hot, this pyrophorus will retain its inflammable properties several days.

Mercury volatilizes to a sensible extent at all temperatures above 19° or 20° C.; but below this point its volatility is imperceptible. This curious property of a metal may be shown by the experiment represented in Fig. 6. A piece of gold leaf is suspended an inch or two above a layer of mercury contained in a bottle. Before long the gold leaf will be seen to tarnish and to gradually form an amalgam with the absolutely invisible vapors given off from the mercury.—*La Nature*.

CARBONIC ACID IN THE ATMOSPHERE.

INVESTIGATIONS respecting the quantitative composition of the air have for a long time engaged the attention of scientists. If we look over the annals of science we find that from the time of Lavoisier until the middle of the present century nearly all renowned chemists have taken part in these investigations. The names of a Priestley, Scheele, Cavendish, Saussure, Humboldt, Dalton, Gay-Lussac, Dumas, Bunsen, Leibig, Pettenkofer, and many others of almost equal renown, prove that the necessary attention has always been paid to this most important subject. Therefore it might be assumed that the composition of the atmosphere as well as its eventual changes are perfectly familiar to the scientific world, and that we have an accurate knowledge of the quantitative proportions of the single gases contained in it. Concerning the most important gases, viz., oxygen and hydrogen, this assumption is true. Experiments which have been made with the very best instruments show that the quantitative proportions of these two gases are subjected to a comparatively little change, and that normal air in its dry state contains in a hundred volumes from 20.9 to 21 volumes of oxygen. According to the latest investigations of Jolly,* the differences of the quantity of oxygen contained in the air are, it is true, somewhat greater, and change from 20.4 to 21 per cent.

We are equally well informed regarding the quantity of water contained in the atmosphere, which varies greatly. In order to ascertain these variations, experiments are made daily in the meteorological observatories. But very insufficient is our knowledge regarding the fourth factor contained in the atmosphere, viz., carbonic acid.

Until lately it had been believed that the quantity of carbonic acid in the air varies in a certain determinate manner, and the experiments of Saussure, Verver, and others seem

perfectly loaded with carbonate, that in the second part, B¹, it had a milky appearance, while in the third part, B², it was entirely clear and pellucid, a proof that a perfect absorption of carbonic acid had taken place. Then the baryta solution was put into a bottle, which could be easily closed, the cylinder and washing bottle were carefully rinsed with known quantities of water, all the liquids were united, and a quantity of water was added, the weight of which corresponded to that by which the weight of the U-formed tube, I I, was increased. Thus was contained a liquid in which, after a complete precipitation of the carbonate of barium, the quantity of the undecomposed baryta could be easily ascertained by adding a measured quantity of the clear solution of baryta, and by a simple calculation a quantity of carbonic acid contained in the examined air was found. [Of course the measured quantity of air had to be reduced by calculation to a temperature of 0° C. and a pressure of 760 mm.]

In this manner Reiset has for six years labored indefatigably to ascertain the amount of the carbonic acid contained in the atmosphere, and by his careful experiments he has obtained the following results:

1. The quantity of carbonic acid in the atmosphere is constant. After comparing all the investigations it was found that, in average, 29.78 volumes CO₂ are contained in 100,000 volumes of air.

2. The experiments made in Paris in the month of May of the years 1873, 1875, and 1879, show a somewhat higher amount, in average, 30.27 in 100,000.

3. In comparing the experiments which were made in thickly-leaved forests and in fields exuberant with vegetation with those made in barren localities, it was discovered that the diffusibility of carbonic acid was enormous. Twenty-seven experiments showed that the average amount of carbonic acid contained in the atmosphere of the forest is 29.17 in 100,000 (volumes), while the air in the barren localities showed a yield of 29.02 CO₂ in 100,000 volumes.

4. Night air contains somewhat more carbonic acid (30.84 vol.) than day air (28.91 vol.).

5. An increase of the CO₂ yield was found by Reiset on foggy days. The mean of 12 experiments showed 31.66 vol. CO₂ in 100,000 volumes of air, the maximum on an unusually foggy day in fall being 34.15.

