RECENT INVESTIGATIONS OF X RAYS.

BY WILLIAM H. HALE, PH.D.

Prof. Arthur W. Wright, of Yale University, interested so many in his description of his investigation of experiments with X rays at the meeting of the National Academy of Science, last May, that a more lengthy account of what has lately been ascertained will doubtless be of interest. A recent visit to his laboratory at New Haven, Conn., found him busy experimenting on the X ray work. He showed me all the results of his recent work at the Sloane Laboratory.

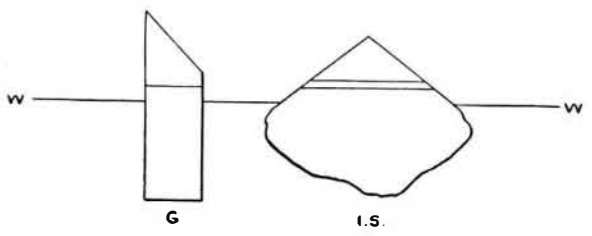
To determine the nature of the X rays has, from the beginning, been a great problem for all investigators, and it still perplexes and baffles all. Are they, in reality, light-rays or rays analogous to light, but of much shorter wave length, or are they projected matter? Both theories have advocates. Prof. Ogden N. Rood thinks that he has demonstrated the fact that they can be reflected to some extent, like rays of light. If every precaution is taken to remove the possibility of error in these experiments, they might not furnish a crucial test for either theory.

The only respects in which the X rays are thus far known to resemble rays of light are in producing fluorescence, and in blackening sensitized plates—photographic action. Tesla and some others, therefore, still maintain that they consist of projected matter.

Obviously, if refraction or polarization can be detected, it would show an analogy to rays of light. Prof. Wright has, therefore, performed experiments to ascertain, if possible, whether these phenomena occur, but with only negative results thus far.

His first care was to eliminate the source of error due to the use of prisms to determine refraction. The thick part of a prism absorbs more rays than the edge. This gives rise to an appearance as if the rays were bent toward the edge of the prism, an action directly opposite to refraction.

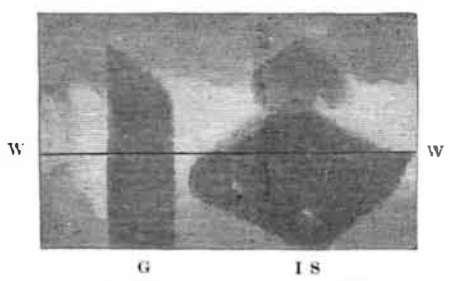
To obviate this a piece of plain glass was used, placed so that rays would strike it at an angle of about 45°. As a test for polarization, a crystal of Iceland spar was placed beside it. A platinum wire was then stretched across the glass and the crystal. Rays of light passing through the apparatus are deflected both by the glass and by the spar; they are also split by the spar so as to produce a double image of the wire. The effect of this refraction and double refraction is such that the straight wire appears, when observed through this apparatus at the angle of 45°, to be broken and moved out of place by the glass and the spar, and to be also doubled by the spar, as shown in the following diagram:



G, glass; I S, Iceland spar; W. wire.

Fig. 1.

The picture taken by X rays, however, is shown in Fig. 2.



G, glass; I S, Iceland spar; W, wire.

Fig. 2.

In this case it will be noted that the wire is shown straight and no trace of refraction or of double refraction can be detected. The glass used was about eight millimeters thick, and the distance traversed by rays going through it at the angle of 45° was about one centimeter. The Iceland spar was one centimeter in thickness, making the path of the rays a little over twelve millimeters.

The displacement of rays of light by the glass was 1·4 mm., and by the spar 1·0 and 1·8 mm., compared with 0 by the X rays.

A further test was made by placing a crystal of Iceland spar about an inch thick over a fine wire grating. The picture taken by X rays showed no trace of refraction or polarization.

A very unexpected result, however, and one which may prove to be of much importance, was obtained in certain other pictures of platinum wires. The wire used was hardly as thick as a pin. The picture of the wire appeared as a bright line in the negative, because the wire is opaque to X rays. Examination of the negative with a microscope, however, discloses a very faint dark line running through the image of the wire, which exactly corresponds with the bright interference lines caused by diffraction of rays of light, as shown in the following much magnified picture:

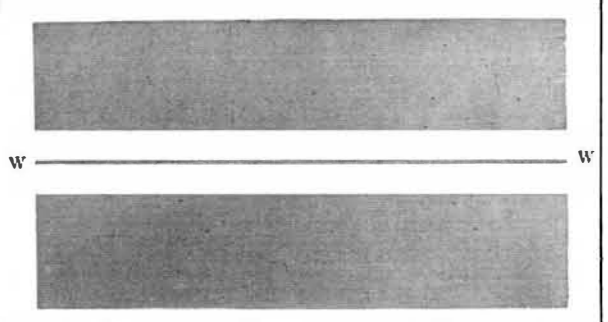
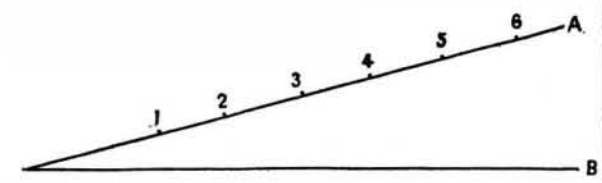


Fig. 3.—MAGNIFIED IMAGE OF PLATINUM WIRE.

Prof. Wright calls attention to the fact that this phenomenon may either be due to diffraction or to the deflection of streams of radiant matter, as when a sand blast is directed against a rod, part of the sand is bent inward.

