8 (54). "**Radium and some methods for its therapeutic application,**" with demonstrations: **HUGO LIEBER.** (By invitation.)

Mr. Lieber gave an account of the discovery of radium by Mme. and Professor Curie, and demonstrated many radioactive phenomena. Special attention was drawn to recently discovered facts bearing on radium emanation. For a time it was thought that radium discharged directly (*a*) the so-called "emanations," which had practically no penetrating power and which, like a gas, were readily carried from one point to another by an air current; and (*b*) the so-called "rays" — *alpha* rays of very low penetrating power, *beta* rays of considerably greater penetrating power, and *gamma* rays of enormous penetrating power. Later investigations have shown, however, that radium discharges primarily *emanations* and *alpha rays* only. However, the emanations soon disintegrate, and the disintegration products yield the beta rays and the gamma rays. Consequently the powerful beta and gamma rays are the products of a decomposition product of radium. The proportions of the radiations given off by a certain quantity of radium and its disintegrated emanations are about 95% alpha rays and about 5% combined beta and gamma rays. Because of their nearly negative penetrative power, the alpha rays, as well as the emanations, are practically unavailable for therapeutic purposes when the radium is used in glass tubes or similar containers. Even the superficial layers of a given radium preparation are relatively impervious to both the emanations and the alpha rays proceeding from the underlying portions of the preparation. Therefore, it is essential, in order to obtain full radioactive effects, that (1) the given quantity of radium should be spread so thin that, from the practical standpoint, an upper layer would not exist and (2) should be held in a container with walls that would be permeable both by the alpha rays and by the emanations.

Aschkinass, Dantzig, Caspari, Scholtz, Pfeiffer, Friedberger, and others have shown that radium radiations exert beneficial effects upon certain diseased tissues, as in sarcoma, lupus, carcinoma, etc. Marckwald states: "The radium rays have, besides a dilating effect, an elective influence upon the cells of quickly-growing tissues, as well also as bactericidal properties, three powers which are known to be very effective therapeutic factors." Germicidal effects of the radium rays have been shown repeatedly. Thus Scholtz lately demonstrated that even typhoid bacilli can be destroyed with radium radiations. It is not surprising, from what was stated above regarding the low penetrative power, etc., of the emanations and the alpha rays, that disappointments have frequently resulted from the therapeutic application of radium. The author believes that in all probability many such disappointments have ensued solely because the practitioner has not had available in such cases just those radiations of radium which are required for therapeutic effects. Then, too, the radioactive powers of each radium preparation should be definitely ascertained in the first place, not taken for granted.

This opinion of past therapeutic failures led the author to conduct some experiments designed to discover a method of applying radium more advantageously. Such a method seemed to require (*a*) a disposition of the radium in very thin layers, so as to yield the maximum proportions of alpha rays and emanations, and (*b*) its application in a container permeable by the rays and emanations. These experiments finally led to the production of what the author terms "radium coatings."

Radium coatings are made in the following manner: Radium is dissolved in a proper solvent and into this proper solvent a proper material is dipped. This material is then withdrawn, with radium solution adhering to it. The solvent quickly evaporates, leaving the material covered with an exceedingly thin film of radium. The kind of solvent to be used is determined by the nature of the material to be coated. Such solvents are employed as have a tendency to soften and to permeate the material which is to be coated. Thus, if *celluloid* rods, discs, or similar instruments are to receive a radium coating in order to be used for the treatment of a certain disease, solvents such as alcohol, amyl acetate, etc., may be employed. These solvents have a tendency to soften celluloid temporarily. As the solvent evaporates, the radium is very uniformly distributed over the celluloid, and is also incorporated on its surface. In order to prevent accidental removal of the radium from such coatings, the celluloid instruments produced in this way are dipped in a proper collodion solution and are promptly removed from the same. In this process the whole radium coating is covered with a very thin film of collodion. In the course of a few days this film of collodion becomes so tough that it will strongly resist destruction, even when considerable force is used, thus affording ample protection for the underlying radium. This thin film, however, permits the alpha rays as well as the emanations to penetrate freely. In the preparation of these coatings both the radium and the collodion solutions are colored with an anilin dye. This is done to show the part that has been coated. Besides, if the radium happens to be removed by accident or otherwise, as by scraping, etc., disappearance of the color from the damaged places makes such removal evident.