At the conclusion of the valuable and highly interesting record of his labors, Mr. Reiset draws our attention to the fact that the figures found by him prove the equal diffusion of carbonic acid, which was already anticipated by Gay-

strong and disagreeable as to render such a soap unfit for finishing purposes. As to olive oil, nothing can be better for the purpose; but it is a very expensive article, and cannot be used except for the production of a soap for the very finest purposes. Within the last few years, however, cotton-seed oil has been generally introduced; it is now produced on an enormous scale, and is very well fitted for the manufacture of fulling soap. The refining of this oil during the last few years has been very much improved, so much so, that some of the best refineries now turn out an article that in taste, color, and appearance cannot be distinguished from olive oil. A soap made with this oil is in every way suitable for fulling purposes of all descriptions, and cotton-seed oil being now much cheaper than tallow, the cost of production of a good soft soap is actually less than that of a pure hard soap. A third reason against the use of "fig" soap has always been a general idea that because it was soft it contained much more water than a soda soap. This is quite a mistake, as it is soft because made with potash, which produces a naturally soft soap, just in the same way that soda produces a naturally hard soap. In fact, in actual practice, taking weight for weight, a good potash soap for scouring and fulling purposes will do more work than a hard soda soap, potash being a superior alkali to soda for such purposes.

The production of a good soft soap has so far been a difficult and delicate operation, requiring large boiling pans and special apparatus for the purpose. Montreal potashes, already mentioned, were taken, dissolved in water, and a weak lye produced. This was agitated with lime and the clear liquor run off; the caustic lye thus obtained was partly used at its normal strength, partly concentrated by boiling for use in the final stage of the soapboiling process, or German carbonate potash was treated in the same manner; this latter article, however, is more difficult to use satisfactorily, owing to its requiring much more lime and labor to render it thoroughly caustic as compared with Montreal potashes. In both cases, the lye thus obtained was full of impurities, and always contained more or less soda. What was much worse, however, this soda was always an "unknown quantity" to the soapboiler, and rendered the formation and production of the soap a difficult operation: the boil, owing to the soda contained in the potash, sometimes unaccountably going wrong, and working altogether differently to what was expected. This soapmaking process has lately been much improved for large soapboilers by the introduction by the Greenbank Alkali Company, of St. Helens, Lancashire, of a pure caustic potash, quite free from soda, thus allowing a perfectly caustic lye to be easily obtained by simply dissolving this article in water. This is, however, by no means the only advantage of this caustic potash, as, being pure and concentrated, a soft soap can be made by consumers themselves without boiling, and in small quantities, by a process very similar to that for producing hard soap with the double-refined powdered caustic soda, as fully explained in the August number of the *Chemical Review*.

The following directions will produce an excellent potash fulling soap for manufacturers' use:

Take 50 pounds of Greenbank pure caustic potash; put it in any metal or earthenware vessel, with 9 gallons (90 pounds) of water. Stir it once or twice; it will dissolve immediately and become quite hot. Let it stand until the lye thus made is cold. Place in any convenient vessel for mixing 22½ gallons of cotton-seed oil. Pour the lye into the oil in a small stream, at the same time stirring with a flat wooden stirrer about three inches broad. Continue gently stirring until the lye and oil are thoroughly combined, and in appearance like honey. Now cover the vessel up and put it in a warm place until the next day. The oil and lye will then be found nearly all combined. Stir up well again, and leave for a few days, when the mixture will become quite even, and the saponification complete; the result being the production of about 345 pounds of very stiff potash soap. If made for use by an actual consumer nothing more need be done; the requisite quantity can be thrown into the scouring vat, either with or without the addition of a small quantity of carbonate of potash to increase the alkali present. The potash soap produced in this way is very much more concentrated than the ordinary "fig soap" hitherto sold. If it is required to make a soft soap similar in appearance and quality to the ordinary fig soap, it can be produced in the following manner: Take 200 pounds of the stiff potash soap, and add to it about seven gallons (70 pounds) of water. Put it into a boiling pan, and gently heat and stir it so as to mix well together; then add about six to eight pounds of crystalline carbonate of potash, which will remove all "stringiness" and produce a clear, homogeneous soap, which also will improve in appearance by keeping for a short time.

