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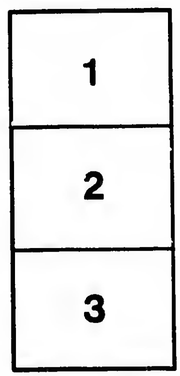
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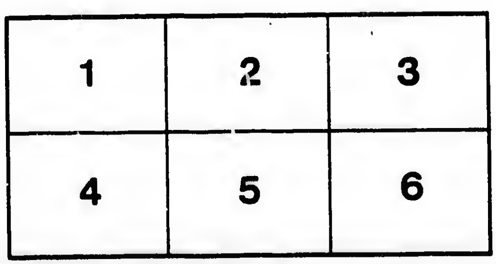
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Cox, J.

THE NEW PHOTOGRAPHY, WITH REPORT OF A CASE IN WHICH A BULLET WAS PHOTOGRAPHED IN THE LEG.

BY

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AND

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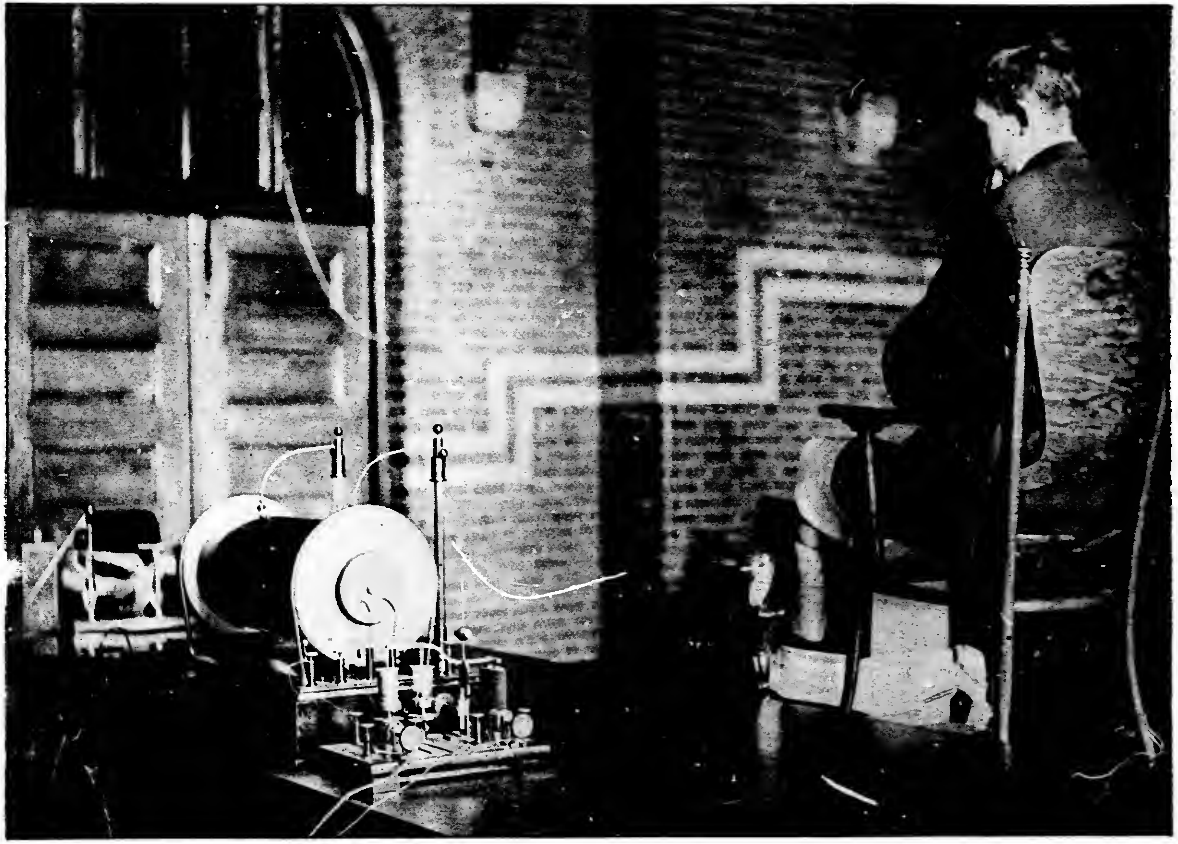

THE NEW PHOTOGRAPHY.

