

two parts of glacial acetic acid and one part of water. The acetic acid must be thoroughly saturated with alumina, and one can only be sure of this after it has remained for two or three days in contact with a portion of the precipitate. The solution of acetate of alumina should be filtered before use, and it must be kept in a well stoppered bottle.—*Photo. News.*

PHOTOGRAPHING A PISTOL BALL AND SOUND WAVES.

THERE is nothing absolutely novel in the photographing of a cannon ball during its flight, but such an experiment is ordinarily regarded as a mere curiosity.

Professor E. Mach, of the Physical Laboratory in Prague, has recently secured some remarkable photographs of a bullet during its flight, and has also obtained camera representations of other extremely transitory phenomena.

No mechanical exposing apparatus of the drop or spring-shutter type was used, but the required instantaneous exposure was secured by illuminating the object with the light of the electric spark. The ball was fired in the direction of a battery of Leyden jars, and in such a manner that it itself made the contact which produced the electric discharge serving to illuminate the projectile. In this way a far shorter exposure was realized than one could hope to attain by any kind of mechanical shutter. Professor Mach's experiments were made in a darkened room, and the objective remained uncovered during the whole of the time, but of course the plate only received the luminous impression of the instant when the ball was illuminated by the electric discharge.

The negatives are extremely small and transparent; but with a magnifying glass it is easy to distinguish the clear and sharp image of the projectile.

Not only has Professor Mach photographed the bullet in its course, but also the air streams which one may see over a Bunsen burner when bright sunlight is allowed to play on it; and, what is more surprising still, he has actually secured camera representations of waves of sound, these last being made visible by Toepler's method, in which advantage is taken of the irregular refraction of light by the air set in vibration by sound. It is to be hoped that by taking advantage of the intense and instantaneous light of the electric discharge, many physical phenomena may be registered by the camera; and we shall look forward with interest for further details of Professor Mach's experiments.—*Photo. News.*

BLEACHING AGENTS OF THE FUTURE.

By E. DWIGHT KENDALL.

"Nothing seems so difficult as the invention of to-morrow, nor so easy as the invention of to-day."

The best means of bleaching are with Nature's oxidizing agents, peroxide of hydrogen and ozone. The method of bleaching by the co-operation of sunlight, air, and moisture, the practice of which extends to most ancient times, depends on the formation of peroxide of hydrogen, from water and oxygen, under the influence of the sunlight. The peroxide [H_2O_2] contains two equivalents of oxygen, or twice as much as water [H_2O], one equivalent being slightly held, and therefore in active condition. The natural circumstances necessary to produce it have been studied; those which limit its production are not well understood. Water being capable of holding in solution only a comparatively minute quantity of oxygen, and the peroxide being formed by the combination of the water with its contained oxygen, the exhaustion of the latter must end the production of peroxide, except as oxygen is thereafter slowly absorbed from the air.

The action of peroxide on organic matter, as in bleaching, involves its own decomposition; it becomes water again, the oxygen given off uniting with the carbon and hydrogen of the organic matter to form carbon dioxide and water; if there be nitrogen in the organic body, ammonia also is produced. At present, peroxide of hydrogen in a form available for bleaching purposes is too costly for general use; its application is limited to fine goods. In its most concentrated state the peroxide has a spec. grav. of 1.45; it is without odor and colorless; it loses oxygen by slight elevation of temperature, but is comparatively stable when diluted with water. It bleaches without having, at any time, an acid character. The ordinary chemical process for obtaining it is not simple, but is susceptible of improvement; a new method, however, is likely to be followed.

Possibly a bleaching agent of the future is the natural purifier of the atmosphere, ozone, a body which has been the subject of much discussion, but whose chemical character and place in nature have been made known by the experimental researches of Schonbien, the discoverer, Williamson, Osann, De la Rive, Faraday, Marignac, Fremy, Becquerel, Horsford, Meldinger, Andrews, Hozeau, Van der Willigen, Cloez, De Lucca, Beauchamp, H. Clauson, Daubeny, Soret, Tommasi, and others.*

No method has yet been devised for producing ozone cheaply for bleaching purposes, although it has lately been employed to whiten sugar. It has also been used for the defuselation of liquors (i. e., the oxidation of the amyl alcohol and grain oils) and in the manufacture of vinegar. In limited quantities it may be obtained in various ways, for example, by the electrolysis of certain acid and saline solutions; by disruptive and, preferably, by silent discharges of frictional electricity through dry oxygen or air; by electro-inductive action: by oxidation of phosphorus in moist air or in moist heated or rarefied oxygen, or in oxygen with an admixture of hydrogen or carbon dioxide; by oxidation of certain essential oils; by treating potassium permanganate or barium dioxide, in fragments, with monohydrated sulphuric acid, etc.

