

ring motion on it, and that it seemed likely that any mechanical properties could be conveyed by suitably chosen motions. This was quite in accordance with Sir Wm. Thomson's suggestive address to Section A at Montreal.

THE HON. SIR WILLIAM R. GROVE, D.C.L.,
F.R.S.

WILLIAM ROBERT GROVE was born at Swansea in 1811. His father was a justice of the peace and Deputy Lieutenant for the county. He received his early education at Swansea Grammar-school, whence he passed to Darlington House, Bath, and afterward to Brazenose College, Oxford. It was originally intended by his parents that he should enter the Church; but for conscientious reasons he preferred to adopt the legal profession, and was called to the bar in 1823.

During an interval of forced leisure, occasioned by ill health, Mr. Grove was led to return to the favorite study of his youth—electricity. Original research was soon followed by important discoveries. In 1839 he communicated to the Académie des Sciences, through M. Becquerel, the first idea of the gas battery (afterward produced by him in 1841), viz., the fact that "if a positive electrode be immersed half in water and half in a tube of hydrogen, and a negative electrode in water and oxygen, the water ascends in the tubes, the galvanometer is deflected, and the water is decomposed and recomposed by galvanic action." Later on in the same year Mr. Grove discovered the nitric acid battery which bears his name, announcing it to the world in a communication to the Académie. In 1840 he was elected a member of the Royal Society. In the following year he laid before the Electrical Society a new and ingenious process for engraving daguerreotype pictures by means of electricity. From 1840 to 1847 Mr. Grove was Professor of Experimental Philosophy at the London Institution, and it was in a lecture delivered there in 1842, "On the Progress of Physical Science since the Opening of the London Institution,"



SIR WILLIAM R. GROVE.

that he briefly and clearly communicated the theory of the "Correlation of Physical Forces." This lecture was afterward further enlarged and published in 1846, since which time it has passed through several editions. The position taken up, to quote Mr. Grove's own words, was "That the various affections of matter which constitute the main objects of experimental physics, viz., heat, light, electricity, magnetism, chemical affinity, and motion, are all correlative, or have a reciprocal dependence. That neither, taken abstractedly, can be said to be the essential or proximate cause of the others, but that either may, as a force, produce the others; thus heat may mediate produce electricity, electricity may produce heat; and so of the rest, each merging itself as the force it produces becomes developed; and that the same must hold good of other forces, it being an irresistible inference that a force cannot originate otherwise than by generation from some antecedent force or forces." In spite of a steadily increasing professional work, Mr. Grove still continued to apply himself to scientific research. In 1847 he received the medal of the Royal Society, for his Bakerian lecture on "Voltaic Ignition, and on the Decomposition of Water into its Constituent Gases by Heat." Passing over several papers on the gas pile, etc., he spent some time in examination of "the electro-chemical polarity of the gases," "the electricity of flame," and the construction of a flame pile. He also conducted several experiments in search of the conversion of electricity into motion. In 1866 he was President at the meeting of the British Association at Nottingham, when he delivered an address on the "Continuity of Natural Phenomena."

In the midst of all this activity in study and research, which entitle Sir William Grove to so high a position among "Leaders of Science," it is hardly credible that he should have yet been able to reach as high an eminence in his own profession. He became a Q.C. in 1853, has been a member of several Royal Commissions, was knighted in 1871 on his elevation to the judicial bench, as Justice of the Common Pleas, and, by the operation of the Judicature Act in 1875, was appointed a Judge in the High Court of Justice.—*Science Monthly*.

PURIFICATION OF DRINKING WATER BY ALUM.*

By Profs. PETER T. AUSTEN, Ph.D., F.C.S., and
FRANCIS A. WILBER, M.S.

THE many discoveries that have been made during the last few years in regard to the transmission of diseases by drinking-waters have caused attention to be directed to the methods of its examination and the processes for purifying it. Chemical analysis can establish the presence of albuminoid matter in water, and by its means we are able to state if the water under examination can become a suitable nidus, or medium, for the development of disease germs. If the germs are actually there, or if the water contains a virus, or ptomaine,† biological examination alone can determine.

While physicians and scientific men are experimenting on the methods of water examination, and are endeavoring to understand fully the meaning of the results obtained, the public are chiefly interested to have some method by which they can purify their drinking water in a simple, cheap, efficacious, and expeditious manner.

