patent, to be either oxide of lanthanum and zirconium or oxide of yttrium and zirconium. The latter may be replaced by a quantity of erbium free from other elements belonging to this group of rare oxides; and the former by oxides whereof the elements belong to the group of rare earths which are found in cerite. Further, the zirconium may be entirely or partially replaced by magnesia.

In the formation of the cylinder, the cotton or woolen material is plaited into the required cone shape, and impregnated with a solution of nitrate or acetate of one of the before mentioned substances; and the tissue having been carbonized, there is left behind, as residue, the earthy matter in the form originally given to the tissue. Consequently, without any special manipulation being required, the burner may be supplied with its incandescent material.

Dr. Auer does not confine himself to the cone-shaped cylinder; but in the event of other forms being adopted, he advises that the more exposed parts of the material should be strengthened by a solution of nitrate of magnesia and alumina. Such is briefly the new incandescent gaslight which it has been stated is to effect a complete revolution in the gas industry.—*Jour. of Gas Lighting*.

PHOTOGRAPHIC REPRODUCTION OF THE LUMINOUS EFFECTS OF ELECTRICITY WITHOUT THE USE OF ORDINARY PHOTOGRAPHIC APPARATUS.

By Dr. M. BOUDET.*

GENTLEMEN: You will, perhaps, remember that it will soon be two years ago that I had the honor of showing you a series of experiments relating to the electric conductivity of rarefied gases. The results of these experiments fully confirmed the opinion of Mr. Edlund as to the conductivity of a vacuum; besides which, they rendered evident the place of formation of the electromotive force that occurs in a glass vessel that contains no air and is being traversed by a current of high tension. From this particular point of view, the experiments performed before you gave a slightly different solution from the one theoretically advanced by Mr. Edlund. At present, I shall set the question of principle aside, and put you in mind of one of the experiments—the only one that has a direct bearing on the new facts that I am going to talk to you about.

Three glass spheres, of exactly the same capacity and of equal thickness, were traversed at one point of their surface by a platinum rod whose free extremity reached the center of the sphere, and whose external portion was covered by a metal ball. One of these spheres was filled with water, another with Dutch metal, and the third contained a perfect vacuum. Finally, the whole three were covered with tin foil over two-thirds of their external surface.

Thus we had three condensers of the same surface, whose proper capacity we compared. Now, the sparks resulting from the discharge of them differed much from each other. That of the sphere containing water was long, thin, sinuous, and wanting in brilliancy, and was accompanied with a sharp crackling sound (Fig. 1). That of the sphere containing Dutch metal was short-

apparatus, but obtained merely imperfect results. More recently, I have tried the experiment anew by operating directly upon the gelatino-bromide of silver plate, and without even using Mr. Ducretet's apparatus. A photographic plate having been laid down flat,

tion to the study of the effluvia, and of the discharges of the Voss machine. The photographic results are shown in Figs. 4 and 5.

In studying the negatives, especially the one that gave Fig. 4, I perceived that the pieces of silver had left

FIG. 5.

sensitized side up, I placed two pieces of silver (a five franc and a five sous piece) upon it at a certain distance apart. I charged one of the condensers, and then putting its external covering in communication with the five franc piece, I placed the button of the lower rod

an imprint of their effigy. Struck by this fact, I placed a single coin in the center of the plate, and connected it with one of the poles of the Voss machine. Then I moved all around it an exciter connected with the other pole of the machine. The piece was thus sur-

FIG. 4.

FIGS. 1, 2, 3.

er, wider, more brilliant, and less sinuous, and the sound was louder (Fig. 2). Finally, the sphere containing a vacuum furnished a dazzling, very short and wide, almost straight spark, and the noise made by it was comparable to a detonation (Fig. 3).

