity.	Observer.	Refractive indices.	Special remarks.
	BeSiO ₃	> 1750°	—	Jäger & van Klooster.	—	—
	MgSiO ₃	1554°	3.175	Allen & Wright.	$n_1=1.641$; $n_2=1.648$; $n_3=1.663$.	—
	Mg ₂ SiO ₄	1750°	—	—	—	—
	CaSiO ₃	1540°	—	Day, Allen, White, Shepherd & Wright.	$n_1=1.609$; $n_2=1.650$.	—
	Ca ₃ SiO ₄	2130°	3.27	„	$n_1=1.714$; $n_2=1.720$; $n_3=1.737$.	—
	SrSiO ₃	1578±1°	3.652	Jäger & van Klooster.	$n_1=1.620$; $n_2=1.590$.	The melt can be supercooled to 1225° when sudden rise of temperature to 1364° accompanied by crystallisation takes place. By rapid cooling of the melt, an almost isotropic glass can be obtained with $n=1.618$, spec. gravity 3.540, and by careful heating a micro-crystalline variety is obtained.
	Sr ₂ SiO ₄	> 1750°	—	„	—	—
	BaSiO ₃	1604°	4.435	„	$n_1=1.670$; $n_2=1.667$.	Small, weakly double refracting crystals. Attempts to obtain the substance as a glass were unfruitful.
	BaSiO ₄	1750°	—	„	—	—
	ZnSiO ₃	1437±1°	3.52	„	$n_1=1.623$; $n_2=1.616$.	Weakly double refracting crystals.
	Zn ₂ SiO ₄	1509°	—	„	$n_1=1.719$; $n_2=1.697$.	Crystals identical with <i>Willemite</i> .
	CdSiO ₃	1242°	4.928	„	Both > 1.739.	Crystals with strong double refraction.
	Cd ₂ SiO ₄	1252—1243°	—	„	Both > 1.739.	Artificial <i>rhodonite</i> ."
	MnSiO ₃	1273±1°	3.716	„	$n_1=1.739$; $n_2=1.733$.	Artificial Mn ₂ SiO ₄ has no fixed melting point. Became dark coloured on heating through decomposition.
17	Mn ₂ SiO ₄	1290—1300°	4.044	„	Both > 1.739.	—
	CaMg(SiO ₃) ₂	1391°	3.275	Allen & White.	$n_1=1.664$; $n_2=1.671$; $n_3=1.694$.	—

free platinum dish in an electric oven, and then completing the fusion in a Fletcher gas furnace.

The silicates of barium, strontium, beryllium, zinc, and cadmium were white and crystalline; that of zinc showed a blue to violet colouring, whilst those of manganese developed a brown colour. In the table on p. 235 are stated some of the properties of the silicates.

n_1 and n_2 are the refractive indices for uniaxial crystals, and n_1 , n_2 , and n_3 for biaxial.

It was found that the meta-silicates have melting points which are related linearly to the atomic weights of the metals, the melting points rising with increasing atomic weights in the case of calcium, strontium, and thorium, and falling with magnesium, zinc, and cadmium.

W. E. S. T.

308. Some Aspects of the Physical Chemistry of Fusing Silicates. A. V. BLEININGER (*Trans. Amer. Cer. Soc.*, 1907, 9, 419).—Measurements of volume showed that in nearly all cases, in fusing a crystalline silicate, the real volume seemed to increase, the effect of bubbles and cavities being eliminated. Quartz shows a decided increase, and felspar expanded to the extent of 6 per cent. By determining the change in volume with rise in temperature, it was found that felspar began its fluxing effect at a temperature much below its melting point, and the vitrification of a porcelain body began at quite a low temperature, while the effect of a flux such as lime was well marked. In a clay body, increases and decreases in volume might occur, and the resulting change in volume was the algebraic sum of many complex changes.

Ceramic silicates were on the borderline between glassy and crystalline structure. In an amorphous substance such as glass, the physical properties were the same in all directions, whereas in crystals they were alike, but in parallel directions. The author found that a specimen of paving brick, which gave poor results under the "rattler" test, showed signs of crystallisation, while the sound brick gave no such evidence.

On fusion, clay and crystalline bodies, such as quartz and felspar, reach a state of fluidity suitable for the production of crystals, which had been found in a piece of Chinese porcelain, and in a piece of a Berlin crucible.

Viscosity was a property of great importance in problems such as the crawling of glazes, and if too great, crystallisation was prevented. Many silicates had a high viscosity at the temperatures usually used. Very siliceous and aluminous silicates were completely viscous, whilst those of the alkaline earths became fluid more readily. For glasses to be blown or moulded, and for crystalline glazes, the change of viscosity with temperature must be of a certain order, and the condition of plasticity of kaolin and ball clay slips would no doubt be better understood from a determination of the viscosities.

Melting points and solidifying points were not necessarily iden-

tical for silicates, due to supercooling and supersaturation. In solid solutions, such as glass, fusion took place during an interval, and even quartz had a melting *interval* rather than a melting *point*, and mixtures of quartz and tridymite were obtained.

Melting and freezing curves were very important in studying the fusion phenomena of silicates, and supersaturation played an important part in crystallisation. A mixture of silicates fused at a lower temperature than the silicates themselves, and eutectic mixtures, that is, mixtures in a definite proportion, which fused at a lower temperature than either constituent, or any other combination of the two, could be calculated, or determined practically, as shown fully by the author. Kaolin added to a cone mixture rendered it more fusible, and fluxes were used in the production of glass or glazes for this purpose.

Le Chatelier observed an absorption of heat during the dehydration of kaolin between 550° and 650° , and also a sudden evolution of heat on heating kaolin to 1000° , corresponding with the isomeric change of state after which the alumina became insoluble in acids.

It was suspected that certain reagents brought about catalytic reactions in igneous mixtures; for instance, steam and hydrofluoric acid converted amorphous alumina into a crystalline variety.

The author discussed the rate of cooling of various types of silicates fully, and he showed the importance of, but the great lack of trustworthy data on, other physical properties, such as porosity, hardness, solubility, fineness of grain, elasticity, and coefficient of expansion.

V. D.

309. Some Properties of Commercial Silicate of Soda.

JAMES G. VAIL (*J. Ind. Eng. Chem.*, 1919, 11, 1029).—A definite compound of the formula $\text{Na}_2\text{SiO}_3 \cdot 9\text{H}_2\text{O}$ could be prepared, but, as far as was known, it had no commercial value, because it lacked those colloidal properties upon which practically all of the commercial applications of silicate of soda depended.

Sodium silicate in commercial use contained more silica than was indicated by the above formula, the ratio between Na_2O and SiO_2 varying between 1:4 and 2:3. Forms more alkaline than the 2:3 variety tended to form crystalline masses, which would interfere with their usefulness, and the practical limit in the other direction, 1:4, was determined by the very low solubility of fused sodium silicate containing larger proportions of SiO_2 . Commercial grades of sodium silicate had the physical appearance of glass, but were less permanent and effloresced in damp air. They were usually coloured, owing to small quantities of iron present. Ferric iron, giving a yellow colour, was more frequently observed in the alkaline types, while those rich in silica were usually coloured green, due to the presence of ferrous iron.

The paper contained data relating to properties such as solution, colloidal nature, viscosities of solutions, strength of adhesives, and cements produced from sodium silicate, the author stating that further studies were in progress.

C. M. M.

310. High Temperature Work on the Silicates. R. C. WALLACE (*Trans. Eng. Cer. Soc.*, 1909—1910, 9, 172).—The main object of the work was to investigate several two-component systems of the metasilicates of the alkalis and alkaline earths, and the three-component system $\text{Na}_2\text{O}, \text{Al}_2\text{O}_3, \text{SiO}_2$.

The author found that the chief difficulty to be contended with was the tendency of the "melt" to solidify as a glass. A marked exception to this tendency, however, was lithium metasilicate, Li_2SiO_3 , which was characterised by its extremely high rate of crystallisation. Hence it had been used in a large number of the two-component systems described. In most cases the mixtures were made from the carbonates and precipitated silica, the purest materials being employed. The following table summarises the chief results for the two-component systems examined:—

Silicate pair.	Miscibility in crystalline state.	Composition of eutectic.		Temperature of eutectic crystallisation.
		Percentage by weight.	Molecular percentage	
$\text{Na}_2\text{SiO}_3, \text{CaSiO}_3$...	Break in miscibility at 70–80% CaSiO_3 ... Minimum in curve at 20% CaSiO_3 . Maximum in curve at 58% CaSiO_3 .	70 CaSiO_3	71.1 CaSiO_3	1140°
$\text{Na}_2\text{SiO}_3, \text{SrSiO}_3$...	Completely miscible. Minimum in curve at 25% SrSiO_3 .	—	—	—
$\text{Na}_2\text{SiO}_3, \text{BaSiO}_3$...	Completely miscible. Minimum in curve at 40% BaSiO_3 .	—	—	—
$\text{Na}_2\text{SiO}_3, \text{LiSiO}_3$...	Completely miscible. Minimum in curve at 45% Li_2SiO_3	—	—	—
$\text{Na}_2\text{SiO}_3, \text{MgSiO}_3$...	Mixed crystals 0–10% and 90–100% MgSiO_3 . From 20 to 80% MgSiO_3 the mixture was a glass.	—	—	—
$\text{K}_2\text{SiO}_3, \text{Li}_{22}\text{SiO}_3$...	Mixed crystals from 60–100% Li_2SiO_3 . From 0–50% Li_2SiO_3 mixture formed a glass.	—	—	—
$\text{Li}_2\text{SiO}_3, \text{CaSiO}_3$...	Break in miscibility between 25–84% CaSiO_3 .	50 CaSiO_3	43.7 CaSiO_3	979°
$\text{Li}_2\text{SiO}_3, \text{MgSiO}_3$...	Break in miscibility between 50–75% MgSiO_3 .	55 MgSiO_3	52.3 MgSiO_3	876°
$\text{Li}_2\text{SiO}_3, \text{BaSiO}_3$...	Break in miscibility between 35–92% BaSiO_3 .	78 BaSiO_3	60.2 BaSiO_3	880°
$\text{Li}_2\text{SiO}_3, \text{SrSiO}_3$...	Break in miscibility between 22–92% SrSiO_3 .	6 SrSiO_3	45.3 SrSiO_3	1000°

Pronounced eutectic effects were noticed in the last four systems in the table, but a eutectic structure was not so definite. Such structures, the author stated, were not so well developed in the case of silicates as with alloys.

The molecular volumes of the mixed crystals in the $\text{Li}_2\text{SiO}_3\text{-CaSiO}_3$ and $\text{Li}_2\text{SiO}_3\text{-BaSiO}_3$ systems did not stand in linear relation to the concentrations. Only in mixtures of two saturated mixed crystals does such a relation hold.

Further work was done on the three-component system



The paper was illustrated by numerous diagrams, graphs, and tables.

C. M. M.

311. The Ternary System CaO-MgO-SiO_2 . J. B. FERGUSON and H. E. MERWIN (*Amer. J. Sci.*, 1919, **48**, 81).—Of the four possible ternary systems which might be constructed from the four oxides, lime, magnesia, alumina, and silica, the system CaO-MgO-SiO_2 proved to be the most complicated. The salts used in the experiments were chemically pure calcium carbonate, magnesium carbonate, and silica, the magnesium carbonate being thoroughly calcined before use. Mixtures of known composition were melted in platinum crucibles and reduced to a fine powder. This procedure was repeated until the final products, glasses whenever possible, were homogeneous. When prepared, a small quantity of each product was heated to a given temperature, kept at that temperature until equilibrium was reached, and then quenched in mercury.

The following definite compounds appeared as primary phases:—

CaO, MgO (*periclase*), SiO_2 (*tridymite*), SiO_2 (*cristobalite*), melting point $1710 \pm 10^\circ$, $\alpha\text{-CaO}, \text{SiO}_2$ (*pseudo-wollastonite*), $3\text{CaO}, \text{SiO}_2$, α - and $\beta\text{-2CaO}, \text{SiO}_2$, MgO, SiO_2 (*clino-enstatite*), $2\text{MgO}, \text{SiO}_2$ (*forsterite*), $\text{CaO}, \text{MgO}, 2\text{SiO}_2$ (*diopside*), $5\text{CaO}, 2\text{MgO}, 6\text{SiO}_2$ (decomposition point $1365 \pm 5^\circ$), and $2\text{CaO}, \text{MgO}, 2\text{SiO}_2$ (melting point $1458 \pm 5^\circ$).

Crystals also appeared as primary phases representing the following solid solutions:—a complete series with *clino-enstatite* and *diopside* as end-members, the *pseudo-wollastonite* solid solutions, the $5\text{CaO}, 2\text{MgO}, 6\text{SiO}_2$ solid solutions, and certain members of the *monticellite* solid solutions. The *monticellite* ($\text{CaO}, \text{MgO}, \text{SiO}_2$) solid solutions were dealt with in detail. Attempts to prepare pure *monticellite* did not succeed, a mixture of crystals of $\alpha\text{-2CaO}, \text{SiO}_2$ and crystals of a *monticellite* solid solution always being obtained.

Fourteen quintuple points were found in this ternary system, the details being given as follows:—

	Composition.				Temperature.
	CaO.	MgO.	SiO_2 .		
Eutectic	30.6	8.0	61.4	between <i>diopside</i> , <i>tridymite</i> and $5\text{CaO}, 2\text{MgO}, 6\text{SiO}_2$.	$1320 \pm 5^\circ$
..	.....$\frac{1}{2}$ 36.0	12.6	51.4	between $\alpha\text{-5CaO}, 2\text{MgO}, 6\text{SiO}_2$ solid solutions, <i>diopside</i> and $2\text{CaO}, \text{MgO}, \text{SiO}_2$.	$1350 \pm 5^\circ$

	Composition.				Temperature.
	CaO.	MgO.	SiO ₂ .		
Eutectic	29.8	20.2	50.0	between 2CaO,MgO,2SiO ₂ , <i>forsterite</i> and <i>diopside</i> .	1357±5°
„	49.2	6.3	44.5	between <i>pseudo-wollastonite</i> , 3CaO,SiO ₂ and 2CaO,MgO,2SiO ₂ .	1377±5°
„	39.0	18.3	42.7	between 2CaO,MgO,2SiO ₂ , α-2CaO,SiO ₂ and a <i>monti-</i> <i>cellite</i> solid solution.	1436±5°
„	uncertain.			between <i>periclase</i> , lime and α-2CaO,SiO ₂ .	Probably above 1900°
Non-eutectic ...	31.3	7.2	61.5	between <i>pseudo-wollastonite</i> , a <i>wollastonite</i> solid solution and <i>tridymite</i> .	1335±5°
„ ...	—	—	—	between <i>tridymite</i> , a <i>wollas-</i> <i>tonite</i> solid solution and a 5CaO,2MgO,6SiO ₂ solid solution.	Probably 1330±5°
	36.7	12.3	51.0	between <i>pseudo-wollastonite</i> , 5CaO,2MgO,6SiO ₂ and 2CaO,MgO,2SiO ₂ .	1365±5°
	31.4	7.6	61.0	between <i>pseudo-wollastonite</i> , a <i>wollastonite</i> solid solution and a 5CaO,2MgO,6SiO ₂ solid solution.	1340±5°
	49.5	6.2	44.3	between β-2CaO,SiO ₂ , 3CaO,2SiO ₂ and 2CaO,MgO,2SiO ₂ .	1387±5°
	33.3	22.3	44.4	between 2CaO,MgO,2SiO ₂ , <i>forsterite</i> and a <i>monticellite</i> solid solution.	1436±5°
	37.3	22.3	40.3	between <i>periclase</i> , a <i>monti-</i> <i>cellite</i> solid solution and α-2CaO,SiO ₂ .	1498±5°
	32.1	26.4	41.5	between <i>periclase</i> , <i>forsterite</i> and a <i>monticellite</i> solid solu- tion.	1502±5°

Full tables of details of experiments, concentration diagrams, models, etc., were also given. F. W. H.

