

ORIGINAL ARTICLES.

A PRELIMINARY REPORT ON THE
ROENTGEN OR X RAYS.

Read at the Meeting of the Chicago Medical Society, Feb. 17, 1896.

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CHICAGO.

Probably no scientific discovery has received wider attention than the promulgation of the use of this ray has elicited.

Prof. William Conrad Roentgen attracted the attention of the world when he succeeded in making photographs of the bones of the human body through the living subject. Earlier experimenters had described photographic activity in cathode rays, and it may be proper to consider some of their work.

In 1879 Prof. William Crookes presented to the Royal Society a paper embodying the results of a series of remarkable experiments on electrical discharges through vacua. Previous to this, experimenters had investigated discharges through rarefied gases, and had observed in a general way the behavior of discharges in comparatively high vacua. Faraday also had speculated on the possibility of an attenuated state of matter in which the behavior of molecules might be expected to be different than in the case of matter in any ordinary form. Such attenuated matter he designated "radiant matter." Crookes, however, was probably the first to conduct an exhaustive investigation on the discharges in very high vacua, and to connect the state of the attenuated gases with Faraday's hypothetical radiant matter.

At ordinary atmospheric pressure an electrical discharge of high tension takes place usually in the form of sparks between the charged terminals, or, under certain conditions, in a practically continuous discharge called a "brush." At a much diminished pressure, say one-thousandth of the atmospheric pressure, the discharge between the terminals becomes continuous and is characterized by a diffuse illumination, the color of which is distinctive of the gas through which the discharge takes place. The discharge is probably in the nature of electric conduction, and the tubes or bulbs prepared to exhibit such discharges are termed Geisler tubes.

At much higher vacua, approximating one-millionth of atmospheric pressure, the character of the discharge in the tube undergoes a marked alteration. The illumination of the path of the discharge is much diminished. A dark space surrounds the negative electrode or cathode in the bulb, the depth of the space being determined by the degree of exhaustion of the bulb, the observed path of the discharge is no longer in a line joining the negative and positive electrodes—the cathode and anode—but appears to be independent of the anode.

Crookes' investigations were conducted principally with discharges of this character, and the highly exhausted bulbs which he used are dominated "Crookes' Tubes."

Crookes applied to the rarefied gases or vapors in his tubes the borrowed term "radiant matter." He assumed that within the exhausted tube the matter was attenuated to such an extent that a molecule is free to move through a sensible distance, enormous in comparison with the similar distance at ordinary pressures, without colliding with another molecule. He supposed that the molecules within the tube were

projected from the cathode at a high velocity, moving from the cathode in lines normal to its surface and being stopped only by collision with other molecules, with a screen in the tube, or with the wall of the tube. At a certain distance from the cathode the rapidly moving molecules thrown off from the electrode collide with the reflected molecules; the distance from the cathode at which the greater number of these collisions takes place was considered as being coincident with the limit of the dark space, and the depth of the dark space surrounding the cathode was taken as representing the average free path of the molecules within the tube.

His experiments demonstrated, among others, the following propositions which are of value in considering the cathode or X rays:

Ordinarily radiant matter moves in straight lines; the path of the matter may be deflected by a magnet; the impact of the molecules on a surface exerts a pressure, which is sufficient in some forms of his apparatus to move vane wheels; the impact of the molecules generates heat in any body with which they collide, and excites fluorescence in many substances capable of such action.

A few years ago Dr. Heinrich Hertz discovered that the effect of the bombardment with the Crookes' tube was not limited by the walls of the tube; in other words, that the effects of the bombardment were noticeable outside of the tube. He observed that fluorescence was excited in fluorescent substances outside of an aluminum window in the Crookes' tube which was being bombarded by the molecules projected from the cathode. He suggested that this might be due to an actual projection of the radiant matter through interstices in the walls of the tube, or of the aluminum window.

In 1894 Philip Lenard, a pupil of Hertz, showed that this assumption was untenable, and that the effects observed outside the Crookes' tube might be more reasonably accounted for as due to a vibration of the ether created by the cathode. These vibrations he found to be capable not only of exciting fluorescence, but of precipitating chemic changes in photographic plates. He observed that the "cathode rays," as he called the vibrations, might penetrate to a considerable distance outside of the tube, all substances being to different extents penetrable by the rays.