Running over the substances which have been suggested and tried for the purification of water, there is none that seems to offer the advantages of alum. Particular attention was directed to its use by Jeunet in 1865, in an article published in the *Moniteur Scientifique* (page 1,007). He found that 0.4 gramme of alum to a liter of water (23.3 grains to one gallon) rendered it drinkable, even when it was quite full of foreign matter. The time taken for this clarification was from seven to seventeen minutes.

Alum is a double sulphate of potash and aluminum, and in this case breaks into potassium sulphate, which remains in solution, and a basic aluminic sulphate. This basic sulphate of aluminum, the composition of which is undetermined, precipitates as a more or less gelatinous and flocculent mass, and carries down with it the foreign matters and humus bodies. The sulphur-

III. Use of water clarified by alum in manufacturing.
IV. Removal of disease germs.
V. Removal of ptomaines.
VI. Removal of organic matter.

The investigation must needs be both chemical and biological. Only the first and part of the second cases have so far been examined.

I. THE EFFECT OF ALUM IN CLARIFYING WATER BY SETTLING.

It is evident that to obtain practical results in the clarification of water by alum, it must be added in such small amounts as to leave no unnecessary excess, and that neither taste nor physiological action should be imparted to the water. At the time of our experiments (January, 1885) the New Brunswick city water was quite turbid from clayey and other matters, so that we were able to obtain some very reliable results.

The amount of alum used in the experiments of Jeunet seems to be unnecessarily high, in case the water is to be drunk. Water was treated with the amount of alum recommended by Jeunet (23.3 grains to the gallon), but no perfect settling was obtained under six hours or more; in some cases not under twelve hours. The water thus treated had no perceptible taste of alum, but it gave a decided reaction for alumina when treated with ammonia, showing that the water contained a certain amount of free alum. While the amount is evidently too small to produce any physiological effect, there seems to be no necessity to use such an excess.

To determine the effect of alum as a precipitating agent, tall cylinders were filled with water and a solution of alum was added, the whole well mixed, and allowed to stand. It was found that in varying lengths of time, depending on the amount of alum used, a gelatinous precipitate settled out, and the water above it became perfectly clear. On adding a relatively large amount of alum, and mixing, the coagulation and separation of the precipitate is at once visible, the water appearing by careful examination to be filled with gelatinous particles. The amount of alum necessary for the precipitation of a water will, of course, depend on the amounts of impurity present, but in the present case, which may be taken as a typical one, we found that 0.02 gramme of alum to a liter of water (1.2 grains to a gallon) caused the separation and settling of the impurities, so that the supernatant water could be poured off. This amount of alum was shown by numerous experiments to be about the practical limit. The complete settling took place as a rule in not less, and usually more, than two days. It is evident that the amount of alum thus added is too slight to be perceptible to the taste, and can exert no physiological action. We were unable to detect the slightest taste or change in the water so treated.

Still smaller amounts of alum will produce a precipitate after longer standing. Sixty liters of the city water were treated with two grammes of alum (this was about 31 grains to 16 gallons) and allowed to stand. After forty-eight hours the precipitation seemed complete, and the water was perfectly clear, while the bottom of the vessel was covered with a brownish, slimy deposit. This substance was collected, dried, and analyzed. It gave—

Carbon.....	16.50 per cent.
Hydrogen.....	2.02 "
Nitrogen.....	0.77 "

It is evident from this analysis that a large amount of the organic matter has been removed from the water by the alum treatment.

On incineration, it yielded 59.28 per cent. of ash, which contained silica and alumina in relatively small amounts, oxide of iron in large amounts, and a considerable quantity of phosphoric acid.

To determine if there was free alum in the water, a sample of the clear water, filtered off from the precipitate produced by the alum, was made slightly alkaline with ammonia and warmed for some time. Only the merest traces of an alumina reaction could be obtained, and, in fact, in some cases, it was doubtful if a reaction was observable. To prove that no more matter could be precipitated by the addition of a greater amount of alum, samples of the clear filtered water were treated with more alum, but there was in no case any indication of further precipitation on standing.

We consider it, then, established that, by the addition of two grains of alum to the gallon, or half an ounce to one hundred gallons, water can be clarified by standing, and that neither taste nor physiological properties will be imparted to it by this treatment. By increasing the amount of alum, the time required for the separation and settling can be diminished, and *vice versa*, by diminishing the amount of alum added, a greater time will be required for the clarification.