312. Wollastonite (CaO, SiO₂) and Related Solid Solutions in the Ternary System Lime-Magnesia-Silica. J. B. FERGUSON and H. E. MERWIN (*Amer. J. Sci.*, 1919, **4S**, 165).—The authors gave an account of a detailed investigation of the *wollastonite*, the 5CaO,2MgO,6SiO₂, and other solid solutions

briefly mentioned in a previous paper (*Amer. J. Sci.*, 1919, 48, 81; preceding abstract).

The results which were obtained confirmed previous determinations regarding the *wollastonite-diopside* solutions. It was found that *wollastonite* took up a maximum of 17 per cent. of *diopside* to form solid solutions. The existence of a *pseudo-wollastonite-diopside* solid solution previously determined, and containing a maximum of 16 per cent. of *diopside*, was confirmed.

A new compound, $5\text{CaO}, 2\text{MgO}, 6\text{SiO}_2$, was found, and was described in detail. It decomposed at 1365° , about 25° higher than the decomposition temperature of the 17 per cent. *diopside* solid solutions. Other solid solutions discussed included those of *åkermanite* in *wollastonite* and also in *pseudo-wollastonite*, and the solid solutions of silica and $3\text{CaO}, 2\text{SiO}_2$ in calcium metasilicate. The *wollastonite* solutions were shown to exist up to a composition having between 60 and 70 per cent. of *åkermanite*, whilst the *pseudo-wollastonite* solutions extended to a composition with about 23 per cent. of *åkermanite*.

There was also presented a general discussion of the results with illustrative diagrams and models. F. W. H.

313. Notes on the Development of the Ruby Colour in Glass. A. E. WILLIAMS (*Trans. Amer. Cer. Soc.*, 1914, 16, 284).—Ruby glass is the term applied to glass coloured red by the use of gold, copper, selenium, and in some cases flowers of sulphur.

The author briefly reviewed the literature on the subject of the production of ruby glass by the use of gold, copper, selenium, and, in some cases, sulphur. The accepted view was that copper and gold were in the same condition as in colloidal solutions. According to Pöschl, particles of gold separated out from the glass on sudden cooling, but, having the magnitude of amicrons only, the glass appeared colourless. On re-heating to the softening point of the glass, the particles increased until they attained the size of ultra-microns, to which the colour was due. The same process occurred in the manufacture of copper ruby.

Several batches for the production of copper-ruby glass were quoted, chiefly from German literature, and mention was also made of gold, selenium and sulphur-red glasses. According to Hohlbaum, phosphoric acid and barium worked favourably in the manufacture of gold ruby, causing the colour to develop more quickly.

In new investigations on the development of the ruby colour, the author heated samples of a commercial copper-ruby glass (which had been cooled rapidly, and was therefore colourless) to definite temperatures in an electric oven, the rate of heating being carefully controlled. His results indicated that the colour produced at any particular temperature was constant and the colour change practically instantaneous, allowing for the time required for the temperature of the glass to become uniform throughout. In the case of the particular glass in question, no colour was developed

below 600°; it was fully developed at 650°, and little or no change observed between 650° and 670°.

The method adopted by the author in his investigations was as follows: The glasses were fused in Battersea crucibles in a small gas-fired pot furnace, the temperature range required for firing and rendering the glass fluid enough to pour being between 1480° and 1520°. Half an hour was taken for complete fusion of the lead glasses and an hour for the leadless glasses. The melt was poured on to a thick iron plate and rolled out to a thickness of from 2 to 5 mm. The thinner portions were usually clear, and colour developed slowly in the thicker portions.

Three series of experiments were carried out.

Series A.—The glasses conformed to the general molecular formula $0.5\text{Na}_2\text{O} : 0.5\text{PbO} : 3\text{SiO}_2$, the batch weights being: flint, 90; red lead, 57; soda ash, 35.3; with 0.5 per cent. of cream of tartar added in each case to ensure reduction. The amounts of cuprous oxide and of oxide of tin were varied in successive melts, the limits being 0.018 to 1.4 parts of cuprous oxide and 0.3 to 3.0 parts of tin oxide to the above batch. Some good glasses were obtained in this series, but the colour change was too rapid to allow of adequate control of the uniformity of the colour. A portion of the lead was replaced by lime in order to harden the glass somewhat, but the results showed that this increased the rate of development of colour.

Series B.—The glass used as the basis for this series of experiments was made from the following batch: flint, 100; potash, 26; white lead, 30; borax, 10; soda ash, 13.2; cuprous oxide, 3.5; tin oxide, 2. One per cent. of cream of tartar was added in each case. In some cases small amounts of iron and manganese oxides were added, but the results were unsatisfactory. This series produced a much better red colour than was obtained in Series A, but generally the colour was too dense and difficult to control. More uniform results were obtained by pouring the glass into water and re-melting. The glasses showed a light amber colour at 500°, changing to light red at 525°, ruby at 550°, and becoming opaque at 600°.

Series C.—Leadless glasses with high silica content. The type of glass used in this series corresponded with the molecular formula $0.536\text{K}_2\text{O} : 0.440\text{CaO} : 4.57\text{SiO}_2$, corresponding with a batch mixture of flint, 200; potash, 68; limespar, 32; with copper oxide, 1.2; tin oxide, 4.46; and cream of tartar, 2. This was found to be too hard, and the silica (flint) was reduced to 175 parts with the above batch. The resulting glass gave a good ruby colour on re-heating, but the temperature required to develop it properly was too high (850°). On replacing some of the lime by lead so as to soften the glass somewhat, much better results were obtained. Thus a clear deep ruby was developed at 570° on reheating a glass made from the following batch: flint, 175; potash, 68; limespar, 25; white lead, 15; cuprous oxide, 1.2; tin oxide, 4.46; cream of tartar, 2. The conclusions drawn by the author were as follows:—

(1) A workable ruby glass is one which will not become coloured

when cooled at the rate obtainable in the pressing process, and yet will give a workable range of temperature for reheating to uniform colour at temperatures below 700° .

(2) Highly fluid glasses become coloured more rapidly than viscous ones.

(3) Replacing lime with lead or soda increased the rate of colour development, lead more than soda.

(4) High silica is necessary for the development of good colour and to give sufficient viscosity, but increases the tendency to streakiness, particularly in lime-potash glasses. Small amounts of lead reduce streakiness.

(5) Iron and manganese are detrimental to good colour.

(6) Remelting improves the uniformity of the colour.

(7) The density of colour is apparently increased with increasing temperature. The time of heating is not an important factor.

J. H. D.

314. Contributions towards a Bibliography of the Art of Glass. M. L. SOLON (*Trans. Eng. Cer. Soc.*, 1912-13, 12, 65).—A bibliography of works on glass published in all European countries, divided into two parts, the first containing those relating to glass-making and technology, and the second to the history of the art, stained-glass windows, and description and illustrations of glass vessels, ancient and modern.

C. M. M.

III.—Lamp-worked and General Scientific Apparatus.

315. Glass Cutter. M. J. SCULLIN (U.S.A. Pat., July 1st, 1919, No. 1308260. Filed January 23rd, 1918, No. 213330).—The glass cutter has a casing, 10 (Fig. 150), in the form of a tube of suitable length, with a measuring scale marked on the exterior. One end of the tube carries two curved bars, 13 and 14, serving as a handle, and the other end of the casing is slotted lengthwise, 15. A small cutting steel wheel, 16, is rotatably mounted on a rod, 19, held in the wall of the casing and allowing the wheel to rotate in a direction crosswise to the casing. A retainer element, 20, is provided to allow of the cutter being held in movable engagement with the glass, and to permit of its being used for cutting tubes of various diameters. This retaining element consists of an L-shaped lever, pivoted at 23 to the casing, so that the arm, 21, is on the inside of the casing, and is connected to the operating rod, 27.

A slideable stop, 29, is mounted on the casing and secured in any desired position by the set-screw, 32, so that any number of lengths of glass all of exactly the same length can be cut off.

S. E.

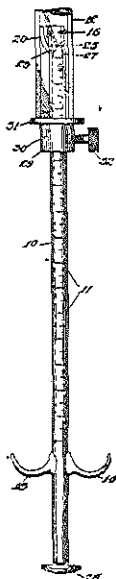


FIG. 150.

316. Machine for Shaping Tubular Glass Articles. R. KOENIG (U.S.A. Pat., May 27th, 1919, No. 1304691. Filed May 31st, 1918, No. 237425).—Lengths of glass tube are filled into a magazine, 15, mounted with its outlet above two pairs of rollers, 29, which are constantly rotated in the same direction by the belt, 30. Burners are fitted so as to heat each end of the tube as it is rotated, and when the glass is hot the forked prongs, 37, 38, and 39, are released by the two cams, 43 and 45, and pulled together by the coiled spring, 42. On coming together these three forks grasp the tube and lift it out of engagement with the rollers and up to such a position that its axis is in line with the axis of the shaping tool, 51. This shaping tool is rotated, and is slideably mounted within

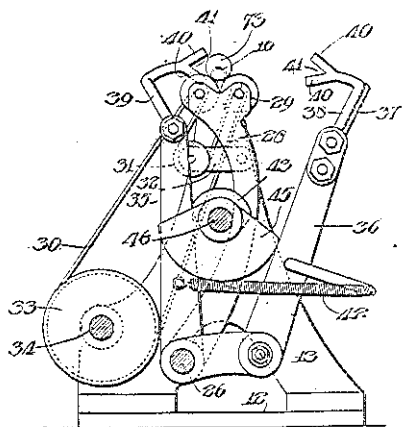


FIG. 151.

the bushing, 49. A coiled spring, 72, normally holds the sleeve, 50, in the outward position, but by the operation of the cams, 70 and 49, the latter pushes the tool towards the hot glass. When the centring head, 59, enters the end of the hot glass tube, further longitudinal movement is stopped, and the arm, 69, causes the sleeve, 50, to engage the tapered surfaces, 56, and thereby moves the jaws, 55, together. At the other end of the glass tube is a stop, 73, the horizontal position of which can be varied, and can be secured in any desired position by the nut, 74.

When the shaping of the neck is completed, the tool is withdrawn by the spiral spring, 72, and an ejecting arm, 79, pushes the finished tube from the rollers on to a chute, 80, leading to a collecting vessel.

S. E.

317. Suggestions for the Standardisation of Chemical Glassware. H. THIENE (*Zeitsch. angew. Chem.*, 1920, 33, 18).—The continuous endeavours which are being made to standardise the products of our industries have happily not stopped short of the apparatus used in the chemical laboratory. The Verein Deutscher Chemiker, in which there is a particular section concerned with chemical apparatus, has set up a series of commissions, each of which has its own sphere of investigation. I am directed by the commission on laboratory glassware, of which Prof. Böttcher, of Ilmenau, is chairman, to publish the proposals for the standardisation of the shape of laboratory glassware. Before

stating the selection which has been made, let me bring to mind the very great diversity of existing shapes and sizes which are to be limited. Such a limitation is advantageous for all concerned, for producer, merchant, and consumer. When the purchaser has not several hundred shapes and sizes from which to choose, the majority of which are seldom asked for, the few standard types can be manufactured in greater quantities, and therefore more cheaply. The merchant needs to keep fewer shapes in his shop, and this again reduces the cost. Finally, the consumer has the additional advantage that the dealer will have these relatively few standard shapes already in stock, or they can be obtained immediately from the manufacturer.

After restricting the number of shapes, the question of the standard measurements of these standard shapes has to be considered. In this direction, the chemist is saved much time, expense, and vexation by standardisation. Hitherto, not only has each factory had its own particular measurements for height and width of neck, but it very often happened that articles were sold from the same factory and bearing the same distinguishing mark which differed so greatly that it was only with difficulty that a resemblance could be seen. Woe to the poor chemist who broke a flask in a larger piece of apparatus! A substitute of equal height, and even approximately the same width of neck, was to be found usually only with difficulty, particularly in the case of ordinary glass, blown either in a wooden mould or without one at all. Even though the articles sold by the Jena glass works had the same dimensions, reform was still needed with regard to the neck measurements, since, for example, Erlenmeyer and ordinary flasks of the same content had not the same neck diameter. I have therefore carried my suggestions further, and selected a number of sizes in every kind in order that they may have the same width of neck. In this way it is possible for the chemist to meet his requirements for ordinary and Erlenmeyer flasks with a very small number of stoppers.

I have entirely eliminated the short, welted round flask, the short flat, short round, and long flat Kjeldahl flask, the slender, conical beaker, as well as the evaporating dish with round bottom.

Before finally fixing the standard shapes and sizes, it is desirable to have expressions of opinion on my proposals from consumers, in particular as to whether or not a still further restriction of the types is possible. Is it necessary to produce high, squat (Griffin beakers) and conical beakers, or is not the Griffin beaker alone sufficient? Must flasks be made with welted and with turned-down edges, or is it not sufficient to have those up to 1 litre with welted necks and above that only those with turned-down edges? Are the long, round Kjeldahl flasks which I have proposed, and the squat, conical beaker the most suitable, even if the latter is still necessary, or are the longer, flat Kjeldahl flask and the slender, conical beaker to be preferred?

Griffin Beakers.

Capacity	50	100	150	250	400	600	800	1000	c.c.
Height	55	65	75	85	105	120	135	145	mm.
Width	45	50	55	65	75	85	95	105	mm.
Capacity	1 $\frac{1}{2}$	1 $\frac{1}{2}$	2	2 $\frac{1}{2}$	3	4	5	—	litres
Height	160	175	185	205	230	250	280	—	mm.
Width	110	120	130	140	145	150	160	—	mm.

Tall Beakers.