The above "cold process" is simple and effective, and even a few pounds alone of soft soap can be made by it; with mechanical mixing apparatus and large pans, soft soap can easily be produced on a large scale by this process. If, however, it is wished to make the soap by the old boiling process, the best way to do so is as follows:

Take 20 gallons of cotton-seed oil, and put it in a pan with 21 gallons of lye of 15° T., made from Greenbank caustic potash, and gently heat by boiling until well mixed. Now add 7½ gallons of caustic potash lye of 40° T., and continue boiling, when the soap will become stiff and difficult to work. To overcome this and take away "stringiness," add about six pounds of fine crystalline carbonate of potash, and continue boiling the soap until it is thoroughly mixed and finished. In this way, even with the old boiling process, soft soap can be much more easily and readily made than with Montreal ash or German carbonate of potash.

As before mentioned, cotton-seed oil is the best to use in either process. For some purposes, however, a small addition of tallow rather improves the soap; if this is desired substitute in the proportion of about eight and a half pounds of tallow for each gallon of oil given in the directions. Linseed oil, or fish oil, can be partly or entirely substituted, but the peculiar smell given to the soap by the use of these oils is in many cases objectionable. Tallow or grease can be used entirely; the result will be a soap quite satisfactory for most fulling and washing purposes, but it will be opaque, and not of the same appearance as a potash oil soap. The addition of some hemp-seed oil to the cotton seed oil will give a color similar to that obtained when olive oil alone is used. It will be evident also that the soap can be made stronger or milder, as required, according to the quantity of caustic potash used, or the crystalline carbonate of potash added at the end of the process; it will be found generally more satisfactory to regulate the strength of the fulling soap with carbonate; or for actual consumers, which is better, carbonate of potash can be added to the scouring vat when the soap is used for scouring or cleaning.

Soda ash, or any other form of soda, never should be

to justify this supposition. In our books of chemistry may be usually found the following sentence: "Atmospheric air contains a small quantity of carbonic acid, which generally varies from 0.004 to 0.006 p. c. in volume."

The latest investigations of J. Reiset,† whose eudiometric discoveries are well known among scientists, now show that the assertion contained in the above mentioned sentence is perfectly incorrect; that atmospheric air has a quantity of carbonic acid which is constant or scarcely varies at all; and that 100,000 volumes of dry air in its normal state contain from 29 to 30 volumes of carbonic acid.

Reiset, in experimenting with large quantities of atmospheric air, has endeavored to eliminate the chief mistake made in earlier investigations. He used for his experiments two transportable aspirators, each having the capacity of 600 liters, which could be easily connected with an absorption apparatus. One of these aspirators was used in a free place far away from human habitations, while with the other experiments were made in such a locality where a difference in the quantity of carbonic acid might have been expected on account of an exuberant vegetation and other causes. Our illustration shows the absorption apparatus which Mr. Reiset used in his experiments.

I is a U-formed tube, which is filled with pumice soaked in concentrated sulphuric acid. In the lower part of this tube is a small glass globe serving the purpose of collecting the diluted sulphuric acid, which else would render difficult the passage of air through the tube. The tube, I, serves as a drying tube, and retains the moisture of the passing air, indicating by its increased weight the quantity of water retained. The dried air passes then through the tube, I, into the washing bottle, F, thus entering the absorption vessel proper. This forms the chief part of the apparatus, and its construction is based upon a principle which was employed by Schloesing in absorbing the ammoniac in the air. As the illustration shows, in the glass cylinder, T, there are fastened three capsules of thin platina plate, C, C', and C'', which have a somewhat conical form. Each of these capsules has a diameter of 4 cm., and contains about 120 small perforations, the width of each perforation being 0.5 mm.