Wishing to fix these phenomena durably, I tried to photograph the three discharges by means of ordinary

upon the fifty centime coin. A spark at once leaped between the two pieces. I renewed the same operation with each kind of condenser, and then put the plate into the usual developing and fixing baths. Figs. 1, 2, and 3 show the positive print that I obtained. You will see that all the details characteristic of each discharge are here reproduced with the greatest fidelity. My object was attained.

I afterward applied the same method of reproduc-

rounded with an aureola of sparks nearly an inch in length. As seen from the positive, all the details of the piece were perfectly reproduced.

To interpret the phenomenon was not one of the easiest things to do. Was the sensitization of the silver bromide to be attributed to a chemical effect of electricity, to the illuminating power of the sparks, or to a mechanical action analogous to that which occurs in the well-known experiment of "Franklin's portrait"?

* A lecture delivered before the International Society of Electricians.

A priori, it seemed to me possible to discard the intervention of a direct chemical effect, and this opinion, moreover, was confirmed by other experiments. There now remained the mechanical and luminous actions. The following are the experiments that allowed me to solve the problem.

When we examine the positive proof of the five franc piece, we see that the salient parts of the effigy come out in white, exactly as if a photograph had been taken by ordinary apparatus. Everything, therefore, pointed toward the taking of a counter proof by means of a matrix in metal. I therefore operated on a very old seal of the city of Padua.

You will see that, this time again, the impressing of the negative occurred just as if it had been a question of an ordinary photograph, and the depressions came out in black in the positive proof. Pushing my investigations still farther, I drew a figure with common ink on very thick paper, which I afterward interposed between a metal disk and the photographic plate. This time again the reproduction was effected as in the case of an ordinary photograph; and what is particularly interesting here is that, although the paper, despite its thickness, was traversed by sparks at several portions of its periphery, the drawing was not reproduced at the level of these points. It became difficult, then, to call in a mechanical action of the discharge in order to explain the impression made upon the silver bromide. On another hand, if this latter effect is really the consequence of the illuminating power of the discharge, we ought to be able to increase the effect obtained by increasing the light under the design to be reproduced, that is to say, by laying the plate on a mirror. Experiment fully decided in favor of such a hypothesis, for the negatives became much sharper, and the contrasts of light and shade much more clearly defined.

Besides, I thought that the effluvia, because of its violet tint, must have a higher actinic power than the white light of the spark, and the result fully answered my expectation.

From the moment that it was proved to me that the impression made on the silver bromide was due to the luminous action of the electric effluvia, and that such action reached its degree of maximum when it was reflected by a mirror, it seemed to me possible to reproduce any object whatever, metallic or not. I then placed upon a sensitized plate an ordinary photographic card of which the under side was covered with tin foil, and afterward passed the effluvia over its entire periphery. In this way I obtained a reproduction of the photograph.

I have to confess that the proof which I show you is far from being as perfect as the others; but this is due to two causes, viz., first, I am only a bad apprentice in photography, and do not yet know what quantity of light is necessary to give a negative all its sharpness; and second, as the card was varnished, there was considerable glittering on its surface under the influence of the obliquely reflected light. I believe that this latter cause plays a large part in the relative darkness of this reproduction. However this may be, the principle exists. The different prints that I have submitted for your examination prove sufficiently that the illumination produced by the electric effluvia, and reflected by a mirror, permits of reproducing with all its details, whether sunk or in relief, any plane object whatever laid upon a gelatino-bromide of silver plate.

Perhaps, on pushing these researches still further, we shall reach truly practical results, and find some industrial applications of the principle. Not having the necessary leisure to continue the experiments myself, I present you with these first tentatives, in order that those of you whom the thing interests may renew them and make them entirely successful.

In the train of this communication, some persons have objected that as common ink contains iron it might be considered as a conductor of electricity, and that as the paper is prepared with a silver salt, a catalytic (?) effect might occur on the contact of the paper with the gelatino-bromide plate. I believe that the presence of the varnish is sufficient to dispose of such a hypothesis.