Capacity	50	100	150	200	300	400	500	600	800	c.c.
Height	65	80	90	100	120	130	140	150	165	mm.
Width	40	45	50	55	60	70	75	80	85	mm.
Capacity	1	1 $\frac{1}{2}$	1 $\frac{1}{2}$	2	2 $\frac{1}{2}$	3	4	5	—	litres
Height	185	205	210	235	250	280	290	320	—	mm.
Width	90	95	100	110	120	130	140	155	—	mm.

Squat, Conical Beakers.

Capacity	50	100	150	250	500	750	1000	c.c.
Smallest diam.	32	39	49	54	61	66	70	mm.
Greatest diam.	43	53	59	69	87	100	110	mm.
Total height	65	70	80	115	140	155	185	mm.

Erlenmeyer Flasks.

Capacity	25	50	100	150	200	300	500	750	c.c.
Outside neck width	20	20	20	25	25	25	30	30	mm.
Total height ...	70	80	100	120	125	145	185	205	mm.
Greatest diam.	35	45	60	65	75	80	90	100	mm.
Capacity			1	1½	2	3	4	5	litres
Outside neck width			30	40	40	40	50	50	mm.
Total height			220	250	275	320	340	390	mm.
Greatest diam.			105	115	130	145	155	175	mm.

*Flat Bottom Flasks with Turn-down Edges.**Flat Bottom Flasks with Weltd Necks.*

Capacity	25	50	100	150	200	300	500	750	1000	c.c.
Outside neck width	20	20	20	25	25	25	30	30	30	mm.
Total height	70	80	100	120	125	145	185	205	220	mm.
Diam. of sphere ...	42	50	61	69	77	86	105	116	128	mm.
Capacity	1½	2	3	4	5	6	8	10	—	litres
Outside neck width	40	40	40	50	50	50	70	—	mm.	
Total height	250	275	320	340	390	410	430	490	—	mm.
Diam. of sphere ...	148	168	190	205	220	240	260	280	—	mm.

Round Flasks, Long, Weltd, or Turned-down Rims.

Capacity	25	50	100	150	200	300	500	750	1000	c.c.
Diam. of sphere ...	42	50	61	69	77	86	105	116	128	mm.
Total height	100	120	145	160	175	205	245	275	290	mm.
Diam. of neck	20	20	20	25	25	25	30	30	30	mm.
Capacity	1½	2	3	4	5	6	8	10		litres
Diam. of sphere	148	168	190	205	220	240	260	280		mm.
Total height	325	335	380	420	450	460	530	550		mm.
Diam. of neck	40	40	40	50	50	50	50	70		mm.

Wide-necked, Flat Bottom Flasks; Wide-necked, Round Flasks.

Capacity ...	50	100	150	250	500	750	1000	c.c. 1½	2	3	litres
Diam. of neck.....	30	30	30	45	45	45	65	65	65	65	mm.
Diam. of sphere ...	55	63	70	85	105	116	128	150	165	190	mm.
Total height	80	90	110	125	150	170	200	215	240	270	mm.

Distilling Flasks.

Capacity	508	100	150	200	300	500	750	1000	c.c.
Diam. of sphere	50	61	69	77	86	105	116	128	mm.
Total height	120	145	160	175	205	245	275	290	mm.
Diam. of neck	20	20	25	25	25	30	30	30	mm.
Diam. of tube	6	7	7	8	8	8	9	10	mm.
Length of tube	8	8	8	12	14	16	18	20	cm.

Kjeldahl Flasks, Round, Long.

Capacity	50	100	200	300	500	800	1000	1500	2000	c.c.
Total height	185	220	260	280	300	340	350	370	390	mm.
Diam. of sphere ...	50	56	71	80	95	115	125	145	150	mm.
Diam. of neck	20	20	25	25	30	30	30	40	40	mm.

Measuring Flasks.

Capacity	50	100	200	250	500	1000	2000	c.c.
Outside neck width.....	12	14	15	19	20	22	29	mm.
Total height	130	160	190	210	250	310	350	mm.
Greatest diam.	46	57	71	76	95	122	153	mm.

Measuring Cylinders.

Capacity	50	100	200	250	500	1000	c.c.
Diameter	27	36	40	43	52	60	mm.
Total height	170	230	270	290	380	520	mm.

Flat Evaporating Dishes.

Capacity ...	5	10	30	90	150	300	500	1500	2500	5000	c.c.
Diameter ...	18	20	30	45	50	65	80	100	130	150	mm.
Outside measurement at the edge.	40	50	60	80	100	125	150	200	250	300	mm.

Crystallising Dishes.

Capacity ...	15	30	60	150	300	500	750	2000	3000	4500	c.c.
Outside diam.	40	50	60	80	100	125	150	200	250	300	mm.
Height.....	25	30	35	45	60	65	75	90	100	110	mm.

Watch Glasses.

Outside measurement	40	50	60	80	100	120	140	mm.
	160	180	200	220	240	—	—	mm.

Reagent Bottles.

Capacity	50	100	250	500	1000	2000	3000	5000	c.c.
Diam. of neck	17	18	22	23	30	35	40	45	mm.
Greatest diam.	43	53	67	83	108	140	155	175	mm.
Total height	80	100	135	160	190	230	270	310	mm.

Wide-mouth Bottles for Solid Reagents.

Content	50	100	250	500	1000	c.c.
Diam. of neck	27	36	38	48	60	mm.
Diameter	43	52	68	80	105	mm.
Total height	95	100	130	160	210	mm.

Retorts.

Content	50	100	250	500	750	1000	c.c.
Diam. of sphere	55	70	85	100	120	130	mm.
Length of still	180	190	250	275	330	350	mm.
Diam. of still at end	12-14		15-17	15-18	17-20	20-25	mm.
Diam. of stopper	15-18			18-22	23-25		mm.

Receivers.

Content	50	100	250	500	750	1000	c.c.
Diam. of neck	22	24	30	34	36	40	mm.
Diam. of sphere	—	62	82	100	116	129	mm.
Total length	—	150	190	255	275	295	mm.

(Translation in full.)

J. R. C.

IV.—Decorated Glass.

318. The Preparation of Metallic Mirrors, Semi-transparent and Transparent Metallic Films and Prisms by Distillation. O. STUELMANN, jr. (*J. Optical Soc. Amer.*, 1917, 1, 78).—The essential part of the apparatus consisted of a wire heated to incandescence by means of an electric current, while the object to be covered with the metallic surface was placed below. If the air in the vessel containing the apparatus were evacuated, the metal vaporized and condensed upon the object. The wire was moved with uniform speed across the object, and a uniform coat of metal was thus deposited. The thickness of the film produced depended on the time of deposition, the temperature of the wire, the molecular weight of the vapour, and its vapour pressure. Any material could be coated provided it did not possess a pronounced vapour pressure at the ordinary temperature and a pressure of 0.002 mm. of mercury. To facilitate the deposition of opaque surfaces of silver, it was found practicable to use an alloy of 15 per cent. platinum and 85 per cent. silver. With this, the silver could be evaporated without melting the wire.

The method required that the surfaces shall be free from grease, but the elaborate cleaning necessary for chemical deposition is stated to be avoided. The deposit could be made on any material, even on paper, and its thickness was well under control. It did not need to be polished before use. A prism could be coated by allowing the wire to remain at rest. The method was superior to cathodic sputtering in that the particles did not penetrate into the glass, and so render the surface optically useless. J. R. C.

319. Protection of Silvered Surfaces. F. KOLLMORGEN (*J. Optical Soc. Amer.*, 1919, 2—3, 16).—To protect silvered surfaces against atmospheric conditions, the author used a mixture of one part of Lastina lacquer and two parts of commercial thinning material. If only a thin layer of this were applied, the lacquer showed interference colours, and, at first, a thicker layer dried in waves and streaks. This difficulty was overcome by centrifuging the mirror during the drying. After a year's use in submarine periscopes the mirrors had shown no appreciable decrease in efficiency and no appearance of tarnishing. The lacquer was soft and easily scratched, and dust must be removed by a camel's-hair brush. Attempts to harden it by baking had not been successful.
J. R. C.

V.—Optics and Optical Instruments.

320. The Reflected Images in Spectacle Lenses. W. B. RAYTON (*J. Optical Soc. Amer.*, 1917, 1, 137).—Under certain conditions spectacle lenses caused stray patches of light and more or less distinct images to lie superimposed upon the field of view. The author analysed the effect of shape and power of the lens and derived formulæ for calculating the position of the images.
J. R. C.

321. The Astigmatism of Lenses. C. W. WOODWORTH (*J. Optical Soc. Amer.*, 1917, 1, 108).—The author defined astigmatism as the asymmetry of the wave-front due to an eccentric stop, the eccentricity being in most cases relative to the object and dependent on its distance from the optical axis. This definition considers that astigmatism is not simply the condition opposed to homocentricity; a multicentric bundle is also not astigmatic if it is symmetric.

To clarify the situation, the author studied, with the aid of diagrams, the shapes assumed by the wave-front while passing through the focal region after refraction at a single spherical surface. In one case the section of the beam before refraction was circular and concentric with the optical axis, and in the other it was circular but eccentric with respect to this axis. The phases through which the wave-front passed in the focal region were examined. It was shown that every item of astigmatism could be worked out on the meridional plane, and for the purposes of lens calculation it was sufficient to compare the extreme ray on this plane with the chief ray to secure a true measure of the nature and the extent of astigmatism of a lens or optical system.

J. R. C.

322. The Design of Lenses for Aerial Photography. C. W. FREDERICK (*J. Optical Soc. Amer.*, 1919, 2—3, 34).—An account of the development of such lenses in America during the war. Those used were of the four-piece, air-spaced type, of speeds from $f/4.5$ to $f/6.0$, and focal lengths from 10 to 20 inches. The author stated that the correction for spherical and chromatic aberration was not of very great importance, owing to the impossibility of focussing the camera properly. Coma also need only be reasonably well eliminated, though since it was easy to do this in a four-piece lens, the sine condition was satisfied within 0.3 mm. for all rays. It was important to avoid distortion, and the correction was reduced to less than 0.01 mm. at the extreme corner of the plate. The most difficult and most important of all corrections was held to be that for astigmatism. This was reduced to 0.5 per cent. of the focal length. All the lenses made were individually measured and adjusted upon the bench by changing the air spacing of the components.

J. R. C.

323. Compound Lens Systems. T. T. SMITH (*J. Optical Soc. Amer.*, 1917, 1, 113).—The author proposed a new solution of the problem of the formation of an image by two or more refractions. Two methods were described for the calculation of the constants in the equation, $u_{m+1} = (A_m u_m - B_m) / (C_m u_m - E_m)$, representing the case of m refractions.

J. R. C.

324. Symbols and Designations for Geometrical Optics. H. KELLNER (*J. Optical Soc. Amer.*, 1917, 1, 40).—An attempt to bring about a uniform system of designation. The author suggested that roman capital letters should be reserved for points, lower-case italics for magnitudes, italic capitals for reciprocals, and Greek lower-case letters for angles. Two exceptions were justified by universal usage, these being λ for the wave-length and Δ for the optical interval. The same letter or designation should be used for similar points or magnitudes on both sides of a refracting surface. Those on the emergent side of the surface were distinguished by a ', for example, f and f' are the focal lengths.

For sign conventions, the original should be referred to. (Explanatory figures are given.) The designations proposed, it was stated, would be used throughout the *Journal* of the American Optical Society.

J. R. C.

325. The Optical Properties of Light Filters. C. E. K. MEES (*J. Optical Soc. Amer.*, 1917, 1, 22).—The optical effects produced by the use of colour filters might be divided, according to the author, into two classes. The first included those resulting from the use of a theoretically perfect filter, that is, a filter of which the faces were plane parallel and one which was free from strain. The effect of such a filter on the aberrations of a lens system and on the size of the image produced was discussed. It caused a species of spherical aberration all over the field, and the

image was curved backward and slightly enlarged. The magnitude of the effects depended on the thickness of the filter and on the refractive index of the glass for different colours. The last factor would cause some chromatic aberration; this was shown, however, to be exceedingly small, and all the errors introduced were obscured by those of the second class arising from imperfections occurring in the filters. These were due to errors of surface and to the fact that the faces were not strictly plane parallel. The investigation of the effects produced could only be performed experimentally. The effect of a filter which showed strain and cylindrical curvature was illustrated by photographs. Good filters could not be tested by a coarse grid such as was used in this case, and a special test object was accordingly designed for observing the definition given by filters and for measuring their effect on the focal length of a lens. An instrument was also designed for measuring directly the difference in the size of the images produced by a set of three-colour filters, which differed slightly in thickness and also in focal length, due to cylindrical or spherical curvature of the faces. In a particular case where the image was 189 mm. long, a difference of thickness of 0.76 mm. produced an enlargement of 0.061 mm. When the difference in focal length of the filters was 37 mm. in 1500 mm., the difference in size of the images was 0.1 mm.

J. R. C.

326. A Compensating Filter in Spectroscopy. M. B. HODGSON and R. B. WILSEY (*J. Optical Soc. Amer.*, 1917, 1, 86).—An extension of a method described by Luckiesh to obtain uniform photographic intensity throughout the spectrum, using a light source yielding a continuous spectrum. The spectrum was first photographed upon the particular brand of plates selected, exposing through the glass to avoid re-focussing in subsequent exposures. After development, this negative was used, with its emulsion in contact with that of the unexposed plate, as a compensating filter.

The use of such a filter was theoretically investigated by the authors, and they found that four conditions were necessary for success, namely: (1) The filter and the print plate must be made on plates of the same emulsion. (2) The filter must be neutral in colour. (3) All densities in the filter must lie on the straight-line portion of the characteristic curve. (4) The straight-line portion of this curve must have a slope of 1 for all wave-lengths. To secure a silver deposit of neutral absorption, elon developer was used, but it was stated that ferrous oxalate developer was even better. Examples are given of the preparation and use of the compensating filter described.

J. R. C.

327. Lippmann Colour Photographs as Sources of Monochromatic Light in Photometry and Optical Pyrometry. H. E. IVES (*J. Optical Soc. Amer.*, 1917, 1, 49).—The Lippmann colour photograph consists essentially of a fairly transparent gelatin

film in which lie thin layers of reflecting material. On illuminating such a film by white light, the reflected light is monochromatic, the wave-length varying with the angle of incidence. The mode of preparation of these films was described by the author. The paper also described two uses of the apparatus as sources of monochromatic light. The first use was as a substitute for coloured solutions or spectroscopic devices in the Crova method of eliminating colour difference in the photometry of two illuminants having continuous spectra. The theory of this method was stated, and the construction and calibration of a special eyepiece, containing the Lippmann film, for the Lummer-Brodhun photometer head described. The peculiar applicability of the film to the Crova method was illustrated by spectrographs, and a table of equivalent wave-lengths of several illuminants was given.