This method is particularly adapted to the clarification of large volumes of water, where filtration is not practical. The cleared water can be racked off to as low a level as possible, after which the sediment should be washed out and the receptacle cleansed by a free use of water.

II. THE EFFECT OF ALUM IN CLARIFYING WATER BY FILTRATION.

In order to test the clarification of water by filtration after addition of alum, the New Brunswick city water was again made the subject of our experiments. It was found that the suspended clayey matters were so fine that the best varieties of filtering papers were unable to remove them. Even when several layers of heavy Schleicher and Schull paper were used, a very large portion of the suspended matters passed through. This, however, is not surprising, since it is well known that the mineral matters suspended in water are of a remarkable degree of fineness. Thus the water of the river Rhine, near Bonn, cannot be clarified by simple filtration, and takes four months to settle. The addition of certain chemicals aids the filtration of suspended matters in some cases, but it does not always entirely remove them. Calcium chloride and other salts are recommended as effective agents in aiding the removal of suspended matters, but in the case of New Brunswick water, at least, they have no apparent action. The following substances were found to have no effect in aiding the filtration of the water: sodium salts—chloride, carbonate, nitrate, acid carbonate, hydrogen phosphate, acid sulphate, ammonium phosphate, sulphate, biphosphate, tungstate, acetate; potassium salts—hydroxide, chloride, bromide, iodide, acetate, phos-

* From the advance sheets of the Annual Report of the State Geologist of New Jersey for 1884.

† Putrefaction alkaloid.

phate; ammonium salts—chloride, sulphate, nitrate, acetate; calcium salts—oxide, chloride, sulphate, nitrate. Zinc sulphate and ferrous sulphate (copperas) had no action. Acid sulphate of potassium and of sodium had a slight clearing action. Acetate and chloride of zinc had an apparent action. Ferric chloride (perchloride of iron) cleared perfectly, as also did the nitrate and sulphate of aluminum.

By the addition of a small amount of alum to water, it can be filtered through ordinary paper without difficulty, and yields a brilliantly clear filtrate, in which there is no trace of suspended matter. In our experiments, a solution of alum was added to the water, the whole well mixed by stirring or shaking, and then filtered after standing from one to fifteen minutes. So far as we are able to determine, the coagulative and precipitative action of the alum is immediate upon thorough mixture, and hence it is not necessary to allow the mixture to stand before filtration, but it can be filtered immediately after mixing.

To determine the amount of alum necessary to precipitate this water, alum was added in decreasing amounts to samples of water, which were then filtered through Schleicher and Schull paper. In this way we found that the minimum limit was about 0.02 gramme of alum to one liter (1.16 grains to one gallon). Beyond that point the action of the alum began to be doubtful, and the water, although clarified by filtration, was not wholly clear. To be sure of complete clarification, we took double this amount—0.04 gramme to one liter (2.3 grains to one gallon)—as a standard calculated to give certain results. This amount can be doubled or trebled without fear of any harmful results, but there is no use of adding any more alum than is sufficient to do the work. The determination of the amount of solids removed from the water by the clarification with alum had not yet been finished.

We consider it, then, as established that, by the addition of two grains of alum to the gallon of water, or half an ounce to the hundred gallons, water can be rendered capable of immediate clarification by filtration. The clear water obtained by filtration, after adding this amount of alum, contains no appreciable amount of free alum, and, in fact, in the majority of cases, ordinary tests fail to reveal its presence.

While the clarification of water by standing is very successful, and well adapted to the treatment of large volumes of water, especially when time is not an element of importance, the case will very frequently occur that a relatively small amount of water is to be purified in a short time. In such a case not clarification alone is demanded, but it is necessary that the operation should take as short a time as possible. Again, in order to make this method of clarification practical for domestic use, the operation of filtration must be made extremely simple. No complicated or expensive apparatus should be used, but the filter must be made out of the simplest articles, such as can be found in every household. In this field there is an opportunity for the exercise of considerable mechanical ingenuity, and when the principles of the filtration are understood and more is known about the different kinds of filtering materials, there will doubtless be many forms of house filters devised out of the odds and ends which may be at hand.