Meanwhile, in order to content the most incredulous, I have performed the experiment anew with India ink and pastel drawings, and with various papers, and the results have been the same in all cases. Moreover, I shall before long show that there is even no need of having recourse to electricity for reproducing any drawing or engraving whatever, thus at once doing away with all questions as to conductivity, and proving that light alone acts in these phenomena of direct photographic reproduction.—*La Lumière Electrique*.

JOB'S CONUNDRUM.

A LECTURE ON WATER-SANITATION.

Before the Polytechnic Association of the American Institute, April 22, '86.

By WILLIAM C. CONANT.

"WHO can bring a clean thing out of an unclean?" Job gave it up; but his conundrum has been solved. The answer lay under Job's feet, but it lay too deep for him to see. Science (which is nothing but an understanding of Nature) and art (which is substantially but imitation of Nature) have in the course of four thousand years penetrated the secret, and they have also bettered the instruction. What the Creator alone had done, man can now do—with improvements.

But to extract a pure crystal element from the solution of mud and mortality supplied by our city aqueducts is more than a conundrum. It is one of the most urgent of practical problems for all accumulating communities, no matter how pure their original water supply may have been furnished to them by Nature. For Nature's water-sanitizing processes, great and wonderful as they are, begin to be overpowered as soon as multiplying men and domestic animals begin to crowd together and to exhaust her chemicals and choke up her filter beds with excess of organic refuse. The problem then instantly arises: how to bring again the clean thing out of the polluted. Pestilence after pestilence presses the question, from generation to generation, until at last it is noticed that the soil beneath the feet of dense populations becomes saturated with germs of malignant disease, which are drained thence into streams and springs, and carried by them to all who drink of them.

That air and water are the grand carriers of disease

and death is now a truism. It is settled that their impurities cause all the untimely deaths by disease that are not due to individual imprudence or transgression. Authorities and instances without end might be cited to prove this, but their real office at the present day would be merely to freshen a conviction that has long been established in every intelligent mind.

While Dr. Farr was Registrar-General of Vital Statistics for the City of London, his tables showed that whenever the temperature of the dirty Thames water was over sixty degrees, the deaths from diarrhoeic diseases in the district dependent on the river water were three times more numerous in proportion to the population than in the other districts. As was stated in a report from the medical members of the Newark Board of Health, "The majority of sanitarians agree that water is the common carrier of contagious diseases, and all agree that it is the vehicle of two of the chief scourges of mortality—Asiatic cholera and typhoid fevers."

During the visitation of cholera in London, one side of a street was ravaged, while the other side, supplied with water from a different source, escaped. An eminent hygienist says that the always floating products of the decomposition of leaves, wood, etc., and all forms of vegetable matter, are the most frequent causes assigned for epidemics of typhoid fever.

The late terrible devastations of cholera in Spain covered in general only the territory just previously covered by unprecedented floods, which left in their subsidence immense quantities of decaying vegetable matter all over the surface of the country.

The recent frightful epidemic in Plymouth, Pa., was literally washed down into the devoted village by a clear mountain stream, from the dwelling of a single sick family. The report on the Croton water by Elwyn Waller, Ph.D., chemist, to the Board of Health of New York city, states the chief dangers in drinking water to be the nitrogenous constituents that predominate in the excreta and decomposing carcasses of animals, washed down from the entire watershed territory that supplies the city with water, together with a more limited, but always present, proportion of such matter in the vegetable decay that everywhere is carried into the streams, besides lower forms of vegetable life which are never absent from water except possibly in rare cases in artesian wells.

One great cause of public supineness on this subject is a false security in the use of waters that have never yet proved pestilential, and that are therefore assumed to be safe for the future also. Nothing could be more opposed to fact, and to fact of constant recurrence, than such an inference as this. The Plymouth epidemic, just mentioned, and a precisely similar case in Lausanne, Switzerland, flowed from sources the least probable, among the conditions of water supply, that could be found anywhere in the world; from mountain streams of rare purity suddenly contaminated, through causes such as can never be generally prevented, with the deadliest germs of pestilence. The same thing may happen, in spite of all precautions, to any stream, spring, or well on which families and even cities are depending for this vital element.