Another set of spectrographs illustrated the possible use of the film in optical pyrometry. The purity of the red light reflected from a film was greater than that transmitted by the best red glass, but the preparation of an optical pyrometer incorporating one of these films had not yet been undertaken. Trials with the optical parts of a Holborn-Kurlbaum instrument, however, showed that the construction could be carried out.

J. R. C.

328. A New Type of Comparison Photometer. P. G. NUTTING (*J. Optical Soc. Amer.*, 1917, 1, 83).—A description of an instrument designed to replace the Martens photometer, but the use of calcite and of the polarisation principle were avoided in its construction. The light beam was divided and recombined by means of biprisms, and the density controlled in a known manner by means of a precision iris diaphragm or a neutral grey wedge inserted at the precise apex of the field pencils. The scale employed was empirical and very nearly linear. The chief advantage of this form of comparator was stated to be its freedom from errors due to polarisation in the light to be measured.

J. R. C.

329. Photo-electric Spectrometry by the Null Method. K. S. GIBSON (*J. Optical Soc. Amer.*, 1919, 2—3, 23).—A detailed description of apparatus suitable for the measurement of spectral transmissions.

Light from a source giving a continuous spectrum was analysed by a constant deviation spectroscope, the eyepiece of which was replaced by a second slit. The approximately monochromatic light issuing from this slit was received by a Kunz potassium hydride photoelectric cell, and the current through the cell was balanced by varying the distance of the source from the spectroscope against that from another cell which was rendered active by a constant illumination. The balance was obtained with and without the specimen (the transmission of which was to be examined) interposed between the source and the spectroscope. The ratio of the squares of the two distances at which balances were

obtained determined the transmission of the specimen. The objections to which the photoelectric method of spectrometry is exposed were, according to the author, removed by this null method.

J. R. C.

330. A Photochemical Theory of Vision and Photographic Action. P. G. NUTTING (*J. Optical Soc. Amer.*, 1917, 1, 31).—In this paper the known general laws of photochemical response to light were summarised and interpreted, and a general theory based on the law of molecular opacity outlined.

J. R. C.

331. The Absorption of Ultra-violet and Infra-red Radiations by Glasses. A. W. SMITH and C. SHEARD (*J. Optical Soc. Amer.*, 1919, 2—3, 26).—Twenty-nine glasses, designated variously as Euphos, Amethyst No. 1, Dark Amber, and so on, no compositions being given, were examined by the authors. A photograph, taken with a Féry quartz spectrograph, registered the transmissions in the ultra-violet. As the specimens were of different thicknesses, and the source of light (a condensed spark between electrodes of iron and an alloy of cadmium, aluminium, magnesium, and zinc) was unsteady, the results were not comparable. The "amethyst" glasses transmitted farthest into the ultra-violet, their limit being about 0.319μ . Noviol 6 was the least transparent, absorbing all rays beyond 0.5μ .

A Hilger infra-red spectrometer was used for the transmissions in the infra-red region. Transmission curves ranging from $\lambda=0.75\mu$ to 4.75μ were given for all the glasses except one, namely, "Pfund" glass, which absorbed the infra-red to such an extent that no transmission was measurable. A Nernst glower was used as the source of the radiations. All the curves were similar in that a large increase in the absorption took place at $\lambda=3\mu$ until it was nearly total at $\lambda=4\mu$. Near the visible region, many of the glasses showed selective absorption.

J. R. C.

332. The Effects of Treating Glass Surfaces with Certain Lubricants. W. SHACKLETON (*Trans. Optical Soc.*, 1919, 20, 155).—Tests were made with three lubricants, namely, Lasin, Everclear, and Nepheless, in order to determine which was the most effective in preventing "steaming" of the glass surface. The temperature at which the untreated glass was obscured was 19° , and this was reduced to -6° , -8° , and -10° , respectively, after the lubricant had been applied. Nepheless, a preparation made by the author, consisted of glycerine with 20 per cent. of sodium stearate added.

J. R. C.

VI.—Illumination and Illuminating Ware.

333. The Fundamental Principles of Good Lighting.
 P. G. NUTTING (*J. Frankland Inst.*, 1917, 184, 287; from *J. Optical Soc. Amer.*, 1917, 1, 134).—This paper, based largely on experimental work on vision, was an attempt to outline the fundamental principles upon which the illuminating engineer might determine in any particular case the proper illumination to secure the desired quality of seeing at a minimum of expense. The first fundamental relation was that between sensation and light stimulus in the steady state. Four kinds of sensibility were defined by the author and measured. (1) Threshold sensibility, the reciprocal of the brightness just perceptible corresponding with each brightness of sensitising field viewed. (2) Photometric sensibility, the reciprocal of the relative difference in brightness of two adjacent fields when that difference is barely perceptible. (3) Flicker sensibility, measured by the just noticeable difference in brightness of two lights occupying the same field of view alternately. (4) Glare sensibility, measured in terms of a field just bright enough to appear glaring. A table of these sensibilities when the field brightness varied from 0.000001 to 10,000 millilamberts was given. It was found that the logarithm of the glare limit was a linear function of the logarithm of the field brightness, such that $G=1700B^{0.32}$. Further, except at the highest intensities, the threshold sensibility $T=125B^{0.66}$. $\log B/T$ appeared to reach a maximum when B was about 1000 millilamberts, after which it rapidly decreased. The discrimination factor varied irregularly. $\log B/\delta B$ was approximately linear in the region from 10^{-4} millilamberts to 1 millilambert, and approximately constant thence up to 1 lambert, when it commenced to decrease.

The author divided the necessary requirements which must be provided for by proper illumination into three classes: (1) in which mere outlines of large objects were to be observed, as in riding along a country road at night; (2) where the outlines of small objects, as in reading, must be clear; (3) embracing sewing and arts and crafts, where critical judgment required was to be expressed by the eye. For class (1) little illumination was required, but glare should be carefully avoided, on account of the sensibility of the eye at this level. In class (2), the specification of a minimum discrimination factor, such as 0.5, was regarded as reasonable; brightnesses ranging from 1 to 250 millilamberts without glare within the field of view were to be chosen. For class (3), it was difficult to prevent eyestrain. The most suitable lighting was limited to nearly a single direction, and that quite elevated.

Ideal lighting was not necessarily that under which the eye was subjected to no glare or no strain whatever, but that which made possible the use of the eye under the most favourable all-round conditions.

J. R. C.

334. A Mathematical Study of a Headlight Beam. O. E. CONKLIN (*J. Optical Soc. Amer.*, 1917, 1, 155).—The author assumed that the headlight had a parabolic reflector and that the source of light was of finite dimensions. On these assumptions, the direction after reflection of the ray proceeding from any point of the source and striking any point on the paraboloid was determined. The formulæ derived for this direction were applied to a study of the effect of the shape of the light source on the shape of the beam. Two particular cases were considered, namely, when the filament used as light source was linear and when it was V-shaped. A satisfactory headlight should have a wide, horizontal spread in order to illuminate the roadsides, and a limited vertical spread in order to avoid glare. It was shown that the beam from the linear filament had the advantage in both respects. Another advantage lay in the simple structure of its beam, which should make it possible to design more efficient headlight lenses than those in use with the V-shaped filament. The author stated that only a small part of the difficulty encountered in producing a satisfactory headlight beam could be attributed to the inaccuracies of the reflector.

J. R. C.

335. The Measurement of Reflection and Transmission Factors. M. LUCKIESH (*J. Optical Soc. Amer.*, 1919, 2-3, 39).—The author reviewed the conditions which influence the values of these factors determined by experiment. In the case of the reflection factor, the value obtained depended on the character of the reflecting surface, the location of the source of illumination, the solid angle subtended by the light source, the spectral character of the illuminant, and the method of photometry. He concluded that perfectly diffused illumination best met the requirements; that is, the light source should be of uniform brightness and should subtend an entire hemisphere. A simple apparatus which satisfied these requirements, and could be used with an ordinary photometer, was described.

In addition to the influences mentioned above, the transmission factor depended, in case one side of the specimen was rough, upon the direction in which the light passed through it. To illustrate this, a table was given of the transmission factors of glasses under various conditions. One side of the specimen was sand-blasted, etched, peddled, coarse-ribbed, fine-ribbed, or wavy-ribbed. The transmission factor was smaller when the smooth surface faced the light source, and the difference was greatest for a narrow beam of light, diminishing as the illumination became more diffuse.

J. R. C.

336. Lamp Manufacture. W. L. VAN KEUREN. General Electric Co. (U.S.A. Pat., December 23rd, 1919, No. 1326121. Filed June 11th, 1918, No. 239480).—In the machine covered by this patent, an electric lamp bulb is held with its open

end vertically downwards in a rotatable holder. The stem is held

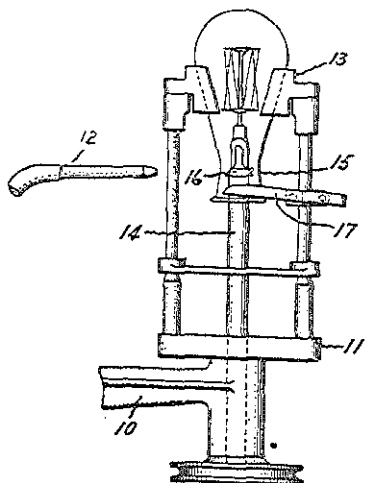


FIG. 152.

inside the lamp and is rotated round the same axis and at the same speed as the bulb. The bore of the neck, 15, Fig. 152, of the bulb is considerably greater than the diameter of the flare, 16, of the stem. A fork, 17, is pivotally mounted on the head by means of an adjustable block, 19, in such a position that the free ends fit round the neck of the bulb, and exert a pull due to their weight, tending to elongate the neck of the bulb. As the glass is rotated in front of the burner, 12, a ring of glass is heated and softened, so that the fork pulling downwards causes it to decrease in diameter until the walls engage with the edge of the flare and become sealed to it. The flames continue

to heat the glass until the waste portion below the flare has been drawn off.

As the pulling down fork rotates with the bulb, it serves to hold it exactly concentric with the stem, and as there is no relative angular movement between the flared end and the fork, no twisting of the hot neck is caused.

In making tipless lamp, the flare has a notch in it, and this is kept open during the sealing-in operation by a pin fitted on to the conical surface of the holder, so that when the lamp is removed from the sealing-in machine there is an exhaust hole of the size of the pin through the flare.

S. E.

VII.—Fuels, Refractories, and Furnaces.

337. An Improved Gas Producer. C. W. LUMMIS (U.S.A. Pat. No. 1305913, June 3rd, 1919. Filed January 27th, 1915. No. 4650).—A gas producer constructed of an iron shell with a firebrick lining has a water-jacket surrounding the hottest zone of the producer, the firebrick lining at this point being comparatively thin. The object is to protect the brick from fusion and at the same time to prevent the adjacent portions of the feed bed being cooled to such a degree as to impair the gasifying operation in these parts of the fuel bed. In the construction shown in the drawings, the upper part, 2, of the producer, which is supported by standards,

2', is separate from the lower or fuel-containing part, 5, so that the fuel section may be rotated if desired without interfering with the arrangement of the gas flues, 4. The lower section consists of a flared iron shell, 5, lined with firebrick, 7, the upper part, 8, of this lining, which is situated in the zone of greatest heat, being about one-half the thickness usually employed. It is stated that a

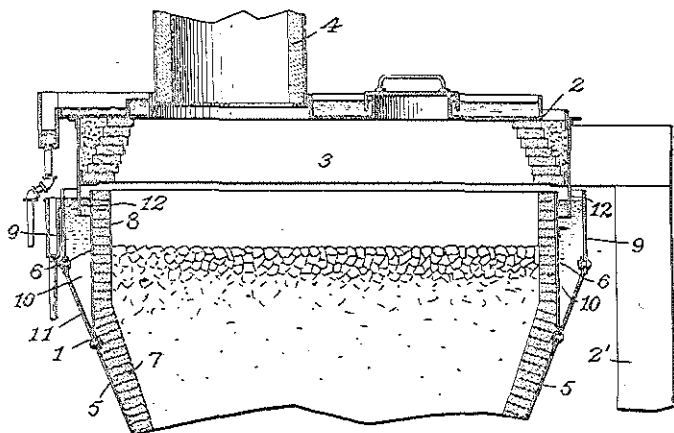


FIG. 153.

thickness of $4\frac{1}{2}$ inches has been found suitable with the ordinary grade of firebrick. Around this zone, the iron shell is formed as an open trough, 10, which forms a jacket for the constant circulation of cooling water, and also receives a depending portion, 12, of the shell of the upper section, 2, and thus forms a seal to prevent the escape of gas. It is stated that the water-jacket cools the lining below the point of fusion, yet the lining prevents excessive cooling of the neighbouring portions of the fuel bed. G. D.

338. The Selection of Refractories for Industrial Furnaces. W. F. ROCHOW (*J. Ind. Eng. Chem.*, 1919, 11, 1146).—The author pointed out that economy in the use of refractories was governed largely by the selection of the class of material best suited for the desired purpose, the quality of the brick, and the design of the furnace. He also emphasised the importance of good bricklaying, care in storing and handling, and proper manipulation and control of the furnace. The proper material to use would be determined by careful study of the properties and of the actual working conditions, together with practical trials. A superficial consideration of these factors, however, was not enough, for economies have resulted in some instances from the use of refractories the chemical composition and physical properties of which would indicate that they were entirely unsuited. Thus, in the

glass industry, silica bricks were used almost exclusively in the roofs of tanks and pot furnaces, although subjected to the action of alkaline vapours. In this case, other refractories which might resist the chemical action better had not the same combination of other desirable properties which made silica superior.

In this paper the author dealt principally with silica and magnesia refractories.

Silica Refractories.—The main advantages were their high thermal conductivity, mechanical strength, and resistance to abrasion at furnace temperature, thermal expansion, spalling tendency, and high softening and fusion point. Together with its other properties, the good conductivity of silica rendered it the best suited material for the construction of the greater part of by-product coke ovens and other furnaces in which heat must be transferred through the refractory. Advantage of its conductivity was also taken in enamelling furnace muffles. In this instance, silica was not confined entirely to the muffle, but was also used in the combustion chamber, in which type of furnace the proper control of the temperatures on heating and cooling was important to avoid danger from spalling. With regard to thermal expansion, it was interesting to note that most of the expansion occurred over a narrow range and at comparatively low temperatures, the critical range being up to about 500°.

In spite of the high thermal conductivity, its good mechanical strength at high temperatures made it possible to insulate silica bricks under very difficult conditions. In contradistinction to fire-clay and magnesia refractories, there was only a narrow temperature range between the softening and fusion points of silica, and hence no deformation occurred up to the melting point. Insulation with kieselguhr had been found to afford appreciable saving in silica bricks used in arches and subjected to high temperatures.