THE NEW PHOTOGRAPHY, WITH REPORT OF A CASE IN WHICH A BULLET WAS PHOTOGRAPHED IN THE LEG.[1]

By J. Cox, M.A.

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Everyone is familiar with the phenomena produced by discharging an induction coil through an ordinary Geissler tube. The vacuum of such a tube corresponds to a pressure of about one-thousandth of an atmosphere, or something less than one millimetre of mercury. On closer inspection the negative electrode, or Kathode, is seen to be covered with a velvety glow. Next comes a short dark space from which a faint violet cone spreads along the tube; the rest, and by far the larger part of the tube, is filled with a cloudy light whose colour depends on the gas within the tube. This light is generally arranged in regular patches or striæ and extends right up to the anode or positive pole.

Some twenty years ago Crookes showed to the British Association a number of tubes in which the exhaustion was carried to the millionth of an atmosphere. In these tubes the phenomena, as had been previously observed by Hittorf, are entirely different. As the vacuum increases the dark space spreads from the Kathode till it fills the whole tube, and the faint violet cone of rays from the Kathode excites brilliant fluorescence in the walls of the tube or any mineral or screen placed to receive them. Crookes exhibited experiments to

[1] Demonstrated before the Montreal Medico-Chirurgical Society, Feb. 7, 1896.

prove that these 'Kathode Rays' not only cause fluorescence, but (1) proceed in straight lines independently of the position of the anode, (2) violently heat the glass or the objects on which they impinge, (3) can set fans in rotation by their impact, (4) are deflected by a magnet, and (5) repel each other when two streams are sent in parallel directions.

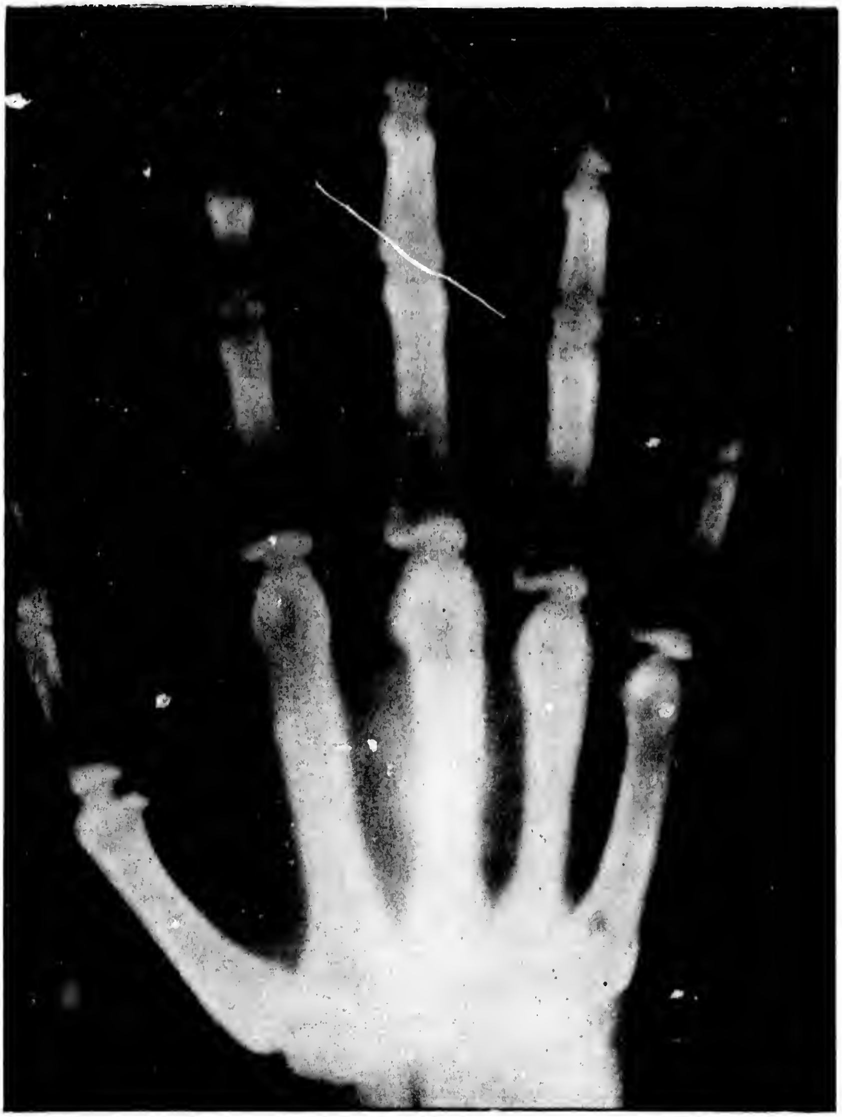
Three views have been held with regard to these Kathode rays. Crookes maintained that they were streams of the remaining molecules of the rare gas, which having conveyed the positive charge to the Kathode left it with a rush which carried them far down the high vacuum before the rare collisions with other molecules brought them back to the usual state of confused motion in all directions. To the gaseous particles in this high vacuum he gave the name of "radiant matter," or matter in the fourth state of aggregation. Dr. Puluj, of Vienna, controverted Crookes' opinions, and made careful researches to prove that the rays were streams, not of gaseous molecules, but of particles actually torn from the Kathode itself.