T has the length of 0.5 m. By means of a tightly-fitting caoutchouc ring the cylinder, T, can easily be connected with the washing bottle, F. Before beginning the experiment, 300 cm. of a clear solution of baryta, the strength of which has been previously ascertained by means of volumetric analysis, are brought into the cylinder. The latter is then joined hermetically to the U-formed tube, I I, which has been prepared in exactly the same manner as the tube, I, and the connection of the apparatus with the aspirator is thus formed.

After the experiment was finished, i. e., after 600 liters of air had passed through the apparatus, Reiset found that a solution of baryta in the lower part, B, of the cylinder was

Lussac, and that notwithstanding the variable amount in which this gas is generated in different localities and added to the air, the diffusion takes place in a minimum of time.

ON POTASH FULLING SOAPS.

By W. J. MENZIES.

IN the first place, it cannot be too strongly insisted upon that nothing but a potash soap should be used for washing woolen goods of every description. It is a very great mistake to use a soda soap for such a purpose. Soda renders wool brittle and harsh, and gives it a yellow color. Potash lubricates the fiber, renders it soft and silky, and tends to bleach and whiten wool. It is generally admitted by the best and most intelligent worsted spinners and woolen manufacturers that this is the case—in fact, that it is difficult to spin a fine woolen yarn without the assistance of a good potash soap. This is quite indorsed by nature; when the wool is still on the sheep it is naturally covered with a waxy, oily substance generally called "grease;" this substance is found to consist to the extent of more than half its weight of actual potash combined with animal matter—hardly a trace of soda being present. It is generally found also in the case of plants, that potash is more easily assimilated than soda; hence it is less liable to do injury when used for scouring purposes, also in the case of vegetable as well as animal fibers.

Potash soap, so far, has not been used in this country nearly so extensively as soda soap. There are several reasons for this. In the first place, potash has not been so easily obtained in a pure form, Montreal ashes being the most general kind of potash in use by soapmakers. This article is obtained from the ashes of burnt trees, principally from Canada. They are collected together and mixed with lime, then thoroughly lixiviated in vats, and the resulting lyes boiled down and poured into moulds forming, when cold, solid blocks, which are then packed into barrels. The result is at best a potash containing some twenty per cent. of impurity; the product also is very variable, owing to the different kinds of trees from which these ashes are obtained. They are also often adulterated more or less with soda ash, the inspection of the potashes in Montreal, and division into "firsts," "seconds," and "thirds," being absolutely no guarantee whatever as to their potash contents. The inspector simply contents himself with testing their total "alkali" strength with an alkalimeter, and therefore in no way distinguishing between potash and soda. In this way it would be quite possible for a parcel of potashes to be branded as "firsts" in the Montreal warehouse when highly adulterated with soda ash, or even actually containing no potash at all.

Another reason why potash "fig" soap has not been much employed is that oil has been generally so much dearer than tallow or grease. Two oils were originally almost exclusively used for soapmaking purposes—fish oil and olive oil. The objection to the first is, that the smell is so very

* *Wiedem. Ann.*, 6, 520-544.

† *Comptes Rendus*, t. 88, p. 1007, and t. 90, p. 1144.

used in conjunction with a potash soap; if this is done it destroys the whole advantage of the potash soap, and it will be better at once to use a hard soda soap. For scouring or removing oils from woollen manufactured goods, even when soap is not employed, carbonate of potash should always be used, and never soda ash or soda crystals. For this purpose take either the best Montreal pearl-ash, or what is better and cheaper, the fine crystallized carbonate potash, lately introduced by the Greenbank Alkali Company, as it dissolves immediately in cold water, and besides being cheaper is much more uniform than Montreal pearl ash, as this article varies so much in quality.—*Chemical Review.*

THE ELECTRIC LIGHT IN THE GERMAN NAVY.