For a high-grade silica brick, Nesbitt and Bell secured an average crushing strength of 1831 lb. per sq. inch at 1350°. The same investigators found that the best clay brick had a crushing strength of 1289 lb. per sq. inch at 1350°. From the load test of the American Society for Testing Material, most fireclay bricks settled somewhat under a pressure of 25 lb. per sq. inch at 1350°, while good silica bricks remained rigid under the same load at 1500°. In selecting refractories, this test was of considerable value, but the conditions, when applied industrially, were seldom as severe as the load test, because only a small portion of the brick was exposed to the intense furnace heat, the remainder of the brick actually supporting the load being comparatively cold.

The specific gravity, in addition to chemical analysis and the load, fusion, and spalling tests used for determining the quality of silica bricks, might be used as a test of the extent to which the permanent expansion should be carried in the first firing. D. W. Ross suggested that a specific gravity of 2.38 might be taken as the upper limit for well-burned brick of the Medina quartzite of Pennsylvania.

Much information of practical value could often be gained by examining the remaining portion of the brick after long use.

Magnesia or Magnesite Refractories.—The author stated that the presence of iron in any proportion lowered the fusion point, but in quantities of from 4.5 to 8 per cent. of ferric oxide it widened the range of vitrification and developed good bonding properties at furnace temperatures. At high temperatures, magnesia bricks were not mechanically strong or resistant to abrasion. They expanded considerably, with the maximum expansion occurring at about 1350°, but on account of this high thermal expansion they had a tendency to spall when heated or cooled too rapidly.

In some cases, it has been found that the use of metal-encased magnesia brick in place of the ordinary magnesia and silica brick has proved an economy. At the temperature of the furnace the steel container melted back 1 or 2 inches from the exposed surface and impregnated the dead, burned magnesite which it enclosed. Thus the surface became practically jointless, which factor, together with the more open structure of this type of material, reduced the spalling tendency and made it considerably less than that of magnesia or silica brick. The stiffening effect of the unfused metal also helped to reduce spalling to a minimum. This brick had been found satisfactory in the back walls, bulk-heads, and gas ports of basic open-hearth furnaces, and in the side walls of electric steel-melting furnaces.

In addition to the physical and chemical properties of refractories, the design of the shape used was worthy of careful attention; difficult and intricate shapes should be avoided as much as possible.

C. M. M.

339. Superior Refractories. Ross C. PURDY (*J. Ind. Eng. Chem.*, 1919, 11, 1151).—Only such materials as pure silicon carbide, fused alumina, sintered magnesia, fusel spinel, crystallised *sillimanite*, and calcined zirconia would meet the excessively high temperature requirements, and have at the same time the many other desired heat, strength, and dielectric properties. Which of the above-mentioned refractory materials would be most suitable in a given case would be much more dependent on physical than on chemical conditions, and the desired physical properties could be obtained with much greater certainty with such refractories than with such materials as clay, bauxite, or calcined magnesite, in which the physical-chemical reactions were only partially completed in the fabricated refractory product.

The author stated that there need be either no bonding material used or but a small per cent. of very fusible material, such as silicate of soda, very fusible clay, or stoneware glazes, in the cases of the superior refractories under discussion.

C. M. M.

340. Relative Volatilities of Refractory Materials. W. R. MOTT (*Trans. Amer. Electrochem. Soc.*, 1918, 34, 255).—Using the electric arc, the author determined the volatilities of

metals, carbides, nitrides, fluorides, chlorides, sulphides, and oxides. Ten different methods of measuring the volatilities were described, each method having its particular sphere of usefulness. The boiling points determined were compared, for standardisation purposes, with the boiling points of tungsten (taken as 6000°) and iron saturated with carbon (taken as 3500°), the temperature of the positive crater of the carbon arc being taken as 3700° . The distillation order of metals not uniting with carbon was found to be:—cadmium, zinc, thallium, lead and bismuth, antimony, silver, tin and copper, and gold. With the exception of manganese, the metals of the iron group did not separate well on distillation in the arc.

The distillation method was applied to mixtures of various metals with half a gram of iron, the metals used having higher boiling points than that of iron. Various amounts of the metals were used, and the following table gives some of the average total times for complete volatilisation of the test substances after the iron had been volatilised:—

Weight in mg. of element used.	Times (in minutes) required for various elements.						
	W.	Ta.	Mo.	Os.	Ir.	Pt.	V.
64.0	95.0	22.0	27.0	12.0	15.0	8.0	6.0
32.0	46.5	15.75	16.0	10.25	11.0	6.0	5.0
16.0	24.0	10.7	9.0	8.0	7.0	4.0	3.0
8.0	17.0	8.0	8.0	6.0	4.5	3.0	1.25
4.0	15.0	8.0	5.5	4.0	3.5	1.0	0.25
2.0	12.0	7.0	4.5	2.5	2.5	0.5	—
1.0	10.5	6.5	3.5	2.5	2.0	0.33	—
0.5	8.0	6.5	—	—	—	—	—
0.0625	4.0	5.7	—	—	—	—	—

From the consideration of all the results by various methods and the published results of other workers, the following series of boiling points was derived:—

Tungsten (carbide ?)	6000°	Platinum	4050°
Tantalum (carbide ?)	5500	Rhodium	4000
Zirconium (carbide)	5100	Vanadium carbide	3900
Thorium carbide	5000	Chromium carbide	3800
Yttrium carbide	4600	Aluminium oxide	3700—3800
Molybdenum carbide	4500	Carbon (sublimes)	3700
Osmium	4450	Magnesium oxide	3600
Iridium	4400	Silica	3500
Thorium oxide	4400	Calcium oxide	3400
Zirconium oxide	4300	Chromium oxide (Cr_2O_3)	3000
Yttrium oxide	4300	Titanium oxide—below	3000
Titanium carbide	4300	Barium oxide	2000

The oxides and carbides of zirconium, thorium, titanium, rare earths, and alkaline earths had boiling points 1000° to 2000° higher than those of the elements themselves. Aluminium oxide boiled at 3700° , whilst aluminium boiled at 1800° . The volatility of the oxides took the following approximate order:— K_2O , Na_2O , Li_2O , V_2O_5 , B_2O_3 , BaO , SrO , MnO , FeO , CoO , NiO , Cr_2O_3 , TiO_2 .

V_2O_4 , SiO_2 , CaO , MgO , $(xCaO, SiO_2)$, $(xBaO, yAl_2O_3)$, Al_2O_3 , TiO_2 , V_2O_5 , ZrO_2 , ThO_2 .

A summary of references was given relating to data bearing on the volatilities of materials. In an appendix the author gave a list of ratios obtained by dividing the boiling-point temperatures by the melting-point temperatures, both being calculated on the absolute scale. The ratios so obtained were very similar for elements of the same periodic group, and corresponding peculiarities were found in each group. The alkali group gave the highest average ratio, about 3.3. The general ratio was about 1.8, and, using this ratio, the author calculated a large number of boiling points.

F. W. H.

341. Melting Points of Refractory Materials. C. W. KANOLT (*Trans. Amer. Cer. Soc.*, 1913, 15, 167).—In the case of complex substances, such as fire-bricks, a true melting point is not obtained, since several anisotropic phases may exist all differing in composition from the isotropic phase produced by fusion. The lowest temperature at which a small piece of brick could be seen to flow was taken as the melting point. The author determined the melting points of many samples of fire-bricks, using an Arsem graphite resistance vacuum furnace and a Morse optical pyrometer. In order to distinguish the sample and watch it during heating, it was placed slightly below the hottest part of the furnace. The results obtained are given in table I.

TABLE I.

Material	No. of samples.	Temperature of visible flow.
Fireclay-brick	41	1555–1725° (mean 1649°)
Bauxite-brick	8	1565–1785°
Silica-brick	3	1700–1705°
Chromite-brick	1	2056°
Magnesia-brick	1	2165°
Kaolin	1	1735–1740°
Bauxite	1	1820°
Bauxite clay	1	1795°
Chromite	1	2180°

In the case of fire-bricks, lumps of foreign matter could be seen melting at a temperature different from that of the mass.

Determinations were also made on the pure refractory oxides, precautions being taken to use crucibles which would produce no contamination during heating, and to overcome the interference of the pyrometer readings caused by the evolution of dense vapour from the oxide.

The results of the work on MgO, Al_2O_3, Cr_2O_3 appear in table II. Many of the bricks tested above were also tested under load. Usually there was not much relation between failure under load and melting point. The relative importance of the tests depended on the conditions obtaining in the ultimate use of the brick.

TABLE II.

Material.	Individual determination.	Weight.	M. p. under load.
Cr_2O_3	1990°	3	1990°
	1991	1	
	1982	1	
	1979	2	
	2000	3	
Al_2O_3	2045°	3	2049°
	2053	1	
	2053	2	
	2041	2	
	2055	3	
	2046	2	
MgO	2808°	3	2800°
	2780	2	
	2818	3	
	2771	1	
	2799	2	
	2799	3	

V. D.

342. The Humidity System of Drying. E. D. GATES (*Trans. Amer. Cer. Soc.*, 1909, 11, 375).—In order to eliminate the unequal shrinkage, and the resulting cracking and warping of terra-cotta ware, on drying, the author introduced live steam into the driers, while raising the temperature, and the humidity was kept so high that no moisture could be absorbed by the air from the ware. Thus no drying could take place until the humidity was allowed to fall, and this was avoided until the ware had assumed the temperature of the drier. Then the steam was shut off and air passed through the steam coils and drier to carry off the moisture from the ware. The steam used helped to heat the chamber.

The author described the arrangement of the coils in the driers, where the humidity was maintained at 80 per cent. until the ware was heated, then, after several hours, the amount of steam injected was gradually decreased and air allowed to enter, when drying began.

From many and varied experiments, the author concluded that:—

(1) A clay body can be heated more quickly and safely in a high humidity atmosphere than was possible with a low humidity, and the body could be raised to a higher temperature.

(2) Actual drying started sooner if the piece were preheated.

(3) Drying could be controlled by regulating the humidity, and took a much shorter time than ordinarily.

(4) Some types of bodies expanded and cracked if heated too rapidly. Heating was safer and quicker with a clay of larger water content than with a stiff sample, suggesting that the clay must be properly aged and worked in order to give successful drying by this method.

V. D.

343. Regenerating Chambers. F. J. DENK (*National Glass Budget*, 1919-20, 28, 1, and 1919-20, 29, 1).—Owing to the low heating value of producer gas (140 B.T.U. per c. ft.) as compared with that of natural gas (1000 B.T.U. per c. ft.), American manufacturers had to consider the question of checker chambers for their furnaces. It was not necessary, and not advisable, to preheat natural gas, even when used in direct-fired furnaces, and in many cases preheating of the air was unnecessary in order to obtain the required melting temperature. A decrease in the supply

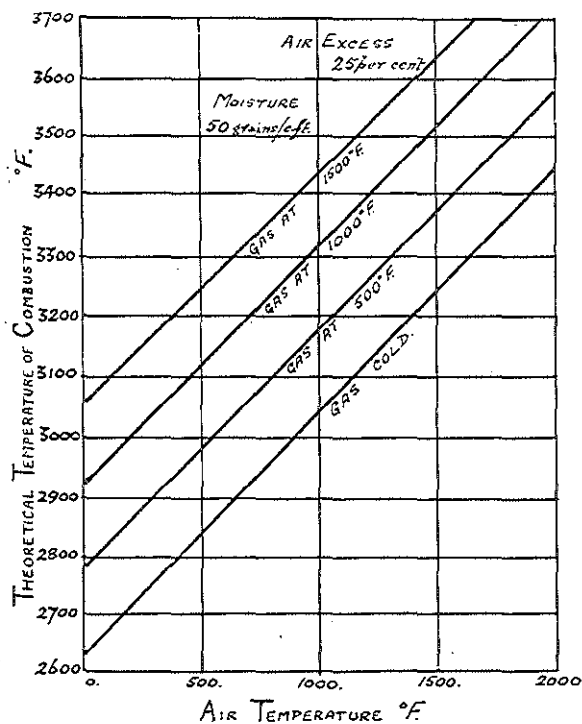


FIG. 154.

of natural gas forcibly introduced producer-gas practice, with the result that the existing furnaces required considerable modification.

The author discussed the two essential requirements for regenerating chambers. They should be so constructed as to abstract as much heat as possible from the waste gases and transfer it to the incoming gas and air, and also to afford easy passage to both incoming and outgoing gases, a vital necessity for efficient furnace work.

In connection with the first requirement, a series of calculations was made, and the results plotted as curves, from which, by inter-

pulation, all required data could be obtained to determine conditions affecting regeneration. The first series (Fig. 154) showed the theoretical temperature of combustion of a rich producer gas (30 per cent. CO and 4 per cent. CO_2) for different temperatures of the air and an air excess of 25 per cent. The second series (Fig. 155) showed the influence of the amount of excess air on the temperature of combustion of a good producer gas (30 per cent. CO and

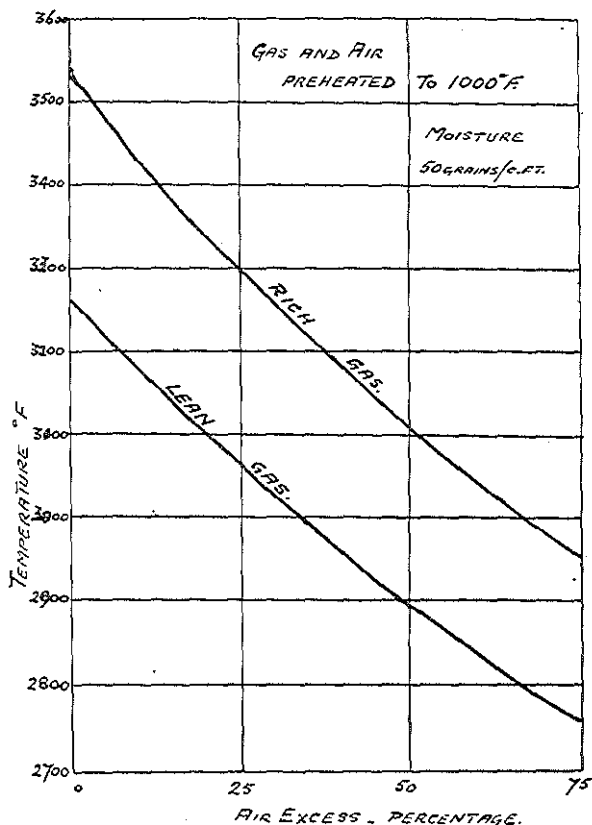


FIG. 155.

4 per cent. CO_2), and also on that of a bad producer gas (20 per cent. CO and 8 per cent. CO_2), both gas and air being preheated to 1000° . In both series the moisture content of the producer gas was assumed to be 50 grains per c. ft.