The causes of ozone in the atmosphere are only partially known; it is to some extent the result of electric conditions. It is not generated by the action of sunlight on moist air. From whatever source obtained, it exhibits the same characteristics.† It is probably the most powerful oxidizing agent known. Its bleaching power is remarkable, a small quantity sufficing to discharge the color of an exceedingly large quantity of indigo disulphonic acid. It also bleaches several rosaniline and methylrosaniline colors; also corallin, iodine green, extracts of dyewoods, and, it is said, even Turkey-red. It readily attacks metals and oxidizes even polished silver; it decomposes salts of manganese monoxide, with separation of hydrated dioxide; it decomposes caoutchouc rapidly; it precipitates iodine like chlorine; it combines

with ethene and destroys hydrogen monosulphide and hydrogen selenide, with formation of water and separation of sulphur and selenium; it converts sulphurous acid to sulphuric acid and thallous oxide to thallic oxide; it precipitates peroxide of lead from plumbic compounds; changes yellow potassium ferrocyanide to red ferricyanide, sulphides to sulphates, and in presence of alkalis and air forms nitrates; it liberates chlorine from hydrochloric acid (which indicates that it is a more energetic agent than chlorine); it causes the explosion of potassium picrate, nitroglycerine, and iodide and chloride of nitrogen, etc. Finally it destroys ligneous and albuminous substances; violently attacks the mucous membrane, exciting catarrhal inflammation, and, in excess, kills animals and plants.

What is ozone? It is oxygen having the density 24, the density of ordinary oxygen being 16; Soret proved this by experiments based on Graham's law, "that the velocity of diffusion of a gas is inversely as the square root of its density." Heat decomposes ozone, reducing it to ordinary oxygen and increasing its volume by one-half. Chemists have agreed that the active character of ozone is due to its atomic structure; the molecule of oxygen being composed of two atoms of oxygen ($O=O$), that of ozone consists of three, [$O-O$] an allotropic condition easily disturbed, one unsatisfied atom being always ready to enter into a new combination. Potassium iodide absorbs this atom from ozone, reducing it to ordinary oxygen, the volume of which remains the same as that of the ozone, but the density changes from 24 to 16.

Ozone is regarded as the natural disinfectant or purifier of the air we breathe. From countless sources, effluvia poisonous to animal life, emanations from putridity, invisible miasmata and germs of contagion are discharged into the atmosphere; the active oxygen of ozone destroys these bodies, converting them into watery vapor and harmless gases. This is believed to be the office of ozone. Why may not peroxide of hydrogen, having like characteristics, have similar functions in the vast seas swarming with living creatures, whose existence requires pure oxygen and depends on the balance of nature? Ozone is gaseous and but slightly soluble in water; hydrogen dioxide is incapable of assuming the gaseous form, but is perfectly miscible with water, in which and of which it is formed; may it not be a scavenger of the sea!—*Textile Colorist.*

PYROXYLIN—GUN COTTON.*

By GUSTAVUS PILE.

Query: In making soluble gun cotton, what strength of nitric acid will yield the best results?