DURING the sojourn of the German Crown Prince in Kiel on July 27 and 28 of this year, the armored frigates Friedrich Karl, Sachsen, Preussen, and Friedrich der Grosse, of the German Navy, were ordered to participate in a sham battle at night. The entire combat was based upon the assumption that the ships were not provided with sufficient netting to protect them from fish torpedoes, and were therefore required to keep a sharp lookout. To assist the guards two very powerful electric lamps were provided at the stern of the frigate Friedrich Karl, and on the steam dispatch boat Grille, and lighted up the waters for a distance of seventeen hundred to twenty-five hundred feet, thus making it impossible for the torpedo boats to approach the frigates without being detected.

cient insulating separator to prevent the spark, and I challenge Mr. Preece, notwithstanding his well-known skill as an experimenter, to the production of an igneous discharge through a mere pinhole in the insulating covering of one or other of the conductors. In practically arranging electric lights for public buildings the insulated conductors are entirely separate, and the likelihood of danger to buildings is absolutely removed by the precautions taken. Mr. Preece's reference to the unfortunate musician and Russian sailor, who appear to have been struck dead by electric discharges while assisting to put up electric lights, is somewhat sensational. They must have been predisposed to succumb to an electric shock, and must have grasped firmly the two unprotected leading wires with moist hands; for I and many other persons have frequently touched both poles of a powerful dynamo machine without feeling any the worse for it. At the same time there are dangers connected with the establishment of this, as of almost any apparatus or machinery, which do not in any way apply to the user not set upon courting danger.

Mr. Preece also charges the electric light with being cold in appearance, but in reality "the greatest source of heat which science possesses." Now, I quite agree with him in this latter proposition, and have, indeed, constructed an electric furnace for fusing highly refractory materials; but I wish to guard against the inference that because the electric arc is hot, electric light must necessarily heat rooms in which it is employed to anything like the same extent as gas, or, indeed, any other illuminant. The following simple

Council of Birmingham to support my plans, measures were taken to obtain Parliamentary power to carry them into effect. It was intended to separate the two constituents of coal by a comparatively inexpensive method, supplying gas of low illuminating but high heating power to consumers at a cheap rate, and reserving the coke for use in locomotive engines and stoves, for which purpose it is eminently better suited than raw fuel. Unfortunately the bill was thrown out by a committee of the House of Lords in consequence of the opposition of the existing gas companies, and the proposal has remained in abeyance ever since.

GAS FOR FIRE GRATES.

While it is admitted by many that gas fuel can be used advantageously for heating furnaces, there still exists great objection to its use upon the domestic hearth, which is one of the largest sources of consumption of raw coal, and certainly the cause of a great amount of smoke in our metropolis. The gas fireplace sometimes used does not meet with public favor, owing to its uncheerful appearance, great consumption of gas, and most of all, from the smell which frequently results from its use. It is said to produce a "dry" heat—a term which, to my mind, conveys no definite meaning, seeing that the heat produced by an open fire place is purely radiated heat, precluding the idea of moisture; but I have observed that in the usual gas grates, consisting of a number of gas jets spread over the grate, and covered in with pumice stone or asbestos, the heavy gases

Armored Frigate Friedrich Karl. Dispatch Boat "Grille." Torpedo Boat. Armored Frigate Sachsen.

THE ELECTRIC LIGHT IN THE GERMAN NAVY.

Our cut, taken from the *Leipziger Illustrirte Zeitung*, represents the attack of the torpedo boats, and shows the brilliant effect of the electric light on the waters.

INTERESTING FACTS ABOUT ELECTRICITY AND GAS.