It is not a difficult matter to get up a large filter that shall clarify many hundred gallons of water a day in an effective manner. Such apparatus already exists, and is used in manufacturing establishments. In their construction, many points, such, for instance, as the cleansing of the filtering material, have been brought to a high grade of perfection. The difficulty lies in devising some form of simple and cheap filter which will filter a small amount of water as effectively as a relatively large amount, which will be always ready, will always work, will be so simple that any one can understand its operation, can be easily made, not easily broken, but easily repaired if broken, and which will not entail much extra work in order to get a clarified water. The filtering material must be cheap, easily obtainable, easily prepared, capable of being cleansed when clogged by use, or so cheap that it can be thrown away and replaced by new without appreciable expense.

It is evident that the shape, size, and arrangement of the filtering apparatus will depend very largely on the kind of filtering material used. Hence we began by experimenting on filtering media. The glass funnel and carefully folded paper will be of but little service outside of the laboratory. But in cases of great importance, such as the preparation of water for the sick, this method is worthy of attention.

In the large Hyatt filters a mixture of coarsely ground coke and sand is used, and does most admirable and effective work. Granulated bone charcoal also makes a most excellent filtering bed. The most practical material for domestic use, however, so far as we have been able to ascertain, is cotton. Cotton batting can be bought in the shops for about ten cents a pound, and a pound of it will go a long way in filtering. It makes a coherent filtering layer, and when clogged by use can be cleansed by boiling up in the water and rinsing, or, as it is so cheap, can perhaps as well be thrown away and replaced by new.

The simplest form of filter for filtering considerable amounts of water is a tube, one end of which is stuffed with cotton. A drain pipe is the best material, since it can be so easily cleansed. The plug of cotton should be from two to three inches thick, and may be held in place by a round piece of wood fitting into the bottom of the drain pipe at its shoulder, and secured by any suitable means. The piece of wood should be perforated, to allow the water to pass through. The shoulder of the pipe may be set in a circular channel cut in a piece of board, and by means of a central channel the water may be made to run off at a point of delivery. In our next report we shall present plans of simple filters, and the results of our experiments with them.

The most practical form of filter for household use, and one that will easily filter a pitcherful of water in a short space of time, can be made out of a bottle. The best form is the long kind in which sweet oil is sold, although almost any kind of glass or earthenware bottle will answer. The bottom of the bottle is cracked off, and the sharp edge removed by rasping with a file. The cracking can be done by tying a thin, soft string, soaked in turpentine, around the place where it is intended to crack, leaving as small a knot as possible, then setting fire to the turpentine, holding the bottle bottom up. After allowing the oil to burn for an

instant, the end of the bottle is placed quickly in cold water, when, if the operation has been rightly conducted, an even crack will be produced, and the bottom of the bottle will come off easily.

A layer of cotton is now placed in the bottle. The cotton must be worked in water, preferably warm water, in order to remove the adhering air, and to wet it well. A wad of the wet cotton is propped into the bottle, and covers the mouth of the neck. Other pieces are dropped in, care being taken to build the layer up evenly, and to add the cotton in rather small pieces. After dropping them in, they should be pressed down and arranged by means of a rod. In this way a layer is made which should be from two to three inches thick. It should not be pressed down too tightly, else it may filter too slowly; neither should it be too light, or water may form channels through it. After a little use the plug generally adapts itself. Particular care should be taken to be sure that the cotton is snug against both sides, since the water is liable to escape there. The plugs, however, are easy to make, and a few attempts will soon teach one all the necessary manipulations.

This bottle filter can be suspended or supported in any convenient way. Perhaps the simplest support is a block of wood having an auger hole bored through the center, and the edges of the hole reamed out. In this hole the bottle sits securely, and the bevel of the hole catches the shoulder of the bottle, thus holding it upright. To use this filter, it is only necessary to pour the water, which has been previously mixed with the right amount of alum, into it, when the clear water will run in a considerable stream from the bottom, and can be caught in any convenient receptacle. It is well to throw away the first tumblerful that runs through, if the plug is a new one, as a little sediment will pass through at first, but this soon stops. It is also advisable to keep the bottle nearly full while filtering, as this hastens filtration.