Finally Hertz and Lenard came to the conclusion that they were not matter at all, either gaseous or belonging to the electrodes, but "Processes in the Æther," *i.e.*, vibrations or radiations of some kind analogous to ultra-violet, or infra-red light.

Three years ago when Prof. Hertz and Dr. Lenard showed me these rays, for the first time brought outside the glass wall of the tube, in Dr. Lenard's room at Bonn, they spoke of them as "molecules," but in the later part of his research Lenard proved that when once excited they could travel across the highest vacua, and for this and other reasons concluded they were pheaomena of the Æther.[1] Dr. Lenard placed an aluminium window opposite the Kathode, and the rays passing through the metal caused fluorescing bodies to shine at distances of 6 centimetres in air, 4 in carbonic acid, and as much as 30 centimetres in hydrogen. Lenard found they affected a photographic plate, and even obtained some shadow photographs by their means.

It was not till last December that the next step was made known to the world by Dr. Roentgen in a paper communicated to the Academy of Wurzburg. It appears that while experimenting with a Crookes tube, which had been covered with black cardboard, in order to see if the eye could detect any rays emerging from the tube and capable of penetrating the opaque covering, Dr. Roentgen noticed that fluorescence was being excited in a screen painted with fluorescing material at some distance from the tube. Following up the hint, he obtained the effect up to distances of two metres, and by means of

[1] Lenard Weidemann's Annalen, 1894.



PHOTOGRAPH OF LIVING HAND SHOWING BONES.

the shadows cast on the screen, soon determined the relative transparency of many substances to the " rays ;" he concluded that they were not the Kathode rays themselves, but emanated from those parts of the glass that were caused to fluoresce ; that they were probably incapable of refraction, or of *regular* reflection, though he found evidence that metals and glass could produce a scattered reflection, as a white wall does with ordinary light. The paper, which is a model of scientific caution, condensation and accuracy, details researches on many other points, such as the susceptibility of the rays to magnetic and statical electric influences, to polarization and to interference, and ends with the very interesting but guarded suggestion that we may here be at last in presence of those longitudinal vibrations of the æther which many physicists have held must accompany the transversal vibrations (*i.e.*, those at right angles to the ray) which constitute ordinary and polarized light, though hitherto they have not been detected.

Near the end of this admirable paper about twelve lines are devoted to some curious photographs or " silhouettes," obtained by making use of the fact that certain substances are much more transparent than others to the Roentgen rays.

It happens that metals and bones are much more opaque than ebonite, wood, paper, flesh and liquids. Hence, Dr. Roentgen says, he has obtained pictures of wires upon a bobbin, weights inside a box, and the bones inside his hand ; and he modestly suggests that there will be useful applications in surgery. Lead being the metal usually fired into human bodies, is fortunately one of the most opaque substances and casts a very black shadow. Hence the possibility of locating bullets, or observing malformations or fractures in the bones.