THE following letter by Dr. Siemens has been forwarded to the *London Times*, in reply to that of Mr. W. H. Preece, on "Electricity in Collieries," which appeared recently:

Mr. W. H. Preece, in addressing you under the title of "Electricity in Collieries" on the 2nd October, points out, very properly, I think, that the employment of the electric light would not be without danger in coal mines, because the electric arc and an accidental spark between conductors would be liable to fire a gaseous explosive compound. When examined before the Royal Commission on Accidents in Mines, I gave evidence to this effect, suggesting only an indirect application of the electric light, by which, if successful, the chances of accident would be minimized. I am not prepared, however, to follow Mr. Preece in his assertion that the electric light generally and under ordinary circumstances is an illuminant dangerous to life and property; his statements in this respect have actually caused unnecessary alarm to those who have trusted electricity for the illumination of public buildings. Mr. Preece says that "if a mere crack or pinhole were to occur in an insulating coating the currents would escape to earth, generating heat and producing fire," emphasizing this statement by asserting that it is not a chimerical one, but the result of practical information of his own. Now, the dynamo-electric current is powerful in the sense of doing a large amount of work, but its intensity is so moderate that it is only by rubbing the two unprotected conductors against one another that vivid sparks are produced. The interposition of a thin shaving of wood or other inflammable substance would in itself supply a suffi-

calculation, based upon actual experiment, will show what is the relative heating effect of the two sources of light within a room. To produce 4,000 candle power by electricity requires a current of 34 webers, which again represents 130 heat-units per minute. To produce the same amount of light by gas takes 200 Argand burners, consuming 16 cubic feet of 20-candle gas per minute, which consumption represents 15,000 heat units. Some additional heat will be produced in the electric arc, however, by the combustion of the carbon electrodes, which consumption amounts to 6.3 grains of carbon per minute, and will produce in combustion 12.5 heat units. The total amount of heat produced by the electric arc is, therefore, $130 + 12.5 = 142.5$ units per minute, or rather less than 1 per cent. of the heat developed with the same amount of light by means of gas. Gas lights produce, however, the further inconvenience of displacing the oxygen of the air by carbonic acid, and by a minor, but still very sensible amount of sulphurous acid.

GAS AS A FUEL.

If this calculation militates against gas as an illuminating agent, it proves, on the other hand, its great value as a heating agent; and just now, when so much is said about the smoke nuisance, I may be allowed to add a few words on that subject. For upwards of 20 years I have been actively engaged upon the development of a system of working furnaces for the manufacture of iron, steel, glass, etc., by means of gas fuel produced in a simple gas-generating apparatus. Some thousands of these gas producers are in operation, and furnish daily proof that gas may be used with economical results; and the smoky factory chimney, where it still exists, proves simply a disregard for the principles of economy. In the year 1853 I was anxious to take a further step in the same direction in proposing to supply towns with heating gas, and, having induced the Town

resulting from the combustion descend through the grate bars, and thus find their way into the apartment.

I have lately constructed in my own house gas grates that are certainly free from the defect just named, and which are at the same time economical and cheerful in their appearance. The arrangement consists in substituting for the fire grate below a solid plate, so as to exclude all communication with the atmosphere, except through the front bars.

A gas pipe perforated above with a certain number of small holes is connected to the ordinary gas service. The grate is filled with ordinary gas coke or anthracite, banked up well toward the back. In this way a cheerful fire can be kindled at any time by opening the gas tap and putting a lighted match to the grate. The gas flames, acting only in front of the grate, soon cause the surface of the coke to glow, without depriving the beholder of the cheerful appearance of the flame. In the course of half an hour the surface of the heap of coke is fairly red-hot, throwing out fully as much heat as an ordinary fire, while not a particle of flame or smoke reaches the chimney; the combustion of the gas prevents the rapid consumption of coke in front, and the absence of its consumption toward the back of the fire. When fairly ignited the gas may be almost turned off, because the coke, once well heated, continues its glow by slow combustion with the atmosphere. An ordinary grate may be converted into a coke gas grate as just described at a very trifling cost, and will be found convenient and inexpensive in its use even when using illuminating gas at 3s. 6d. per thousand cubic feet. Its economy will be materially increased by a sort of regenerative arrangement by which the heat, gradually accumulating at the back of the fire, is utilized to supply the gas flame with a current of hot air—an arrangement which it would take too much space to describe, but which I shall be happy to place at the disposal of the association recently formed with the laudable object of improving our winter atmosphere.