Rutherford considers the emanation to be the result of successive chemical changes in the thorium. By chemical action the thorium atom produces a substance which he calls thorium X, and by a further chemical change, this thorium X produces the emanation. The emanation expels from itself a negatively charged body, which constitutes the Becquerel rays. These rays are the same as those produced by radium, polonium, actinium, and uranium.

It has been recently proved by scientists who have experimented with thorium, that its radioactivity and emanations are antiseptic, antifermentative, and inimical to germ life. In conjunction with Hugo Lieber, we have shown that grape juice, when exposed to radioactive matter, will not ferment for a month, even though it is kept in a warm room, with the bottle uncorked. In other experiments the oils of juniper and erigeron were used. These oils ferment and decompose in a few days if left exposed to the light. But after treatment with thorium emanations, even in the presence of light, they nevertheless were preserved in their original state for several weeks.

The antifermentative property of thorium emanations is further shown by the following experiment:

Two bottles were taken, each containing agar-agar, starch, and mold (such as may be obtained from fermenting fruit). The contents of one of these bottles were subjected to the radioactive emanations of thorium, and those of the other were not. In the first bottle the growth of the mold was greatly inhibited, whereas, in the second bottle, the mold grew abundantly and soon filled the bottle. From these observations it is evident that thorium has a marked effect on micro-organisms and fermentation, a fact suggestive of a vast field of usefulness in medicine.

The radioactivity emanates from thorium in every form, whether in powder, solution, paste, or ointment. The best results, however, are likely to be obtained from the gaseous emanations when used as an inhalation. This form of emanation may be obtained, either by making a solution of thorium nitrate, or, better still, by heating the oxide in a glass receptacle, on a sand bath. For external application thorium may be made

of the emanations leaves in the lung cells a fine film of radioactive matter, which, in turn, produces the phenomenon of induced radioactivity in the same parts. This "induced" radioactivity will remain in the air-cells long after the original emanations have been exhaled. In most cases it lasts for from one to two days, after which it gradually disappears. In this connection it is interesting to observe that the radioactivity of thorium can be proved, even after it has entered the lungs. If a patient inhales the thorium emanations, and then, while in a dark room, exhales, allowing the breath to come in contact with a photographic plate, the exhalation affects, and partly decomposes, the silver salts on the plate.

As the induced radioactivity of the thorium emanations lasts from twenty-four to forty-eight hours, this acts as a guide to indicate the proper frequency for the treatments. An inhalation given every day or every other day would keep the lung cells constantly in a radioactive and antiseptic condition. While the thermometer in the Lieber apparatus should indicate a temperature of from 250 deg. to 300 deg. F., the emanations are partly cooled by passing through the glass and rubber tubing, and may not be much above the normal body temperature at the moment of inhalation. These inhalations may be taken for a period of fifteen minutes at the outset, which period may be gradually increased to half an hour.

This method of treating tuberculosis will not interfere with other measures, such as dietetic, hygienic, and even drug treatment.

CONDUCTIVITY OF DIELECTRIC LIQUIDS UNDER THE INFLUENCE OF THE RADIUM RAYS AND OF THE ROENTGEN RAYS.*

From the French of M. P. CURIE.

I HAVE ascertained that the rays of radium and the Roentgen rays act on dielectric liquids as on the air, communicating to them a certain electric conductivity. The experiment is performed in this way: The liquid experimented with is placed in a metallic vessel,

FIG. 4.—LIEBER'S APPARATUS FOR THORIUM INHALATIONS.

1. Bunsen burner. 2. Tin vessel containing white sand. 3. Glass vessel containing thorium oxide. 4. Thermometer. 5. Inlet for air. 6. Spiral glass tube to prevent escape of emanations. 7. Outlet for emanations. 8. Mouthpiece for inhalations.

into a paste or a 25 per cent ointment, and used as an antiseptic in chronic skin diseases, particularly those of parasitic origin.

Thorium in Tuberculosis.—Dr. Soddy, of London, and Prof. Rutherford, of Montreal, have suggested the use of thorium inhalations for tuberculosis. Certainly, from its antiseptic and antifermentative actions, it would appear to be a desirable agent to apply directly to the tissues affected in the fight against the tubercle bacillus.

As I have previously stated, there are two methods of obtaining these radioactive emanations, for use in the treatment of tuberculosis. One method is to use a saturated solution of nitrate of thorium in a large shallow receptacle. The larger the area of the vessel, the greater the amount of the emanations. A slight current of air can be caused to pass over the solution from a compressed air tank, while the patient is inhaling. With the nitrate of thorium there may be more or less free nitric acid; this must be neutralized by passing the emanations, before inhalation, through a wash-bottle containing a saturated solution of sodium bicarbonate.

The other, and by far the best, way of obtaining the emanations, is by heating the oxide of thorium. The apparatus I am using for this method of inhalation is the invention of Hugo Lieber. The accompanying cut shows the various parts of the apparatus, and the method of administering the thorium emanation.

The radioactivity of thorium is many thousand times less than that of pure radium, but thorium is also many thousand times cheaper (\$7 a pound), and it can be used for a longer period of time at each treatment, thus making up by the increased duration of the treatment what it lacks in potency.

Rutherford states that "when thorium nitrate is changed into an oxide by heat, it temporarily loses its radioactivity. However, when it is exposed to the air, it soon begins to regain its activity. In four days it is one and a half times more active; in twelve days, two and a half times; and at the end of two weeks it reaches its maximum radioactivity, which is four times as great as was the original nitrate of thorium."