THE DANGERS OF DRINKING

grow constantly with the growth of population.

"Life eminent creates the shade of death."

Life is suicide. It not only wears itself out, it continually produces and uses the means of its own destruction. This fact is most remarkable with respect to cumulative life, or the community of man, in its collective operation. It is not necessary to go to large cities for the most striking illustrations of the process. A single house far up on a mountain side, by a pure stream, has in repeated instances, such as I have already referred to, contributed through that stream the seeds of a plague that decimated populations far and near. The natural conditions of existence were the most salubrious; but the accumulation of human life engendered dangers of which Nature knows nothing.

And so it may happen at any time and any place, where human life accumulates and works unguardedly on the elements that are "ordained to life," but are liable to become charged from the human system with the germs of death.

Thus indeed it does happen, here and there, all over the world. A woman from a cholera district washed her clothes in a stream in Spain, and half depopulated with cholera the region below, while not a case occurred above. Modern news collection discloses these sudden epidemics with appalling frequency, but their frequency is nothing new under the sun.

To quote Professor Cook, of Rutgers College, State Geologist of New Jersey: At first, when a country is thinly settled, we get pure water from wells; but as the country becomes covered with towns, cities, and factories, the earth gradually becomes filled with their accumulated impurities. Thenceforward, the rainfall and drainage, soaking through the ground and into the wells, makes them more and more unwholesome and dangerous. The same is true of springs. Streams draining a thickly settled country, or a farming region where fertilizers are used, and where Paris green and other poisons are freely applied to destroy insects, must often become very much contaminated. The natural filterage and chemistry of purification, which suffices to remove the impurities coming from a sparse population, is overpowered by the enormous filth of great multitudes, with their often noxious manufacturing refuse, and of course fails to do a work for which its measure is so inadequate.

Driven wells have no such exemption as some suppose. Their water may be good at first, even in a crowded city, but the inevitable filth of the situation will be sure at length to make its way down the sides of their pipes to the water courses which they drain. Of four samples of driven well water submitted to Professor Cook, one after standing became black, covered with scum, and gave out an offensive odor. Moreover, the sources of contamination are liable to exist in connection with the subterranean water, unsuspected, at a great distance from the point where it is tapped by a well. Within my own knowledge, a driven well 40 ft. deep, in a valley, was constantly pungent with copperas, apparently from the vaults and cesspools of a hotel of epidemic repute a mile away on the mountain. The silly copperas did nothing to neutralize the organic poisons to which it was applied. All it did was to identify with a poisonous source the water of that deep and remote well, and that it did unmistakably.

Until lately, the most of these local epidemics were classed among the inscrutable mysteries of Providence. Now, they are clearly known to flow from fountains poisoned by the disorders and mistakes of man. The channels that convey these human mischiefs are often subterranean and long, defying scrutiny, and consequently their sources are only to be suspected, not discovered. But wherever a mysterious visitation of malignant disease falls upon a community or a family, we now look with certainty for the cause in some contamination, near or remote, of the common elements of life, especially water. If we cannot discover it, more's the pity; but we are none the less certain that it exists.

The inference from all this multitude of facts is irresistible, that plagues are possible at all times and places, and are actually occurring, from time to time, from the sudden and secret contamination of any supply of drinking water that is not systematically purified.

Theoretically, contaminated waters are classed among avoidable causes of disease, but practically they have been unavoidable hitherto for nearly all mankind. It is from this cause that sanitary improvement lags so far behind the other arts of life in this great age of progress. In the matter of life, health, and longevity, man has not yet begun to reap the fruits due to him from the progress of science and arts. Not until the present hour have the dangers and devastations of contaminated water met with their match among the masters of applied science. Hitherto, the invention of apparatus adequate to the effectual and economical purification of all waters, in all situations, and on the large and continuous scale indispensable to a real sanitary revolution, has been delayed. This now happily accomplished, that which still remains necessary is for those who have the ear of the public to rouse the public mind out of the apathy of discouragement on this subject; to revive sensibility to the appalling facts of mortality and pestilence, now preventable, to which hopeless use and wont have hardened us. It is time for humanity to lift up its head, and begin to aspire, not unreasonably, to a better condition on this earth than it has ever seriously imagined heretofore.