The great difference between radium used in containers, composed even of exceedingly thin aluminium, and radium used in the form of the coatings here described, was demonstrated. Thus, in their relative influences on the electroscope, it was seen that a delicate rod coated at its tip with radium bromid of 10,000 activity and holding, therefore, very little radium, compared very favorably in its effects with a gram of radium bromid of 10,000 activity in a *glass* tube, or with 10 mg. of radium bromid of 1,000,000 activity in a very thin *aluminium* tube.

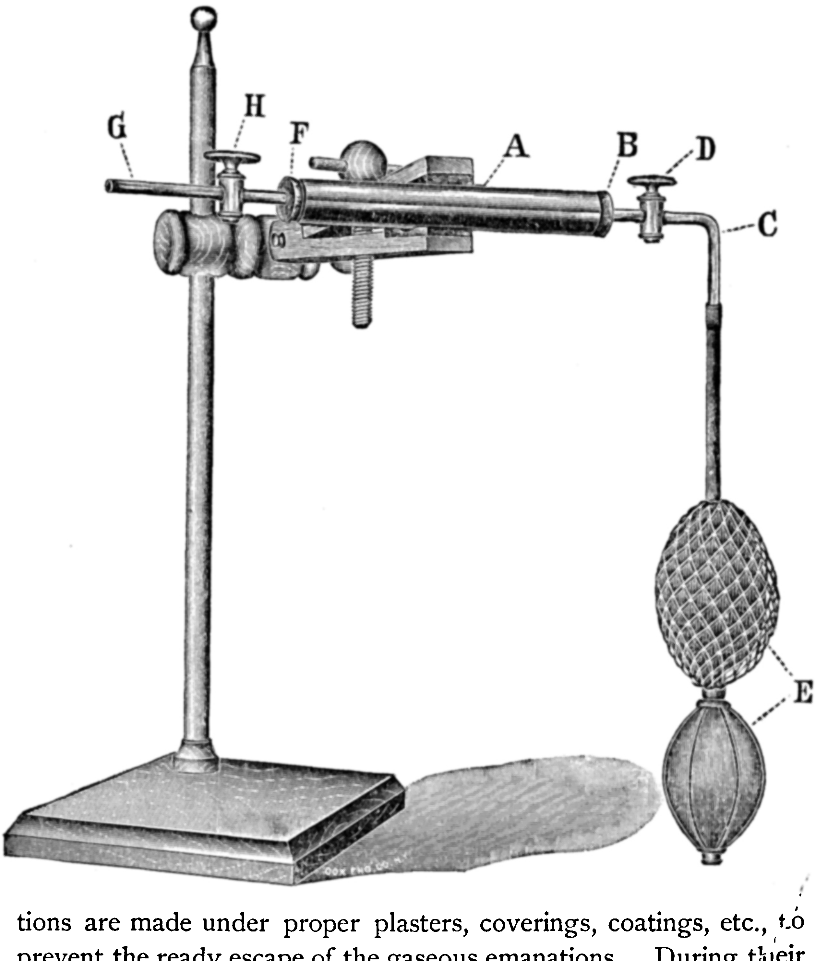
As is well known, when we observe the effect of uncovered radium upon a zinc sulfid screen, such as is shown in the spinthariscope of Crookes, we see a large number of brilliant scintillations. It has been proved conclusively that these scintillations are produced solely by the impact of the alpha rays upon the zinc sulfid. If what has just been said is correct, that is, that the alpha rays can penetrate the collodion coating of the author's celluloid rods, discs, etc., then the latter should yield evidence of these scintillations when placed upon a zinc sulfid screen. Such scintillations were abundantly demonstrated with various forms of the coatings.

The radium coatings make it possible to apply radium directly to practically any part of the body. The radium thus applied would be practically equivalent in radioactive effects to the same amount of uncovered radium in the same thin layer. Any instrument could be conveniently coated with radium at a proper place, by the method indicated, and the radiations could be brought into action wherever desired.