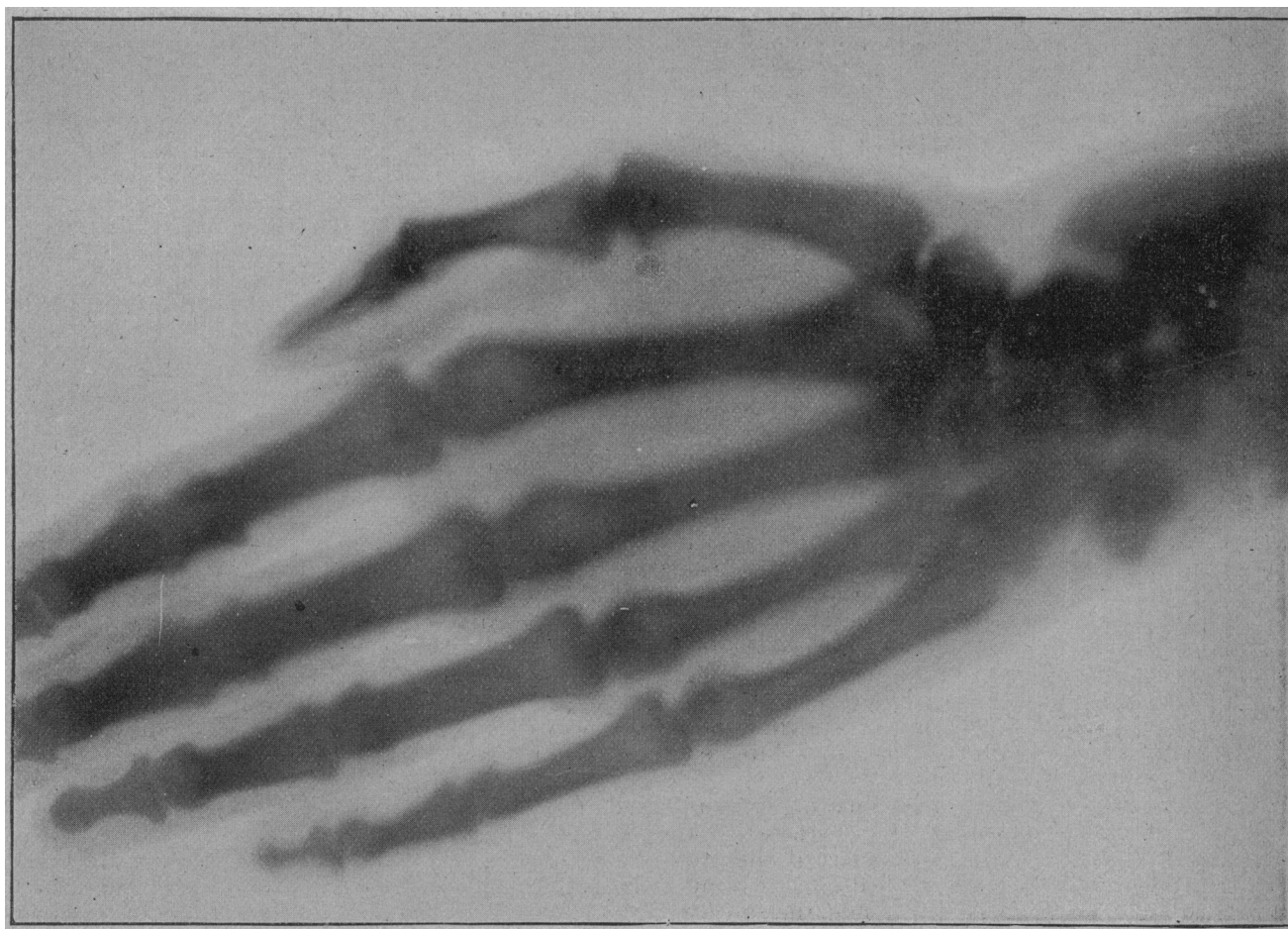
Within the last three months Professor Roentgen has announced the discovery of a ray proceeding from the excited Crookes' tube characterized by behavior different from that of the cathode rays. He stated that the newly discovered Roentgen, or, as he designated it, the "X" ray, proceeded not from the cathode, but from the point in the wall of the tube upon which the radiant matter in the tube impinged. The point from which these X rays emanated can be shifted by changing the path of the radiant matter with a magnet so as to make the molecules strike on a new point of the tube. The X rays, on the other hand, could not be deflected by a magnet, were not reflected by any body which obstructed them, and were not refracted by any body which was transparent to them. For the most part the law of the X rays, as announced by Roentgen, are quite similar to those announced by Lenard for the cathode rays. Hence there is still some doubt as to whether the X rays are not in fact identical with the previously known cathode rays. However, the announcement of Professor Roentgen's