The mixing of the water with the alum previous to the filtration should be done in a separate receptacle. The only requisite here is that the vessel in which the mixing is done must be clean. A pail, jug, can, or any other vessel used in the kitchen will do. It is well to have the pail or can marked on the inside with scratches so as to be able without difficulty to judge how much water there is in it, since the amount of alum should be added in about the right proportions. The eye gets very accurate in judging the volume after a little practice, but it is better and just as easy to be accurate. A clean tin can of two to four gallons capacity is a good size, and, if possible, should not be used for any other purpose than for the drinking water. It should be kept scrupulously clean, and after each use should be washed out and dried. It can be graduated by pouring into it a gallon of water, and marking with a file or other sharp point a scratch just at the level of the water. Then another gallon is poured in, and its level also marked. In this way a graduation is easily made which is sufficiently accurate for all the purposes here intended. As a rule, a can of four gallons capacity will be found quite large enough to filter the water used by a family of average size. The necessary amount of the alum solution is added to the water, the whole well mixed by stirring, and then poured into the filter. Here, again, one or two points should be observed. The mixing is best done with a long handled spoon. A very practical stirrer is a small cake turner, for by means of its flat end a most thorough mixing can be effected. This mixer should not be used for any other purpose than to mix the water. Experience shows that, if the vessels used for mixing or holding the water are not kept perfectly clean, the water may acquire a taste, and this will be laid to the process instead of to lack of care. To facilitate the pouring into the filter, it is well to have the can provided with a mouth or spout. In fact, there is no form of can better than the regular garden watering pot, with its long spout.

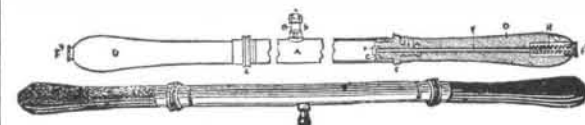
The solution of alum is made as follows: Dissolve half an ounce of alum in a cup of boiling water, and when it is all dissolved, pour into a quart measure and fill to a quart with cold water. (This solution should be kept in a bottle labeled "ALUM.") Fifty-four drops of this solution contain 2.3 grains of alum, which is the amount to be added to one gallon of water. The old-fashioned teaspoon holds about forty drops; the new spoons, however, hold about seventy drops. Hence, a modern teaspoon, scant full, will be about the right amount to add to every gallon of water to be filtered. No harm would be done if by mistake two teaspoonfuls are added; in fact, ten teaspoonfuls would have to be added to bring the amount of alum up to the figure recommended by Jeunet (*loc. cit.*). A more satisfactory method will be to procure a small measuring glass. One fluid drachm will be the right amount. It will be found, without doubt, that the amount required for some waters will be even less than that suggested above. We would suggest, therefore, that those who use this method of clarification determine for themselves by experiment how little of the solution is required to make the water they use run through the filter perfectly bright and clear.—*Chemical Laboratory of Rutgers College.*

THE AMMONIAPHONE.

THE accompanying diagrams illustrate one of the most remarkable inventions of the age. It is the outcome of twenty-nine years of hard labor in pursuit of a definite object. Dr. Carter Moffat says that when but a boy he was struck with the rather curious idea that the beauty of Italian vocal tone was due to something in the air of Italy, and that Italy as a resort for invalids was due to the same cause. He began at that early age to make chemical experiments, to prepare endless varieties of gases, solid substances, and fluid bodies, to inhale and to partake of these materials, in the hope that his voice might become benefited, and made strong and musical. It was his passion to improve the singing and the speaking voice, and he still felt that the beauty and mellowness of the Italian tone were to be attributed to its atmospheric peculiarities. For more than six years he attended the post mortem rooms of the Glasgow Royal Infirmary, and made over thirty-five analyses of the military tubercles in the lungs of persons who had died from consumption.

A little over ten years ago, Dr. Carter Moffat had occasion to visit Southern Italy, and he relates that no sooner had he reached the shores of the Adriatic than