Furthermore, there is an opinion to be corrected, but which has been industriously fostered (from a motive which was good in time past) by the sanitary guides of the people themselves, namely, that dirty water is not necessarily unwholesome. People in cities especially have needed encouragement to drink, and to drink without panic, the repulsive water of their aqueducts. They might otherwise do worse. It was the best they could have, and it was wise to try to shut their eyes and make the best of what could not then be bettered. Commercial considerations have powerfully influenced publicists and even professional men to palliate the evils of a water supply for which they could see no remedy. But common sense needs only to be left to itself to see that dirt is not good to eat. The senses reject it with instinctive loathing, and it is decidedly "cheeky" in doctors to tell us that we may as well swallow it as not. The time is now past for this kind of "pious fraud." There is no further necessity for drinking dirty water, to say nothing of poisoned water, whether on the Mississippi, the Ohio, the James, or any other muddy stream; on water courses lined with manufactories and cities, with their filth-vomiting sewers; or in capitals like New York, Boston, Philadelphia, Washington, or Chicago, whose costly water supplies are all growing more repulsive, more in peril of secret contamination, and more in need of a fresh "character" every year from the complaisant medical servants of such municipalities.

The announcement deserves to command universal attention—water purification is now a perfected art. The thing is done; done on a large and illimitably elastic scale of quantity and rapidity; done without interruption; done without end; and done almost without practical increase of water charges in cities—perhaps two or three per cent.

You can see all this for yourselves on any day and every day of the year, in Raritan, Somerville, or New Brunswick, N. J.; in great manufacturing establishments, sugar refineries, breweries, hotels, etc., in this neighborhood; and in such cities as Chicago, Cincinnati, and others, in the West; and at the late Exposition at New Orleans the muddy Mississippi was transformed, to the extent of a million and a half gallons per day, into crystalline water rivaling for purity and brilliancy the water of the most famous bleachery springs, and from which had been separated, by accurate demonstration, ten tons a day of solid filth!

THE ESSENTIAL PRINCIPLES OF THE OPERATION

are four, three of which are exact copies from Nature, and the other is an improvement on Nature's less practicable device. First, the microscopic impurities that will go through anything that water will go through (and these are the most corrupt and dangerous of all) must be detached from their state of solution or intimate diffusion, and conglomerated in particles not too minute to be stopped in the meshes of a fine bed of sand and coke. Nature has done exactly this thing in every drop of pure spring or well water in the world, and has done it in exactly the same way that the answer to Job's conundrum does it. How is this?

ANSWER: All soils contain traces, usually very minute, of the salts of potassium, aluminium, calcium, or iron. Every drop of water passing through the soil is affected by an inconceivably small quantity of one or more of these salts. The effect of the infinitesimal dose is among the wonders of chemistry. It seizes upon every atom of soluble impurity diffused in the water, and either transforms and precipitates them, or sticks them together so that they cannot pass through the great filter beds of sand and porous seams of rock that Providence has arranged for the sanitation of drinking water. These metallic salts, together with the organic and other impurities that they have collared and corraled, are thus entirely detained for the nourishment and health of plant life, in which they play a second time a part of utility wonderfully out of proportion to their quantity.

The double sulphate of potash and alumina commonly called alum, is a pungent and astringent salt, which few except children enjoy tasting. It is not poisonous, and yet, to keep it in water pitchers, as many of the good people of Richmond, Va., are said to do, in companion chunks to their ice, could not be recommended for a salutary effect on the alimentary canal, in the long run. But why do they do this?