As has already been stated, radium emanations will always follow the air current. Consequently, if some uncovered radium is placed in an air current, the current will carry with itself the emanations, which emanations will ionize the air and discharge the electroscope. The author demonstrated these phenomena with some strips of celluloid coated with radium and covered with collodion. The same phenomena were demonstrated with a tube which had been similarly coated with radium and collodion on the inside. When air was blown through this tube toward the electroscope, the latter was discharged instantly.

It has been stated that radium radiations destroy bacteria. Rutherford and Soddy and others have accordingly advised that radium emanations be blown into the lungs in tuberculosis. The author believes that the difficulties in the way of testing such a therapeutic application of radium are solved by the apparatus described below. (See the figure on the next page.)

The apparatus consists of a celluloid tube, A, with a complete coat of radium on the inside and a collodion covering on the radium coating. By means of a tightly fitting rubber stopper, B, a small glass tube, C, is inserted, which at its end has a large perforated bulb in order to produce a uniform air current throughout all parts of the tube. This glass tube, C, has a glass stop-cock, D, and connected with the latter is a rubber bulb, E. By means of another rubber stopper, F, a glass tube, G, with a glass stop-cock, H, is inserted into the other end of the tube. With the loose end of the last glass tube, G, any desirable apparatus may be connected by means of a narrow rubber tube, etc. If we close the two glass stop-cocks and allow them to remain closed for several hours, a considerable quantity of emanations will collect within the closed tube. If we now blow up the rubber bulb, E, and slowly open the exit stop-cock, H, and then slowly open the entrance stop-cock, D, the compressed air will enter the coated celluloid tube, A, the emanations which will have collected within the tube will follow the course of the air current, and on inhaling this air, the patient will receive the full charge of radium emanations in his lungs. A cancer of the throat or of any other part of the body may be treated by the application of a proper radium rod directly, and beside that, by blowing the emanations, if necessary, directly into the seat of a cancer through a finely pointed hollow exit rod. It is a well-established fact that these emanations are readily deposited upon surfaces with which they come in contact, especially moist surfaces. If, therefore, we permit these emanations to slowly pass into or upon a diseased tissue, they will doubtless adhere to a considerable extent to the tissues treated in this way, especially if the applica-



tions are made under proper plasters, coverings, coatings, etc., to prevent the ready escape of the gaseous emanations. During their retention in this way, the emanations disintegrate, as was stated above.

A very great advantage of these radium coatings is that all instruments, etc., coated by the method described, can be readily sterilized without loss of radium, for the protective coat effectually resists even continued boiling. The author demonstrated the radioactivity of a strip of celluloid which had been coated with radium and thereafter had been covered with collodion. The strip was then placed in water in a test tube and the contents vigorously boiled. Both the radium and the collodion solutions used for the preparation of the coatings had been colored with a soluble blue anilin dye. That the collodion protected the radium in this experiment was shown by the fact that the water, after boiling, was entirely free from color. The strip also retained its original radioactivity.

The availability of the radium coatings for many kinds of biological investigation is so obvious that nothing need be said here on that point. [See page 86 (150).]

9 (55). **"Some of the physical phenomena of muscle fatigue,"** with demonstration of tracings: **FREDERIC S. LEE.**

The investigation of the subject has been continued by the employment of a method by which the isotonic curves of all the contractions of an excised non-curarized muscle stimulated at regular intervals, are superimposed upon a recording surface. The differences which were previously pointed out in the mode of fatigue of the muscles of the frog, the turtle and the mammal, have been confirmed. Lohmann's work, in which a frog's gastrocnemius on being heated to a mammalian temperature, shows a course of fatigue similar to that of mammalian muscle, has been repeated and found incorrect. Both that muscle and the turtle's coracoradialis profundus, similarly heated, continue to give their characteristic curves of fatigue. [See page 60 (124).]

Kaiser's method for determining the point of the isotonic curve where the contractile stress terminates, has been employed for the frog's gastrocnemius, and it has been found that as the height of the curve diminishes in the course of fatigue, the contractile stress terminates at progressively lower and lower points. The lowering of the latter does not, however, seem to keep pace with the lowering of the summit of the curve. Hence the two points seem to approach one another.