Under the general term gun cotton, there are included several varieties differing somewhat from each other in chemical composition and physical properties. By the action of nitric acid on cotton or cellulose, a number of equivalents of hydrogen are displaced by an equal number of equivalents of nitric oxide, which number may be altered by operating with different strengths and proportions of nitric and sulphuric acids, producing different forms of gun cotton, according to the amount of substitution. The variety which contains the greatest number of equivalents of nitric oxide is the most explosive, and is known as detonating cotton; it is, however, insoluble in ether and alcohol, and useless in pharmacy. As the quantity of nitric oxide is reduced, the products will be found less explosive, and at the same time more soluble, until a variety is reached containing so small an amount of nitrogen as to be but partially soluble, losing the explosive quality; merely burning instead, and leaving behind an ash. In the manufacture of any one kind, there will always be found present some of the other forms, which prove a source of trouble when preparing the particular variety best suited for making collodion; for when those forms which are but sparingly soluble in ether are present to any great extent, the resultant cotton will be very inferior or altogether useless. Our object, therefore, is to determine, if possible, what particular proportion and strength of acids will be required to produce the form of gun cotton that will be readily soluble and have as small an amount as possible of contamination with other varieties. In seeking to solve this question, I have made a great many experiments, using nitric acid of varying strengths, from 1.380 up as high as 1.450 sp. gr. I have added the sulphuric acid in large and small proportions; and following the suggestions of Mr. Charles H. Mitchell, whose paper appears in *The American Journal of Pharmacy*, 1872. I substituted various strengths of nitrous in place of the nitric acid, and in addition I made a number of experiments with having the mixed acids at different temperatures at the time of immersing the cotton, ranging all the way from 60° to 140° F. (15.5° to 60° C.), and in one instance continuously increasing the heat until 190° F. (87.7° C.) had been attained, when every trace of fiber had broken down. As a result of my labor, I do not find it an easy matter to state just what is the best formula of all that I tried, for I have obtained very good products when using the weakest as well as the strongest acids; still I am not willing to acknowledge that I learned nothing for my pains, and, taking all things into consideration, I believe that by using nitric acid of 1.450 specific gravity a very good cotton can be obtained with much less liability of a failure than where the weaker acids are employed; in fact, I met with little difficulty, and secured a good crop each time I operated with it. Cotton prepared from this acid will be found quite explosive, leaving no ash. It dissolves in the mixture of ether and alcohol, as directed in the Pharmacopœia, making a solution of such great viscosity, however, that at least twice the amount of liquid there stated is required to make a collodion of a proper fluidity. For these reasons, therefore, I offer the following formula, and believe it to be the best of all my efforts toward a solution of the query:

Take of nitric acid 1.450 sp. gr. and sulphuric acid 1.385 sp. gr. equal volumes each, and mix with a glass rod in an evaporating dish; cover this with a pane of glass and set aside till the temperature, which will be about 120° F. (48.8° C.) at the time of mixing, has fallen to 95° (35° C.) or 100° (37.7° C.). Then add as much absorbent cotton (not in thick wads, but well separated) as can be thoroughly saturated, and allow it to stand for ten hours longer. The acids are then to be poured off and kept for future use. Throw the cotton into a large vessel of water and wash well, a small amount of sodium carbonate being added to the last of the wash water. Transfer to a glass funnel or percolator, and allow a stream of water to pass through in order to remove every trace of adhering acid; after which, press out as much water as possible, pick it somewhat apart, and place it on several thicknesses of paper in a proper place to dry. The amount of acid may be taken by weight instead of volume, by

using them in the proportion of 10 parts of the nitric acid and 12 of sulphuric acid, the quantities being relatively the same in either case. When absorbent cotton is used, the amount ordered in the official formula appears to be too great, and I have had to be satisfied with about three-fourths as much; but if cotton yarn be used, which I have found to answer very well, nearly twice the weight can easily be incorporated. Samples of gun cotton and collodion, illustrating some of the peculiarities noticed, are presented for your inspection.—*Pharmacist.*

LIQUEFACTION OF GASES.

THE FREEZING OF ETHER AND ALCOHOL.

On the evening, of June 13, Professor Dewar gave an experimental lecture at the Royal Institution on *The Liquefaction of Gases*. Mr. Warren de la Rue presided. Among those present were Professor and Mrs. Edward Frankland, Sir William Bowman, Professor Tyndall, Lord Ranelagh, Professor Hughes, Miss Otley, Colonel Pinney, Dr. Topham, Dr. Maudslay, Miss Emmett, Dr. Macpherson, Earl Percy, Captain Baillie, Dr. Tidy, Mrs. Ralli, Rear-Admiral De Kanow, Mr. Dent, Mr. and Mrs. William Crookes, and Dr., Mrs., and Miss Edmunds.

Professor Dewar had arranged in the theater a variety of pieces of apparatus for the production of extreme cold far below that obtainable by means of a solution of solid carbonic acid in ether. He first, however, drew attention to an iron vessel containing carbonic acid liquefied by pressure; when the carbonic acid was permitted to escape by turning a stopcock it chilled itself by expansion, and became condensed as carbolic acid snow, which could be handled with impunity despite its intense coldness, because it does not touch the hand, a layer of its vapor being always between the hand and the snow. This snow floated on the top of cold water, but when he compressed it into carbonic acid ice by a force of between one and two tons to the square inch, it sank in water, and gave off bubbles of gas freely. The ice could not be so easily handled as the snow. A solution of solid carbonic acid in ether gives a temperature of -80° Centigrade, which is the boiling point of carbonic acid; at this temperature mercury is frozen rapidly. By placing the mixture under the air-pump, to increase the evaporation, he obtained a temperature of -110° C., and he stated that -115° C. is about the lowest temperature obtainable by means of solid carbonic acid, which was the lowest temperature Faraday could obtain in the state of knowledge in his day.