discovery was accompanied by the statement that the bones were less penetrable to the X rays than the soft tissues, that a photograph or shadow picture might be obtained showing the bones within living bodies. This startling statement gave a prominence and value to his work which obtained for it instant recognition.

The surgical importance of securing outlines of deeply imbedded bones or foreign substances appealed to me strongly. My first experiment was made with a two-cell battery, a one-half inch spark induction coil and an incandescent lamp for a Crookes' tube. This experiment was made on the 4th inst. and was unsuccessful. On the same day, after a liberal use of the telegraph I secured two Crookes' tubes from a house in Philadelphia. The tubes could not be secured

company with Mr. Scribner and Mr. McBerty, my experiments were resumed.

Our first efforts were made with a four-volt primary and a $1\frac{1}{2}$ inch induction coil. The tube was placed immediately above the object to be photographed, with the latter resting on the wooden slide of a holder containing a photographic plate. In this way, with thirty minutes exposures, shadowgraphs were secured. These shadowgraphs gave but dim and indistinct outlines of the bones. Experiments were then made by varying the time of exposure, the distance between the bulb and the plate, the voltage of the primary current and the number of interruptions. After these experiments, which gave but fair shadowgraphs, a lead diaphragm with an aperture of one-half inch in



ROENTGEN PICTURE TAKEN BY DR. BERRY AND CHAS. E. SCRIBNER, FEB. 14, 1896.

either in Boston or New York. One of these tubes is worthless. The other is the one with which all our successful work has been done.

The tube is spherical in shape with four electrodes entering it, one pointed terminal at each end, a disk terminal in one side and a pointed terminal in the other side. All of these electrodes are made of aluminum connected with a platinum wire. As I use it the disk terminal is the negative or cathode and the pointed terminal the anode. From the cathode emanate the rays which travel in straight lines and independently of the anode, producing in this tube a greenish-yellow light.

On Thursday the 6th inst., on invitation of Mr. Scribner, I took the tubes to the experimental laboratory of the Western Electric Company, where, in

diameter was interposed between the bulb and the plate, the distance of the bulb from the plate reduced to eight inches, and longer exposures made. The aperture in the lead diaphragm was placed below and in a line with the fluorescent spot in the bulb. These changes gave improved results. By varying the distance from two to fifteen inches between the bulb and sensitized plate, increasing the aperture in the lead diaphragm, and with the bulb six inches from the plate a perfect shadowgraph of the bones in the hand, wrist and a part of the forearm was obtained.

On Tuesday, the 11 inst, a small buckshot was located in the hand of a painter, between the fourth and fifth metacarpal bones near their carpal ends by means of the shadowgraph, and this shot I removed

in Mercy Hospital. This is the first instance in America as far as I can learn, of the removal of a foreign body following its location by such means, and where it could not be located by any other means.

These shadowgraphs show that the soft tissues make some impression on the plate. It does not seem improbable that with a more intimate knowledge of these rays, some way of controlling them, as is the case with all other known rays, will be found. It may then appear that the varying changes in disease and health of the soft tissues, as shown by the shadowgraph, will become known and in this way a cirrhotic liver may be differentiated from a normal one, or pulmonary tissue in pneumonitis from normal tissue. Certainly, calculi of the kidneys or gall ducts should be easily disclosed.

In the shadowgraph (see illustration) the marrow cavities of the metacarpal bones clearly appear, thus showing that these rays do penetrate bone tissue, making it not improbable that the pathologic changes in bone tissue can be shown as well as foreign bodies of substances impenetrable to these rays that may be deeply imbedded in bone.