In using Lieber's thorium apparatus, the inhalation

in which a thin copper tube is inserted. These two metallic pieces serve as electrodes. The vessel is kept at a given potential by means of a battery of small cells, of which one of the poles is earthed. The tube is connected with an electrometer. When a current traverses the liquid, the electrometer is kept at zero with the aid of a quartz piezo, which gives the measurement of the current. Another copper tube connected with the earth serves as a protection for preventing the passage of the current through the air. A bottle containing the radium-bearing salt is placed at the bottom of the first copper tube. The rays act on the liquid after passing through the glass of the bottle and the walls of the metallic tube. The radium will also act by placing the bottle beneath the vessel.

In order to act with the Roentgen rays they are introduced through the bottom of the vessel.

The increase of conductivity by the action of the radium, or the Roentgen rays, seems to be produced for all dielectric liquids; but in order to note this increase it is necessary that the conductivity peculiar to the liquid should be quite small in order not to conceal the effect of the rays. By operating with the radium and the Roentgen rays I have obtained results of the same order.

When the conductivity of the air or of another gas under the action of the Becquerel rays is studied with the same arrangement, it is found that the intensity of current increases proportionally with the difference of potential between the electrodes, when this difference of potential is slight, a few volts with the apparatus referred to; but when the difference of potential increases more and more, the intensity of the current no longer increases proportionally. The effect of an increase of tension goes on diminishing, and for high tensions (100 volts) the intensity of the current increases only to a small part of its value when the difference of the potential is doubled.

The liquids studied with the same apparatus and the same very radiant product behave differently. The current is proportional to the tension when this varies between 0 and 450 volts, even when the distance of the

electrodes does not exceed 6 millimeters. The conductivity occasioned in different liquids by the radiation of a radium salt acting under the same conditions may then be considered. The numbers of the following table, multiplied by 10⁻⁴, give the conductivity in ohms per cubic centimeter:

Carbon sulphide	20
Petroleum ether	15
Amylene	14.
Carbon chloride	8
Benzine	4
Liquid air	1.3
Vaseline oil	1.6

It may, however, be supposed that liquids and gases behave in a similar manner, but that for liquids the current remains proportional to the tension up to a much higher limit than for gases. The law of proportionality in the preceding series of experiments ceases to be verified only for tensions above 450 volts.

By analogy with what occurs for gases, the limit of proportionality may be lowered by employing a much weaker radiation. Experiment has verified this supposition. The product employed was one hundred and fifty times less active than that made use of in the first experiment. For tensions of 50, 100, 200, and 400 volts, I have obtained currents, which may be respectively represented by 109, 185, 255 and 335. The proportionality is no longer maintained, but the current still varies a great deal when the difference of potential is doubled.

Some of the liquids examined are nearly perfect insulators when sheltered from the action of the rays and kept at a constant temperature. Such are liquid air, petroleum ether, vaseline oil, and amylene. It is then quite easy to study the effect of the rays.

Vaseline oil is much less sensitive to the rays than petroleum ether. It is perhaps correct to refer this fact to the difference of volatility between these two hydrocarbons. Liquid air in a state of ebullition for some time in the experimental vessel is more sensitive to the action of the rays than that which has just been poured in. The conductivity produced by the rays is a quarter greater in the first instance.

I have studied the action of the rays on amylene and on petroleum ether at temperatures from +10 deg. to -17 deg. C. The conductivity due to the radiation becomes feebler by a tenth part only of its value when the temperature descends from +10 deg. to -17 deg.

In the experiments in which the temperature of the liquids has been varied, the radium can be kept either at the surrounding temperature, or carried to the same temperature as the liquid; the same result is obtained in both cases, from the fact that the radiation of radium does not vary with the temperature, and still preserves the same value even at the temperature of liquid air, as I have verified directly by measurement.

A CALORIMETER FOR COAL AND OIL.

It is of interest in the industries always to know with certainty the calorific capacity of any given variety of coal and oil, and for determining this there have been devised a certain number of calorimeters, the use of which, however, requires precautions and manipulations that are often very delicate. In many manufacturing there are laboratories in which all experiments that require a little care and study are performed, but such is not the case in the minor industries, in which simple and practical apparatus are indispensable. The want of such instruments is frequently the cause of expenses that might be avoided by manufacturers if they were provided therewith. It is evident that it is very important to know perfectly the quality of the coal employed, since coal that is well adapted for use in one case may prove inferior in another.

The calorimeter devised by Mr. Campbell Houston, of the Technical College of Glasgow, marks a progress in this line, and requires but a few manipulations, while the experiment proceeds under the eyes of the operator. The apparatus consists essentially of a large test-glass, which is filled with water into which is inserted a thermometer. The specimen of coal to be examined is reduced to powder in a mortar, and 30 grains of it are then put into a crucible, which is placed in a glass vessel that may be hermetically closed. This vessel is provided with an aperture to permit of the entrance into the interior of a tube for introducing oxygen taken from a reservoir. It is always well to employ the oxygen that is sold in the market in special cylinders. It may be manufactured upon the spot, but that is a complication.

After the powder has been put into the closed vessel, the latter is placed in the test-glass, into which has previously been poured two quarts of water, that is to say, a weight of about four pounds. The temperature indicated by the thermometer having been noted, the current of oxygen is allowed to enter, and the coal begins to burn. The entrance of the oxygen is regulated by a valve placed at the outlet of the cylinder containing the gas. At the beginning of the experiment, the extremity of the tube should be at the upper part of the vessel, and afterward be gradually and gently made to enter the interior until it reaches the lower part, at the end of the experiment, the duration of which is about ten minutes. After the combustion has terminated, the current of oxygen is maintained for a few seconds, and then interrupted. Then, after the water has been well stirred, in order that it shall be of the same temperature in all its parts, the graduation of the thermometer is read. The operator has now all the data necessary for the determination of the calorific power of the specimen submitted to exper-

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