In the lower temperatures now obtainable, he said, an air thermometer is useless for measurement, for air itself can now be liquefied by cold and pressure. The thermometer he used was, he stated, both simple and effective. It consisted of long, thin bands of copper and iron soldered together at the ends so as to form a thermopile. The soldered junctions of one end of the pile were kept at a constant temperature by being placed in water containing melting ice; the other end of the pile was put in the liquid the temperature of which had to be ascertained. The current from the pile passed through the coils of a reflecting galvanometer, which threw a vertical line of light upon a long white paper scale stretching all across the back of the theater of the Royal Institution. The movements of this line of light along the scale indicated the temperature obtained in each experiment.

Liquid ethylene was the substance employed to produce the intense cold afterward employed by the lecturer. About five pounds weight of it, under a pressure of 100 atmospheres, was stored in an iron bottle. His assistants had been about a fortnight making this quantity. They made it a little at a time and then put it in the large bottle, which stood in a vessel surrounded with ice and salt to keep it cold; for ethylene cannot exist in the liquid form above the temperature 10° C. Ethylene is the chief illuminating constituent of common coal gas, and burns in air with a smoky flame. The boiling point of ethylene is -103° C., and by placing it under the air-pump a cold of -145° C. or -150° C. can be obtained. The following are the temperatures at which the gases named become liquid:

BOILING POINTS BELOW THE FREEZING POINT OF WATER.

| | Boiling Point below F. P. of Water. | Boiling Point in Vacuum. |
|--------------------|--|-----------------------------|
| | Degrees Centigrade. | Degrees Centigrade. |
| Carbonic acid | -80 | -116 |
| Nitrous oxide..... | -90 | |
| Ethylene..... | -103 | -142 |
| Oxygen..... | -184 | -198 |
| Nitrogen..... | -198.1 | |
| Air..... | -192.2 | |
| Carbonic oxide.... | -193 | |

The greatest cold yet obtained by man has been reached by two Russian physicists, Wroblewski and Olszewski, who by the use of liquid oxygen produced a temperature of -200° C. Hydrogen has been condensed into a mobile, colorless fluid; and although, chemically, hydrogen possesses the properties of a metal, in its liquid state it presents no appearance of metallic reflection.

The experiment of most interest to photographers was that in which Professor Dewar froze absolute alcohol. This was done by allowing some liquid ethylene to flow through a brass tube surrounded by solid carbonic acid and ether. When thus cooled it was passed into a large test tube, in the middle of which was placed a glass tube with a flattened bulb at the end, the bulb being full of absolute alcohol. The evaporation of the ethylene was then accelerated by the use of the air-pump, and the alcohol was frozen into a mass as clear and transparent as crystal. The tube containing it was turned bottom upward, and as it melted it assumed exactly the consistence of glycerine, flowing in a sluggish way down the sides of the tube. Ether requires less cold than alcohol to freeze it, and in several of the experiments ether ice formed on the sides of the glass vessels; but Professor Dewar said nothing about its peculiarities, except that it interfered with the view of what was taking place inside the vessels. The warm air of the theater was constantly condensing as snow or hoar frost on some of the vessels used in the experiments, and the chief difficulties of the lecture were the projecting of the experiments on the screen by the electric light so that all present might see what was taking place.

During the evening Professor Dewar momentarily liquefied oxygen. The lecturer also proved that ozone is a blue gas, which at a very low temperature dissolves in bisulphide of carbon, forming a blue liquid. As the temperature rises, the ozone oxidizes the bisulphide of carbon with explosive violence. He said that there was no reason why some of these condensed substances should not be utilized for prac-

*The writer investigated the nature of ozone, and published matter relating thereto in 1848-49.

†The purpose of this communication does not require reference to the electro-chemical theories of Prof. Odling and others, respecting ozone and antiozone.

*A paper read at the Pennsylvania Pharmaceutical Association meeting.