he perceived the peculiar tint of the vegetation to be quite different from what it is in our own country. His chemical knowledge at once informed him that the yellow-green tint of the grass, the vine, the olive, the cabbage even, was due to a bleaching action—to something in the air—whence he proceeded to analyze the air and dew of the neighborhood. He says: "Reverentially did I kneel and withdraw that sparkling globule into a glass tube, and with anxious mind I applied a few delicate chemical tests. Roaming from plain to plain and valley to valley, I made over seventy-three analyses of the air and dew. I went to the valley in which the celebrated sympathetic tenor Guiglini was said to have been brought up, and in that peaceful spot I found the atmosphere almost saturated with peroxide of hydrogen and free ammonia. I noted the maximum proportion of hydrogen peroxide to be present in the air about from eleven to two in the daytime, dwindling down to a mere trace at dusk, and developing with the sunlight. The free ammonia appeared to be present in always about the same amount, no matter what hour of the day." These and subsequent experiments proving successful, he devoted himself to the perfection of the ammoniaphone, a task which engrossed his attention for nine years. The instrument which forms the subject of the later patent (taken out by Mr. C. B. Harness) consists of a metallic tube, containing a piece of rope saturated with ammonia, peroxide of hydrogen, and a few flavoring compounds, and provided with a mouthpiece midway between its ends. A ferrule or ring, having an internal screw-thread, is soldered or otherwise fixed at each end of the tube, A, D, are handles, each provided with an externally screw-threaded piece, E, which fits into one of the rings or ferrules, C, so that the handles may be screwed or unscrewed at will. Through each of the handles is passed a rod, F, one end of which extends through the piece, E, and carries a plate or disk, F, provided on its inner face with a washer of leather, India rubber, or other suitable material, so as to form a valve capable of closing the orifice or passage in the piece, E. A spiral spring, H, is placed upon each of the rods, F, so that it bears at one end upon the end of a recess or cavity in the handle, and at the other end upon a cap or push-piece, F, fixed on the outer end of the rod. This spring tends to press the washer, G, against the end of the piece, E, and thus close the orifice or passage, thereby preventing the admission of air to the tube. A small aperture, I, is formed in each of the handles, D, for the admission of air to the tube, A, when the valve is opened. The mouthpiece, B, has a perforated screw-cap. The person desiring to use the apparatus grasps the handles, D, and applies his mouth to the mouthpiece, B, then, by pressing push pieces, F, he



opens the orifices for the admission of air to the tube, A; he can then conveniently inhale the vapor of the substance contained in the tube. The instruments are made of various strengths, the strongest lasting for twelve months, when the saturated rope requires to be renewed. Weaker forms are more generally employed, which, when called into use four times a day, last for about two and a half months. We cannot but bear testimony to the remarkable qualities possessed by the instrument. Prior to determining to notice it, we examined it. One draught of air was inhaled, when, to our astonishment, the intensity of the voice was almost doubled, while its clearness was almost as greatly increased. The ammoniaphone is gaining many patrons, and it deserves them, for we are convinced that it is no exaggeration to say that "the employment of the ammoniaphone according to directions Italianizes the voice, and makes a weak voice, or a drawing-room voice, strong, rich, clear, and ringing."—*Knowledge.*

LIQUID PARAFFIN.

By LEON CRISMER.*

LIQUID paraffin is an oily substance, consisting of a mixture of hydrocarbons of the marsh gas series, which boils between 125°-240° under a pressure of 6 mm. It mixes with chloroform and ether in all proportions, forming a clear liquid, provided the chloroform and ether have previously been treated with metallic sodium to remove all water. The addition of a very small quantity of water or aqueous alcohol is sufficient to produce a turbidity in these solutions. This fact may be employed by a means of detecting water in chloroform or ether. In the same way, absolute alcohol dissolves a certain amount of liquid paraffin, forming a perfectly clear solution. A trace of water is, however, sufficient to produce a distinct turbidity.

The author also used liquid paraffin for the preparation of hydrobromic and hydriodic acids. A weighed quantity of phosphorus in the form of sticks is introduced into a flask, and covered with liquid paraffin. A quantity of bromine necessary for the formation of phosphorus tribromide is then gradually added; the flask being kept cool by immersing it in water. A regular evolution of hydrobromic acid may then be obtained by allowing water to enter the flask drop by drop. Hydriodic acid is prepared in a similar way.

HYDROGEN DIOXIDE.

By M. TRAUBE.†

SCHONBEIN's reaction for the detection of hydrogen dioxide, by means of potassium iodide, starch, and iron sulphate, requires a neutral solution. In the presence of free acid the reaction is very much less sensitive; and in very strong acid solution it is impossible to detect minute quantities of the dioxide. The author has found that the reaction loses none of its sensitiveness in strongly acid solutions, if a small quantity of copper sulphate is present. If to 6-8 c. c. of a solution containing potassium iodide, starch, and minute traces of hydrogen dioxide, from 1 to 4 drops of a 2 per cent. solution of copper sulphate and a little of a half per cent. solution of ferrous sulphate are added, a blue color will be produced in a very few seconds.

* Berichte d. deutsch. chem. Gesell., 17, 649.

† Ibid. 17, 1062.