I have exposed tuberculosis bacilli to the action of the X rays for two hours but have not had time to make cultures, so I can not make any report as to the germicidal or other action of the rays at this time. The therapeutic uses of this ray, if there are any, must be determined by careful experiment, and speculative thought in this direction is apt to be disappointing. Many uses are suggested to which this ray can be put, and the newspapers are full of experimental researches in this country and abroad. We find that many of the Universities in the East, as well as our own, are making experiments, and various reports have been printed in the papers on the work of these scientists. Out of all this work must proceed some good.

Among the claims are many ludicrous ones, as they appear in the papers. For instance, it is said that at Columbia College the shadow of a bone was projected on the brain of a dog and he immediately became hungry. In another case reported in the paper a New York physician succeeded in getting a good negative of his own brain. Is it pardonable to suppose that the plate was simply "foggy?"

Whatever the future may show, these shadowgraphs prove, at least, that as far as the extremities go, no engraving can portray the bones as well as a good shadowgraph.

Bario-platino-cyanid becomes phosphorescent under these rays. Upon a fluorescent screen of this powder it is perfectly possible to project an instantaneous shadow which would reveal to the surgeon all that a good shadowgraph would show, and it is in some such way as this, it seems to me, that this process will be most used by surgeons. If I am correct in this, two minutes time would give the surgeon a clear idea of the condition of the parts he wishes to investigate, thus doing away with the present great disadvantage of the long exposure necessary to secure a good shadowgraph negative.

Fractures through the shaft of bones are usually easily diagnosed, but those near joints are sometimes difficult to recognize. This difficulty will be easily overcome by means of the Roentgen ray.

Some of the features of this work are remarkable in showing the striking difference between the penetra-

bility shown by bodies to this ray as against the white rays of the sun. For instance, glass which is so easily penetrated by the white rays, is very feebly, if at all, penetrable by the X ray. On the other hand, aluminum is readily penetrated.

One medical use may be in convincing patients who believe that they suffer from some organic disease, when none is present, that they are mistaken by showing them a shadow of the organ that they fear is affected.

Beyond Roentgen's application of his ray, and his statement that the ray can not be deflected by a magnet so far no advance has been made on the work of Prof. Philip Lenard as shown by his papers published in 1894.

THE PROPOSED INTERNATIONAL MEDICAL INSIGNIA.

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Since the recent publication of various articles with reference to the above subject have appeared in the leading medical journals of this country, and especially of those from the editorial pens of the *Boston Medical and Surgical Journal*, the *Journal of the Army and Navy* and of the AMERICAN MEDICAL ASSOCIATION, much interest has been excited and great unanimity of opinion expressed concerning the symbolism and esthetics of our profession. As one phase of the development of this question it may be stated that Col. C. H. Alden, Assistant Surgeon General of the U. S. Army, has been appointed chairman of a committee to adopt insignia to distinguish the medical corps of the Army from officers in other branches of the service, and as the medical officers of the National Guard may adopt the same design he has requested the Surgeon Generals of different States to offer suggestions as to the most appropriate emblem for this purpose, and for this reason the author of this communication has been lately engaged in a critical study of this subject in all its bearings, giving due attention to the requirements of the medical fraternity in civil life as well. As a result of this investigation we find that particular symbols have in all ages been assumed by the various civilized and uncivilized families of the human race. They have been placed upon the standards and banners of tribes and nations, upon the genealogic escutcheons of kings and the nobility, and for centuries they have been borne by members of many social, religious, literary and scientific organizations; by those of numerous and diversified trades or guilds, as well as by various civil and military officials as an expression of their position in the world or of their rank and special line of duty. In view of these facts we ask why should not physicians, although incased, like the knights of old, in the close armor of medical ethics, have at least the privilege in the exercise of their life-saving mission of proclaiming to the world the secret of their identity or nature of their vocation by means of some mystic heraldic emblem. While it is universally understood that the great mission of the medical profession is the protection of life, and while this should be symbolized, the insignia should also be expressive of the ancient origin of the noble art of healing. Early insignia were usually very simple, the colors in strong contrast and their form and outline such as could readily be distinguished even in the dust and confusion of battle. In order that our insignia,