Although it was found that the actual flame temperature was about 500° F. lower than the theoretical temperature of combustion, it was considered that, other conditions being equal, the temperatures of combustion allowed a fairly accurate estimate of

the actual flame temperature to be made. Whereas the theoretical temperature of combustion for cold gas containing 30 per cent. CO and 4 per cent. CO_2 , with air preheated to 1000°F ., was 3025°F ., giving an actual temperature of 2500°F ., the theoretical temperature of combustion of a gas with 25 per cent. CO, calculated under precisely similar conditions, was about 2875°F ., corresponding to an actual temperature of about 2400°F . The latter temperature was too low for ordinary glass melting, and hence regeneration was necessary when using a producer gas with 25 per cent. CO or less.

Although harmless, it was not necessary to have a temperature in the regenerators of more than 1500°F ., for with 25 per cent. excess of air and a gas with 25 per cent. CO, both gas and air being preheated to 1000°F ., the theoretical temperature of combustion would be 3180°F ., corresponding to an actual flame

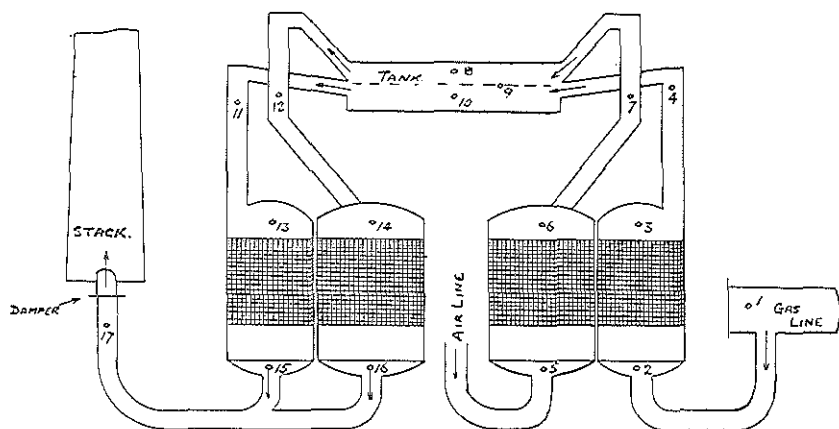


FIG. 156.

temperature of 2700°F . If the percentage of CO were below 25, a slight increase in the temperature of the regenerator would make up the deficiency in heating value.

From Fig. 155, illustrating the influence of excess air on the temperature of combustion, it was shown that the temperature of combustion decreased with increasing excess of air, and that the highest flame temperatures were obtainable with the theoretical quantity of air. Producer gas could not be burned in present furnaces without excess of air, but the excess should not exceed 25 per cent. For the efficient working of regenerators it was further recommended that reversals should be made at regular intervals, the intervals not being too long; sizes of valves and chambers should be carefully calculated, and the walls of chambers and furnace watched carefully to avoid the presence of cracks and holes. When the most suitable steam pressure had been found for use with the particular coal available for the producers, it should

be strictly adhered to, and there was no reason why the gas should not contain regularly 24 to 26 per cent. of CO. Regular determinations of CO and CO₂ should be made in order that the causes of production of poor gas might be immediately removed.

In order to obtain satisfactory heat absorption and transference in the regenerative chambers, it was possible that free passage of gas through the chambers might be seriously hindered, with a corresponding decrease in the furnace efficiency. The following table shows the general conditions which should, in the author's view, operate in regard to draught and pressure, whilst Fig. 156 illustrated the positions at which measurements were taken.

Point.	Location of Point.	Average pressure or draught: inches W.G.
<i>Gas Line.</i>		
1	Between reversing valve and re- generator.	+0.6
2	Below regenerator.	+0.2
3	Above "	+0.16
4	Between gas chamber and port.	+0.28
<i>Air Line.</i>		
5	Below regenerator.	-0.04
6	Above "	+0
7	Between air chamber and port.	+0.12
<i>Furnace.</i>		
8	Above centre line.	Very small pressure.
9	On centre line.	+0
10	Below centre line.	Very small draught.
<i>Flue gas line.</i>		
11	Between port and gas chamber.	-0.12
12	" " air "	+0.06
13	Above regenerator—gas.	-0.58
14	" " —air.	-0.58
15	Below " —gas.	-0.76
16	" " —air.	-0.72
17	Near stack damper.	-1.32
+ indicates pressure.		- indicates draught.

The data given are intended to be read relatively, but draught and pressure, respectively, should be found in other furnaces at similar points to those indicated in Fig. 156. The reasons for the existence of draught and pressure at various points were given and discussed in detail, and indication was also given of how those conditions could be made of use in order to determine the causes of lack of efficiency in the furnace.

The causes of fusion in the regenerative chambers were enumerated, and it was emphasised that furnaces should be designed in such a way as to minimise all the possible defects, so as to prolong the life of the furnace.

F. W. H.

344. **The Simplex Muffle Lehr.** C. E. FRAZIER (*National Glass Budget*, 1919-20, 2, 1).—In the average open type of lehr the following disadvantages were found:—(1) glass could not be satisfactorily annealed, owing to the arch being further away from the glassware in the centre of the lehr than at the sides; (2) to obtain sufficient heat to anneal the glass properly in the centre of the lehr, it was often found that the glass at the sides was melted down; (3) glassware from an open-type lehr, whether the lehr was fired by producer gas or fuel oil, was always covered by a bloom.

The muffle lehr prevented the bloom being deposited on the glass,

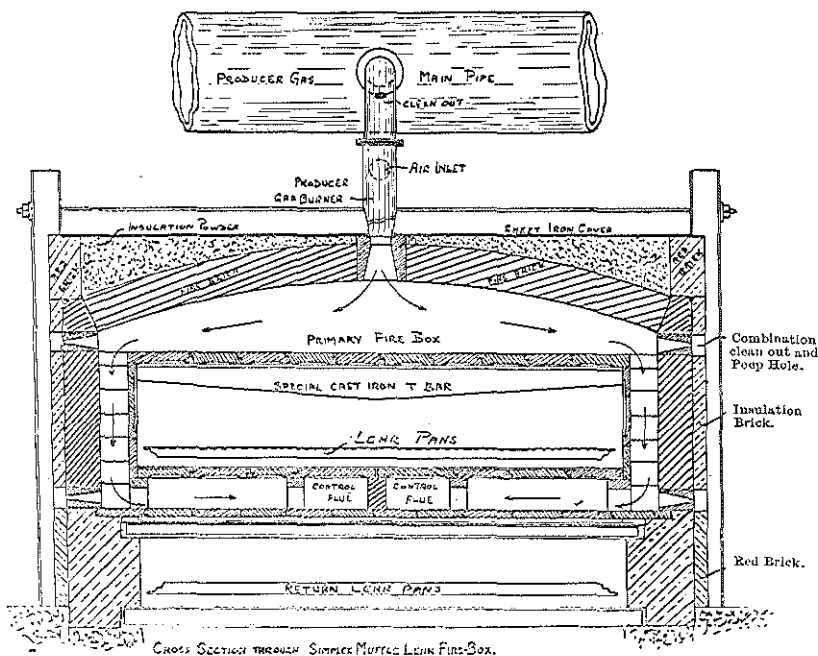
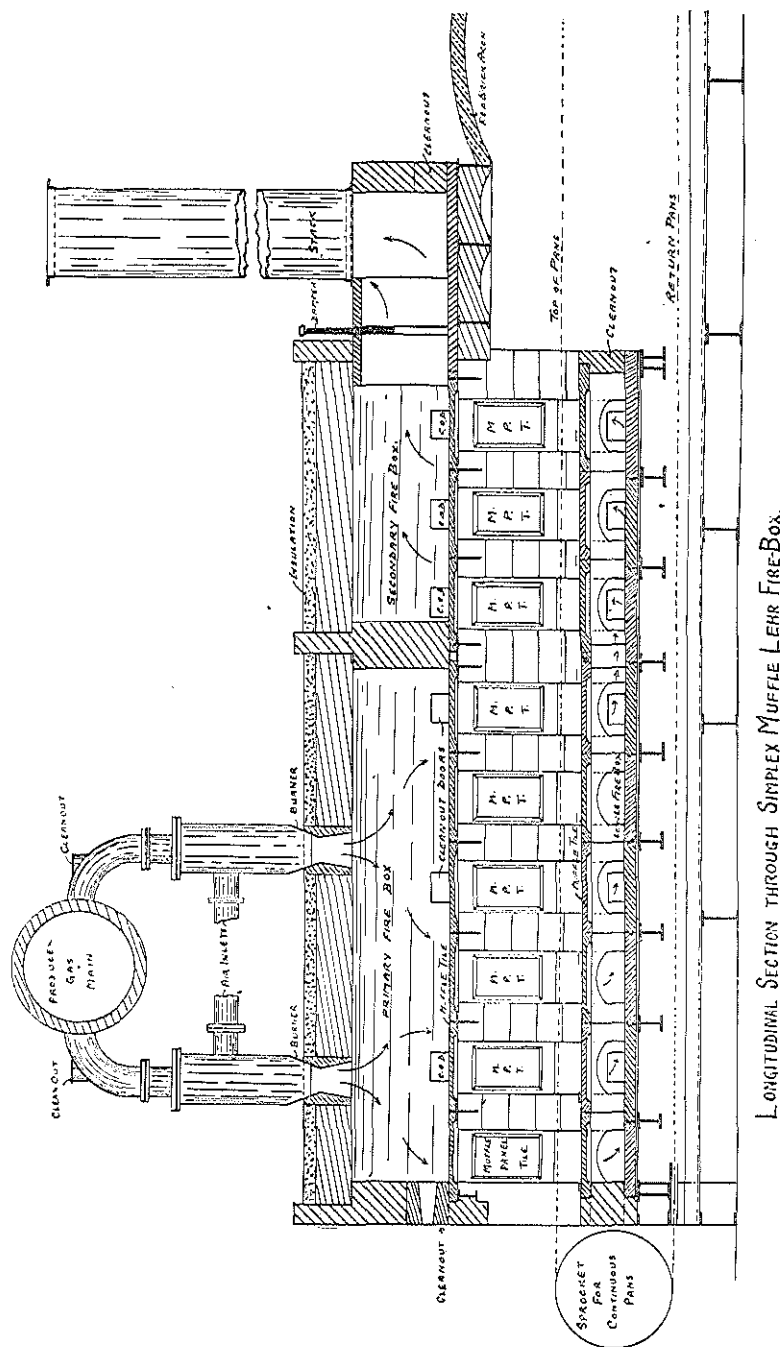


FIG. 157.

since the flame did not come into contact with the glass. The circular arch muffle type lehr prevented the bloom, but owing to severe loss caused by breaking of tiles, particularly in the centre of the arch, the Simplex muffle lehr was designed, with a flat arch supported by cast iron and permitting the use of thin tiles, and accordingly increasing radiation and decreasing fuel consumption. Tile breakage was reduced to a minimum, since the tiles had only their own weight to support, and the construction of the lehr was such as to allow free expansion and contraction. Broken or cracked tiles could be replaced through the "clean-out" doors whilst the lehr was in operation. The burner, of simple and strong



construction, was in the top of the fire-box, the flame being drawn down either side and underneath the pans; it was also in an easily accessible position and ensured a self-cleaning fire.

Draught control being applied to each lehr, a uniform temperature was obtained throughout the fire-box, together with an economical distribution of heat. The system of dampers in the fire-box was so arranged as to permit of transference of heat to wherever it was necessary. Compared with the open-type lehr, the Simplex muffle lehr proved that a uniform temperature throughout the fire-box and a uniform fall of temperature throughout the first 25 feet were essential to the efficient annealing of glassware. The following figures show the difference in this respect between the open type and muffle type of lehr:—

Distance from front of lehr.	Temperature.	
	Open lehr.	Simplex muffle lehr.
9 feet	900°	900°
15 „	725	820
20 „	560	760
25 „	525	700
30 „	420	580
35 „	300	440
40 „	220	380

The Simplex muffle could be applied to old lehrs, whether of hand-pulled or continuous type, at a small cost. F. W. H.

345. Muffle Lehrs. B. F. MORTON (U.S.A. Pat. No. 1295564, February 25th, 1919, Filed September 13th, 1918, No. 253948).—In a muffle lehr the muffle is supported by two sets of arches within the combustion chamber, and is so constructed as to prevent leakage of gas from the combustion chamber into the muffle. Fig. 159 is a longitudinal section of the front end of the lehr, and Fig. 160 is a cross-section. Gas is admitted by a valve, 10, to a longitudinal duct, 6, which is separated by longitudinal walls, 7, Fig. 160, from two air ducts, 4. The tops of these ducts are formed by tiles, 11, which also form the floor of the combustion chamber, 12, apertures, 13, 14, in the tiles admitting air and gas respectively into the combustion chamber. The gas and air are preheated before mixing by heat from the bottom of the chamber, 12. Within the combustion chamber are a number of arches, 16, which support the bottom, 17, of a muffle, 18, the arches and the bottom, 17, thus forming the top chamber. The roof of the muffle is formed of T-shaped tiles, 21, Fig. 159, which in turn support tiles, 22, the legs of the T-shaped tiles, 21, being straddled by the flanges of channelled tiles, 23. The whole forms a composite arched roof for the muffle, the joints of which are gas-tight. The spaces, 29, between the channelled tiles, 23, form secondary combustion chambers communicating with the main combustion chamber, 12, and also, by means of ports, 32, in the crown, 20, with a longitudinal flue, 26, built above the

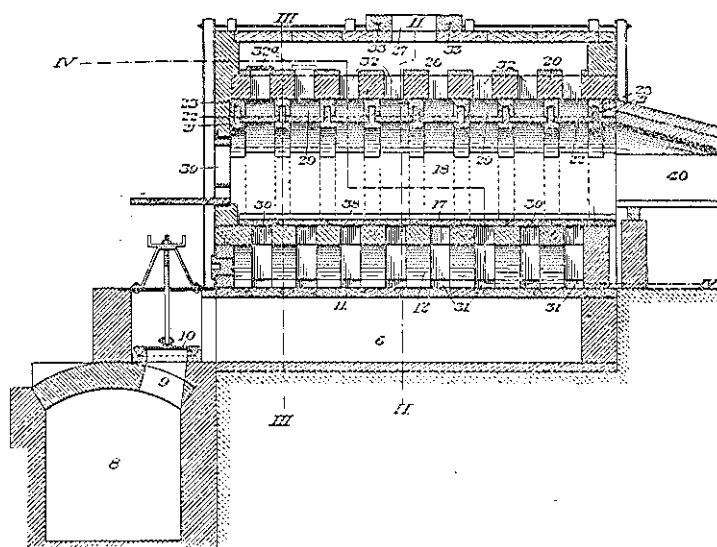


FIG. 159.