It is this startling aspect of the discovery which has seized on the popular imagination, and led to all kinds of wild speculations on the part of those who failed to understand the first brief reports of Dr. Roentgen's results. When further research shall have increased the sensitiveness of this process as much as the modern dry plate exceeds in speed and brilliance the slow and misty daguerrotypes of the early photographers, there is no reason to despair of obtaining pictures, at least in outline, of those organs of the living body (and their contents) which are not hidden behind too great a thickness of bone. For the present we must be content to obtain, by a long exposure, a shadow of the bone or foreign substances divested of the surrounding flesh. The process simply consists in placing the object to be pictured between a Crookes tube and a sensitive plate enclosed in an ordinary plate holder, or, better, in black and orange paper. The operation is carried on in ordinary daylight, since the plate is never exposed to it. The plate is developed and fixed in the usual way.

Nothing has yet been done, beyond what was accomplished by Dr. Roentgen himself, to elucidate the nature of the new rays, but his photographic experiments are beginning to be repeated. With the splendid McDonald collection of apparatus at hand, I found no difficulty in reproducing them at the first attempt, in which I was aided by Mr. Nevil Evans. Wasting no time over photographs of coins or other small objects, we have obtained the pictures of hands now exhibited.

What will mainly interest your Society is that within four days of our first attempt we have made two trials of the process as applied to surgery. On Wednesday Dr. Armstrong kindly brought me a case of injury to the hip; but I am sorry to say that after one hour's exposure we obtained not a trace upon the plate (22 in. x 18 in.). I am inclined to attribute this failure to the presence of lead in the black paint of the dark slide kindly loaned by Messrs. Notman, as lead even in a pigment has been found to obstruct the rays.

This morning (Feb. 7th) Dr. Kirkpatrick was good enough to give me the opportunity of trying to locate a bullet which had begun to cause trouble in the leg of a patient. As this is probably one of the earliest cases of the successful application of Roentgen's rays, especially in penetrating such a thickness of flesh, the negative, which clearly shows the flattened bullet lying between the tibia and fibula, will be seen with interest. The plate was a Stanley (sensitometer 50) and the exposure 45 minutes. It is clearly under exposed, and should have had at least an hour and a half. Near the top of the plate may be observed a copper wire tied round the leg, 3 centimeters above the entrance to the wound, from which to measure distances. (This wire does not show clearly in the print, although quite apparent in the negative.) The bullet was 6 centimetres below the wire, where indeed it had been suspected to lie. It may be said that in this case the new process converted a surmise into a certainty.

The tube which I have found by far superior to all others tried at present is a Puluj tube containing a brilliant fluorescing screen, and hence called the "Schirm-Lampe." It is No. 3080 in the catalogue, of Geissler, of Bonn, (price 15 marks).

This tube was excited direct from the secondary of the large Kukenkorff coil (10 inches spark) fed with 4 ampères at 8 volts on the primary.

The very perfect photograph of the hand showing sesamoid bones was taken with the same arrangements (except that the plate was wrapped in orange paper instead of being placed in a dark slide) by

PHOTOGRAPH OF BULLET LYING BETWEEN TIBIA AND FIBULA.

Messrs. King and Pitcher, of the McDonald Physics Building, on the evening of February 7th. The exposure was, in this case 30 minutes.

A photograph of the arrangements in the Physics Lecture Theatre will make clear any omissions in my account.

I must leave Dr. Kirkpatrick to explain the medical aspects of the case.

The patient was shot in the leg on Christmas night last. He entered the Montreal General Hospital at once, when efforts were made to find the bullet.

These having proved ineffectual, the wound was cleansed and an antiseptic dressing applied. The wound healed in a few days and the patient left the hospital apparently well. However, February 1st he began to suffer pain, and a tender point developed on the inner side of the leg, just behind the tibia and 3 c.m. below the point of entrance of the bullet, which was on the back of the calf toward the outer side.

On February 7th the bullet was photographed and our surmise as to the location of the bullet was proved to be correct. He re-entered the hospital, and the next day I made an incision parallel to and just behind the tibia, and found the bullet lying against the outer edge of this bone. The bullet, which was flattened, weighed sixty-four grains, and measured twenty-three mm. in length by fifteen in breadth. A groove ran longitudinally along the surface of the bullet showing where it had rested against the edge of the tibia.

Although the plate was so much under exposed that it was with great difficulty that a print was obtained from it, still the location of the bullet was plainly indicated in the negative, and any doubt which I had regarding its situation was at once removed.

The patient recovered rapidly and left the hospital ten days after the operation.