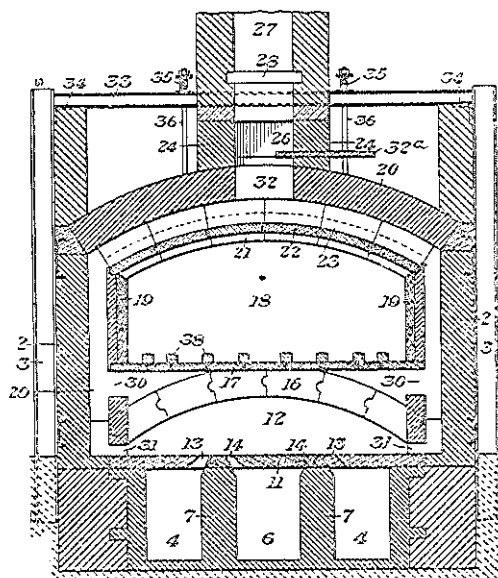


FIG. 160.

crown. Thus the burning gas is led from the combustion chamber, 12, right round the muffle before passing into the flue, 26, and

dampers, 32a, above each port, 32, enable the temperature in the different portions of the muffle to be regulated. Longitudinal tiles, 38, within the muffle are used to cover the joints between the bottom tiles, 17, of the muffle, and may also serve for supporting the runaway for the lehr pans.

G. D.

VIII.—Chemical Analysis.

346. A Colorimetric Determination of Lead Dioxide in Litharge. WALTER V. MORGAN (*J. Ind. Eng. Chem.*, 1919, 11, 1055).—The method had been found advantageous by the author in connection with rubber work, where it was important to know the amount of oxidising agent present. With slight modifications it would also be found applicable to the determination of oxidising agents in general when they occurred as an impurity with non-oxidising agents.

The procedure recommended was as follows. Five grams of litharge are boiled for a minute with a solution containing 2 grams of aniline hydrochloride dissolved in 10 c.c. of water and 5 c.c. of concentrated hydrochloric acid. The solution is then cooled to permit the separation of any lead chloride which has been formed, and filtered to remove lead chloride and any litharge which has not been dissolved. As the method depends upon the oxidising power of the dioxide, it is not necessary to convert all the litharge into lead chloride. The lead dioxide oxidises the aniline to aniline purple, the intensity of the colour being proportional to the lead dioxide content. Hence the filtrate is compared with standards made by adding definite amounts of lead dioxide to the above-mentioned solution.

C. M. M.

347. The use of Nickel Crucibles for the J. Lawrence Smith Fusion in Determining Soil Potassium. SETH S. WALKER (*J. Ind. Eng. Chem.*, 1919, 11, 1139).—The scarcity and high price of platinum caused the author to investigate the possibility of substituting nickel for platinum crucibles when determining the potash value of soils by the Lawrence Smith method.

He found that the same result for soil potassium was obtained whether the soil was fused in a platinum crucible or a nickel one, but owing to the attack of the fusion mixture on the nickel crucible its life was short.

C. M. M.

348. Electrometric Titrations, with special reference to the Determination of Ferrous and Ferric Iron. J. C. HOSTETTER and H. S. ROBERTS (*J. Amer. Chem. Soc.*, 1919, 41, 9, 1337).—The authors described a method for the direct electrometric titration of ferrous iron with standard dichromate solution

and investigations into the most suitable conditions desirable for the estimation. By this method, extremely minute quantities of ferrous iron could be accurately determined in the presence of a very large excess of ferric iron. A combination method was also described for the determination of total iron.

Electrometric titrations found many applications, including the determination of iron in optical glass, raw materials for optical glass making, and in glass pots. F. W. H.

349. The Determination of Zirconium by the Phosphate Method. G. E. F. LUNDELL and H. B. KNOWLES (*J. Amer. Chem. Soc.*, 1919, **41**, 11, 1801).—The method recommended for the estimation of zirconium was a modification of that suggested by Nicolardot and Reglade (*Compt. rend.*, 1919, **168**, 348; this JOURNAL, 1919, Abs., p. 205).

The solution containing the zirconium was rendered acid by the presence of 20 per cent. by weight of sulphuric acid. The volume varied from 25 c.c. for small amounts (0.0005 gram ZrO_2) to 200 c.c. for larger amounts (0.01 gram ZrO_2). The temperature was raised to between 40° and 50° , and excess of ammonium phosphate added. The excess used was from ten to one hundred times the theoretical amount required by the ratio of Zr to P_2O_5 , and the larger excess of the precipitant was necessary when small amounts of ZrO_2 were estimated. After addition of the ammonium phosphate, the mixture was allowed to stand in a warm place for two hours for complete precipitation of amounts of ZrO_2 exceeding 0.005 gram, and six hours or more for smaller amounts. The precipitate was then filtered while still warm, as much of the supernatant liquid as possible being decanted before transferring the precipitate to the filter. The precipitate was washed with a cold 5 per cent. solution of ammonium nitrate. Ignition was carried out in a partly covered platinum crucible, slowly until the paper was completely incinerated, and then very strongly over the blow-pipe or a Meker burner.

The large excess of precipitant was necessary in order to obtain complete precipitation and a precipitate of normal composition. Washing with ammonium nitrate solution almost entirely overcame the tendency towards hydrolysis of the zirconium phosphate. Slow ignition prevented decrepitation of the precipitate and ensured complete combustion of the paper. The zirconium pyrophosphate was not hygroscopic, and the factor for conversion to ZrO_2 was 0.4632. By this method, zirconium was completely separated from aluminium, iron, chromium, cerium, and thorium, and also from titanium if sufficient hydrogen peroxide were added to the solution before precipitation of the zirconium. The addition of 10 c.c. of H_2O_2 had no adverse effect on the precipitation.

Historical notes and tables showing details of experiments dealing with the effect of varying conditions were also given.

F. W. H.

IX.—Machinery for the Working of Glass.

350. Method and Machine for Gathering Glass. K. E. PEILER, HARTFORD FAIRMONT CO. (U.S.A. Pat., December 9th, 1919, No. 1324464. Filed December 4th, 1916, No. 134827).—The object of this machine is to feed glass from a tank or pot in portions of uniform size, consistency, and temperature, and to deliver them without any undue chilling.

A gathering head is mounted obliquely, and is thrust into the molten glass by the action of the cranked lever, 19 (Fig. 161), operated by a roller running in the cam groove, 22. At the same time, it is rotated so as to gather a mass of glass round it. This rotation continues until the cam disc through the lever, 19, has withdrawn the gathering head and brought the glass within a

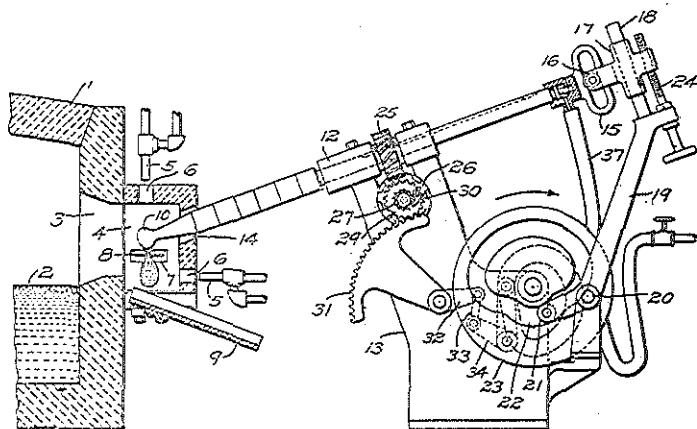


FIG. 161.

chamber heated either by the furnace flames or by separate jets. Here, with the rotation stopped, the glass is allowed to fall from the iron and is cut off by mechanically operated shears, which pass through openings, 7, in the opposite sides of the chamber. In order to follow the varying levels of glass in the pot or tank, the connection between the lever, 19, and the link can be varied by the screw, 24. This gives a longer or shorter stroke into the furnace, but always comes to the same discharge position. The gathering head is rotated through the splined gear wheel, 25, and the segmental rack, 31. In between these two is a ratchet wheel with a pawl, 30, which drives the gear wheel, 25, while the segment is moving in one direction only. The segment is made to reciprocate by the angle lever, 34, operated by a roller in the cam grooves, 36, which causes the segmental rack to move over its travel quickly in one

direction and slowly in the other; thus the gathering head is rotating for about two-thirds of each cycle.

The gathering head, which is of highly refractory material, and the iron stem are hollow, and overheating is prevented by blowing through a supply of compressed air from the flexible tube, 37.

S. E.

351. Glass Working Apparatus and Process. F. L. O. WADSWORTH, BALL BROS. GLASS MANUFACTURING Co. (U.S.A. Pat., July 29th, 1919, No. 1311474. Filed April 24th, 1914, No. 834230).—This invention relates specifically to the arresting of the flow of glass from a gravity flow feeder, so that no lapping or piling up can occur during the time of mould movement. This effect is produced by severing the stream of molten glass at a point near the outflow orifice and then immediately subjecting the severed end and the sides of the stream to a momentary chilling. On removing the chilling means, the internal heat of the metal reheats the chilled skin, and the downward movement begins again.

The stream-arresting device consists of two reciprocating blocks of manganese steel or compressed carbon, with their adjacent faces shaped so as to form a downward-pointing cone when placed together, the base of the cone being approximately the same diameter as the stream of glass. When the glass is to be cut and chilled these blocks are brought together and a shear blade passed across the narrow end. The blocks can be immediately opened, and the chilled surface of the depending cone of glass will itself arrest the flow of glass from the tank for a short period. S. E.

352. Apparatus for Feeding and Delivering Glass. J. SCHIES (U.S.A. Pat., August 12th, 1919, No. 1312876. Filed August 28th, 1914, No. 859099).—Molten glass is allowed to flow continuously over the edge of a lip or flow block extending from a doghouse built on to the nose of a tank. The glass may flow vertically downward into a mould or it may be diverted and carried back to the furnace.

When sufficient glass has flowed into the machine mould, a movement is imparted to the feedblock by which the stream of glass is severed, and the severed end directed towards a waste trough. Just as the next mould is being brought into position a reverse movement is imparted to the feed block, thus cutting the stream of glass at the upper end of the block, and directing the fresh stream into the mould now in position. The glass deflected to the waste trough is quickly returned to the furnace by buckets carried on an endless chain. On passing over the upper sprockets, the buckets are tilted by means of pins, and the glass is dumped on to an inclined spout leading into the furnace. S. E.

353. Process of, and Apparatus for, Drawing Glass. H. T. BELLAMY and J. C. SMITH, Western Electric Co. (U.S.A. Pat.,

May 13th, 1919, No. 1303452. Filed December 26th, 1917, No. 208926).—The apparatus is specially designed to press thin glass vessels, such as small cylindrical glass vessels, and to avoid cracking due to excessive cooling, the ram and the die are in contact with the hot glass only for an exceedingly short time.

In operation, a very hot glob of glass is held in front of the pad, 90 (Fig. 162), which projects a very small distance through a die, 55. The pedal is then depressed, and the crank, 27, moves through one complete rotation, causing one full reciprocation of the rod, 41. This presses the round-ended ram, 47, into the glass, and when the glass separating the ram and the pad has been reduced to the desired thinness the pad is quickly withdrawn by the action of the rod, 104. The pad is held up to the ram just long enough to cause

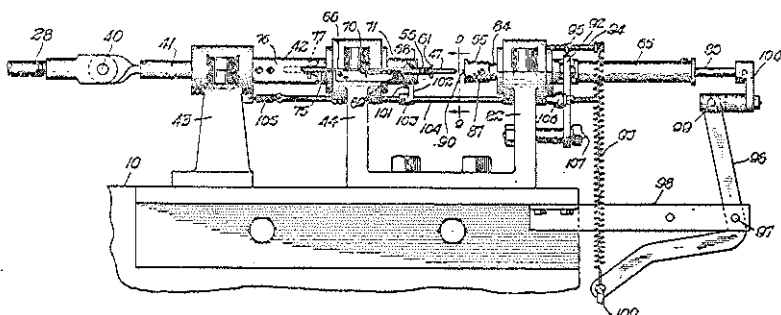


FIG. 162.

the glass to take a definite shape and to stiffen, but not long enough to cause it to crack. The ram, 47, continues to move forward and draws plastic glass from the bulk, 110, with it through the die. Towards the end of the stroke the sleeve, 49, begins to move forward, and as it fits accurately in the hole of the die, it shears off the plastic glass from that which has passed through the die on the ram. On the return stroke, the sleeve, 49, is held in position for some time by the pawl, 68, thus preventing the drawn glass from coming back with the ram. The temperature of the bulb as it is stripped from the ram is such that it is still soft, and to prevent deformation, it is allowed to fall on to an inclined surface covered with some soft material to break the force of the impact. In rolling down this surface, the bulb becomes sufficiently cool to retain its shape. The superfluous mass of glass encircling the sleeve is pushed off the end of the ram at the inward end of its stroke by the forked arm, 61.

S. E.

354. Process and Apparatus for Feeding Molten Glass.

B. D. CHAMBERLIN, EMPIRE MACHINE CO. (U.S.A. Pat., December 2nd, 1919, No. 1323450. Filed May 1st, 1916).—In this apparatus, molten glass flows from a tank through a discharge orifice, *M* (Fig. 163), terminating in a cavity in the

floor of the tank. Within this cavity is a flow tube, b^7 , which, being smaller than the cavity, leaves the annular air space, b^8 . The upper end of the flow tube is reduced in size and apertured at m' , to register with the orifice, m , the furnace structure.

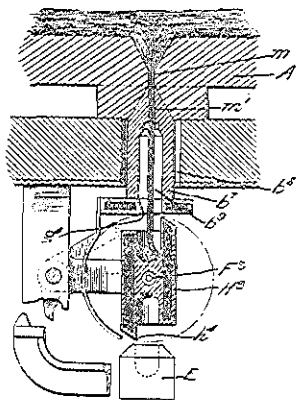


FIG. 163.

movement through 180°, thus shearing the downward-flowing stream of glass, and depositing the charge in a mould, E , below its pivotal point. In practice, the temperature of the space surrounding the chamber, b^9 , and the hot glass flowing through the inside of the chamber, raise the temperature of the flow chamber sufficiently to prevent any appreciable cooling of the glass as it flows through the chamber, prior to its being severed. S. E.

355. Apparatus for Feeding Molten Glass. W. A. LORENZ, HARTFORD FAIRMONT Co. (U.S.A. Pat., April 8th, 1919, No. 1300180. Filed August 7th, 1917, No. 184874).—The object of this invention is to provide means for transferring gather-

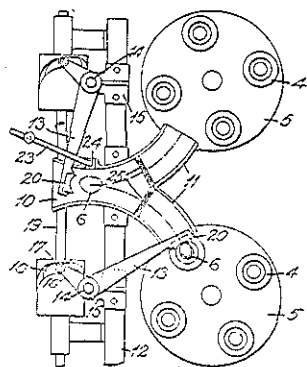


FIG. 164.

ings of glass from a gathering apparatus to the moulds of various machines in a substantially horizontal plane, thus avoiding the necessity of bringing the moulds directly beneath the glass outlet.

The molten glass on being separated by shears in the usual manner falls into a trough, 25 (Fig. 164), with a suitable refractory lining. The trough has two or three curved branches, 11, according to the number of machines to be fed, each trough ending vertically above the machine moulds. Horizontal arms, 13, reciprocating on vertical shafts, 14, move alternately along these troughs, and have fitted at their free ends blocks

of carbon or other refractory material, 20. Thus, the gobs of glass as they fall are swept along the troughs and into the moulds.

The troughs may have flowing along them small streams of water, which is allowed to escape through small holes in the bottom just before the end of the trough is reached. The pusher arms are operated by rolls, 17, running in cam grooves, 18, in drums rotating on a horizontal axis, 19, and mounted underneath the rocker shafts.

S. E.

356. Blowing Large Bottles, Carboys, and the Like.
J. RAU (U.S.A. Pat. No. 1292051, January 21st, 1919. Filed September 28th, 1916. No. 122751).—Relates to a means of blowing by machine large bottles such as carboys and the like of 5 to 15 gallons capacity. The invention consists in forming the parison of the same length as the finished articles, so that during the final blowing the parison does not elongate, but spreads laterally until

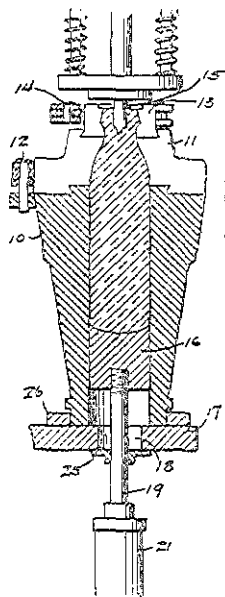


FIG. 165.

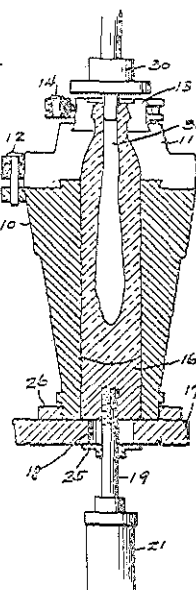


FIG. 166.

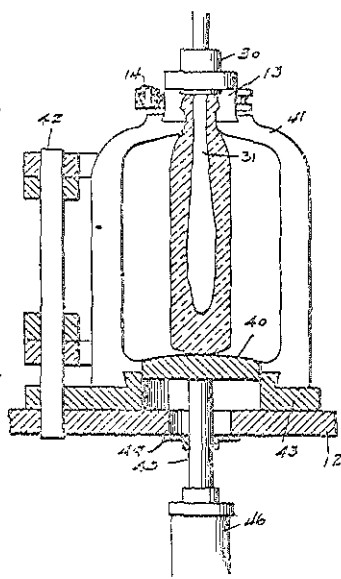


FIG. 167.

it fills the finishing mould. In applying the process to a machine, the parison mould, 10, Fig. 165, has a movable bottom, 16, which can be raised or lowered by a rod, 19, connected with the piston of an air- or liquid-pressure cylinder, 21, secured below the rotary table, 17, of the machine. An adjustable stop, 25, on the rod, 19, limits the upward movement of the mould bottom. In use, the mould bottom is raised and the mould is filled with metal, which is pressed by a plunger, 15, to form the ring of the bottle and the

mouth opening. Air is next introduced from a blowhead, 30, Fig. 166, the mould bottom, 16, being allowed to descend at the same time, so that the parison elongates as shown, the final length being approximately that of the finished bottle. The parison is then transferred to a finishing mould, 41, Fig. 167, and a movable bottom, 40, raised to support the bottom of the parison and prevent it from elongating. Thus, during the final blowing, the parison expands laterally until it fills the mould. G. D.

357. Pressed Glass. J. H. GROTH (U.S.A. Pat. No. 1290738, January 7th, 1919, Filed October 6th, 1917, No. 195095).—Relates to means for pressing glass articles having recesses or apertures, such as holders for cut flowers. The invention consists in providing the press plug with pins to form the apertures, and in so constructing this plug that when it is lifted from the mould body, the pins are withdrawn from the glass before the plug begins to move upwards. The stem, 1, of the plug has a flange, 2, formed on its lower end, to which a disk, 3, is secured. Pins, 5, pass through holes in the disk and their heads are clamped between the disk and the stem. The plug, 9, is formed with a recess, 8, in which the disk, 3, slides, and is also provided in its lower portion with aper-

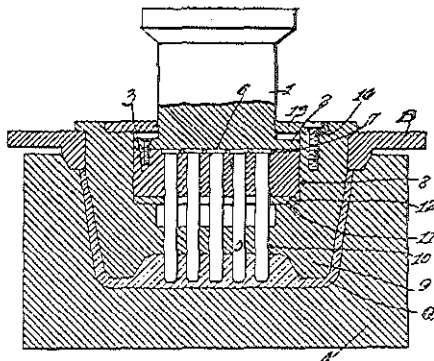


FIG. 168.

tures, 10, through which the pins, 5, slide. A retaining ring, 13, prevents the disk, 3, from being lifted out of the plug, but permits them to move relatively to one another, a spacing washer, 12, being seated in the lower part of the recess to regulate the amount of the relative movement. The mould body, A, and the ring, B, are constructed as usual. In use, a gather, G, is pressed as usual, but when the plug is raised, the first effect is to loosen the pins, 5, from the glass, the stem moving upwards until the flange, 2, contacts with the ring, 13. Continued movement of the stem then lifts the plug from the mould. G. D.

358. Machinery for Production of Pressed Glass. P. EBELING (U.S.A. Pat. No. 1297122, March 11th, 1919. Filed February 14th, 1918. No. 217278).—Relates to a mould for press-

ing prism pendants, 9, Fig. 169, such as are used for chandeliers, the supporting wires or pins, 8, being inserted during the pressing operation. A four-part mould body, 1, Fig. 170, has moulding spaces, 2, the plug, 3, having corresponding spaces. The body, 1, has an annular recess, 4, for the reception of a ring, 5, which has

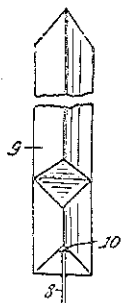


FIG. 169.

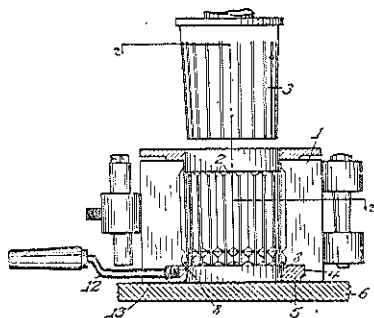


FIG. 170.

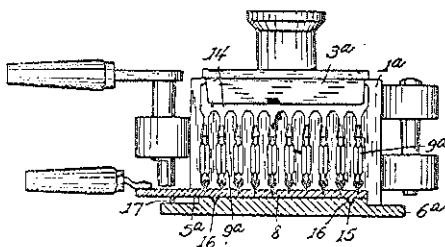


FIG. 171.

a circular row of perforations in which the pins are inserted. Thus the metal is pressed into a cylinder composed of prisms united by a thin fin or web of glass, which is broken away, the rough edges of the prisms being afterwards ground. In a modification, shown in section in Fig. 171, a two-part mould body, 1a, is used, the moulding spaces, 9a, extending downwards from the space, 14, for the surplus metal. The pins, 8, are inserted in a straight supporting bar, 5a, which is held in a space in the lower part of the mould body.

G. D.

359. A New Form of Mechanical Boy. P. WECHT (U.S.A. Pat. No. 1300066, April 8th, 1919. Filed April 6th, 1918. No. 227105).—In a mechanical boy, the support, 19, of the mould halves, 3, is secured to vertical racks, 5, which engage toothed segments, 9, secured on a shaft, 10. A pinion, 11, also secured on

the shaft, 10, is engaged by a rack, 12, attached to a pedal, 15.

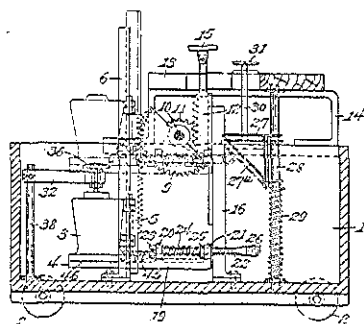


FIG. 172.

Thus by depressing the pedal the mould may be raised out of the water in the tank, 1. The mould halves are pivoted to a post in the support, 19, and are connected by links to a sliding rod, 22, a spring, 24, being arranged to keep the mould halves open. The mould is closed by a second pedal, 31, which is secured to a vertically movable member, 27, having an inclined surface, 27a. When the mould is raised, depression of the pedal, 31, causes the

member 27, to engage the end of the rod, 22, and slide it forward, thus closing the mould. The bottom, 36, of the mould may be carried by a fixed support, 32, so that it co-operates with the mould halves. The bottom may be revolvable on its support, and may bear a design, a star, for instance, which it may be desired to impress on the ware, the bottom being free to rotate with the article as it is turned in the mould. Alternatively, a fixed bottom may be carried by the support, 19.

G. D.

360. A Tube Drawing Machine. F. G. KEYES (U.S.A.

Pat. No. 1291921, January 21st, 1919. Filed February 18th, 1913. No. 749124).—Relates to a "means of drawing a tube of any material admitting such treatment in such a manner as to ensure the formation of a tube having a uniform external diameter and a central opening substantially regular." The material, 3, which may be glass or quartz, is liquefied in a crucible, 2, and a tube of suitable material is dipped into the liquid and drawn upwards through a heat-resisting die, 5, a blower, 11, supplying air to the central tube in order to maintain the diameter while drawing. Outside the die, the tube, 10, is cooled by a closed annular holder, containing boiling metal, 7, such as mercury, which is connected to a con-

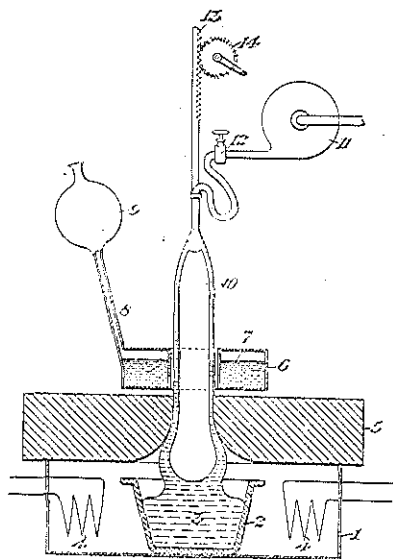


FIG. 173.

densing chamber, 9. The crucible may be of tungsten, and a

coating of tungsten may also be applied to the lower side of the die, 5.
G. D.

361. Paste Mould Machine. F. W. STEWART (U.S.A. Pat. No. 1294319, February 11th, 1919. Filed October 27th, 1915. No. 58218).—Relates to a "paste mould" machine, that is, a machine which receives a pipe with a marvered parison and completes the blowing in a pasted mould, the article being turned in the mould while being blown. The principal improvement constituting the present invention appears to be the means for cooling the mould. The machine comprises a table, 2, for supporting the moulds, 67. sprayers, 64, for cooling the moulds, and a pillar, 4, for supporting the cylinders, 8, which control the nozzles, 15, that engage the blowpipes, 76. Metal having been gathered in the pipe, 76, and marvered, the pipe is placed in the supports, 77, and a handle, 41, turned. Air is thus admitted to cylinders, which close the mould, 67, about the suspended parison, and is also admitted to a cylinder, 8, which forces the nozzle, 15, down in the pipe and commences to blow the article in the mould. At the same time an electric motor, 34, operating through gearing, oscillates the nozzle, 15, and therefore the pipe, 76, so that the article is turned in the mould while being blown. The turning of the handle, 41, also admits air to a cylinder, 49, and raises a spray pipe, 64, within the second mould, as shown. As the spray pipe reaches its position, a valve trigger, 61, engages a fixed stop and admits water, which is sprayed over the inside of the mould. When the article is blown, the operator moves back the handle, 41, and the air pressure opens the mould, raises the nozzle, 15, and lowers the spray pipe from the other mould.
G. D.

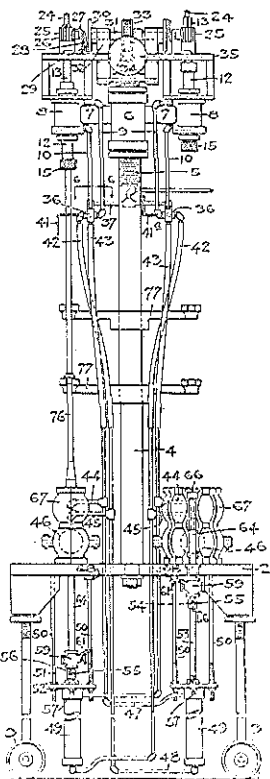


FIG. 174.

362. Grinding and Polishing Lenses. W. J. DRUIFF and ANGLO-AMERICAN OPTICAL Co. (Brit. Pat. No. 123270, July 30th, 1918, No. 12423).—Apparatus for grinding and polishing lenses comprises a table or support, 11 (Fig. 175), for the lenses,

a revoluble tool, 20, mounted by means of a universal joint at

FIG. 175.

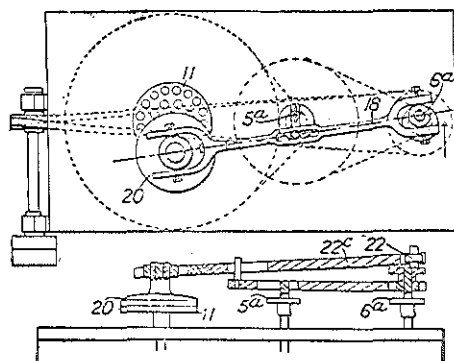


FIG. 176.

one end of an horizontally-disposed arm, 18, the opposite end of which is engaged by a crank-pin, 6^a, on a vertical shaft, while, intermediate between its ends, the arm is slotted to engage a crank-pin, 5^a, on another shaft. The apparatus shown is for treating spherical lenses, and the table is mounted on a vertical shaft. The shaft of the crank-pin, 5^a, runs at a lower speed than the other crank-shaft, and the shaft of the table at a still lower speed. The cranks are preferably adjustable in throw. For cylindrical lenses, a guided table is employed. For "figuring," a modified arrangement (Fig. 176) is used; the arm, 18, does not carry the tool directly, but engages, by a pin-and-slot connection, with an upper arm, 22^c, which carries the tool at one end and engages at the other with a crank-pin, 22, carried by, but angularly displaced from, the first pin, 6^a.

H. G. C.