Prof. Wright is now investigating this subject, and among his last experiments, since his return from Washington, he has taken pictures of a series of wires so arranged upon a plate as to occupy successively increasing distances from the photographic plate on which their image was cast, and he finds that this faint inner line is not observable at very short distance from the wire, but becomes apparent when there is an interval of two or three inches between the wire and the plate. The following diagram shows about the angle at which the plate holding the wires and the photographic plate were placed, the apparatus being viewed from above.



A, plate holding wires, 1, 2, 3, 4, 5, 6; B, photographic plate.

Fig. 4.

Fig. 5 is the picture thus obtained, the wires being magnified for distinctness.

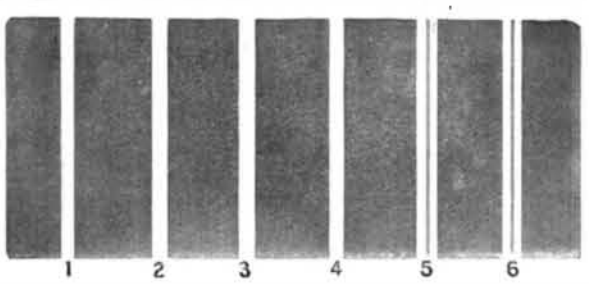


Fig. 5.—MAGNIFIED PHOTOGRAPH OF THE WIRES.

The supposed diffraction line is not seen at all in wires 1, 2, 3, and 4; is very faint in 5 and is most distinct in No. 6, being the wire most distant from the photographic plate.

Meantime, while conducting these abstruse investigations, Prof. Wright has obtained some results of a very practical nature. Experiments were made with eight gallstones, the largest being about the size of a hazel nut. They were wrapped in rubber, and inclosed in the center of a piece of beef about three inches thick. The X ray picture showed them all, but with different degrees of distinctness. In a subsequent picture the rays were passed through Prof. Wright's arm also, and the gallstones could still be made out, though very faint where the bone of the arm had been interposed.

The importance of this application of X rays to surgery is obvious; and it is of special interest, because the stones are not calcareous, but of the nature and density of hardened wax, and hence it might have been supposed that they would be transparent to the X rays. Prof. Wright informs me, however, that all were from the same person; and with the usual caution of scientists, he reserves decision of the question whether gallstones from other persons would give the same result; suggesting the possibility that those employed in the experiment may have contained traces of calcareous matter which would render them less transparent to X rays than some others might prove to be.

The publicity given to this result, however, will doubtless incite other investigators to further investigations, and this point may, therefore, soon be settled.

BY enactment of Congress, the topographic as well as the geological maps and atlases of the United States Geological Survey may now be purchased by the public. They are now sold at a merely nominal price. In quantities, they may be purchased for two cents each. Lists of the maps may be had on application to the director of the survey.

Science Notes.

W. N. Hartley and H. Ramage have recently examined a large number of ores and minerals by means of spectrographic analysis, says the Mining and Scientific Press. Most notable is the wide distribution of gallium, which was found in 68 out of 168 specimens, occurring in most magnetites, bauxites and blendes, and nearly half the clay ironstones and manganese ores. Rubidium appears to be even more widely distributed, occurring in most iron ores. Indium was found in thirty minerals, including all the carbonates of iron and tin ores and most blendes. Thallium, while less widespread, was frequently found. Iron and sodium were found in every specimen, and potassium in all but two, one a blende and the other a tin ore. Calcium, copper and silver were found in all but a few cases. Such a wide dissemination of gallium and indium is unexpected, and the same might be said of silver. Among metals not looked for by the authors, titanium is known to be found almost universally, and possibly the same is true of gold.

The bill providing for taking the twelfth census and the establishment of a permanent census service was reported favorably on May 10. This bill was drawn up by the Hon. Carroll D. Wright in accordance with the joint resolution of Congress. The bill provides for a permanent census office at Washington, the duties of which will be the taking of the twelfth and each succeeding decennial census and the collection of other statistical information in intervening years. The director of the census and assistant director are to be appointees of the President, but the assistant director must be an experienced, practical statistician. It is estimated that the annual cost of the permanent census bureau will be less than $500,000 per annum, and that the decennial enumeration with the tabulation of results will cost three or four million dollars more; so that the permanent census bureau would cost far less than the eleventh census, which cost some eleven and one-half million dollars. Various items are to be omitted from the decennial census and considerable work is to be relegated to other bureaus. Certain classes of statistics are to be published annually.

Mr. H. M. Richards, who has previously studied the effect of wounds on plant respiration, now describes (Annals of Botany, xi, 29) a course of experiments on the evolution of heat by wounded plants. He finds, says Natural Science, that accompanying the increased rate of respiration is an increase in the temperature of the parts affected. A kind of fever supervenes, and as in the case of respiration, the disturbance runs a definite course, and attains its maximum some twenty-four hours after injury. It is interesting to note that the attempt to rally from an injury is accompanied by somewhat the same symptoms, increased rate of respiration and evolution of heat, in plants as in animals. Owing to the nature of the case, the reaction is less obvious in the former than in the latter, and a delicate thermo-electric element was required to appreciate the rise in temperature; but, compared with the ordinary temperature of plants in relation to the surrounding medium, the rise after injury is "as great, if not greater, than in animals." The maximum in all the plants investigated was between two and three times the ordinary excess above the surrounding air. Potatoes proved the most satisfactory objects for experiment, and it was found that in massive tissues (such as potatoes or radishes afford) the effect of injury was local, whereas in the case of leaves (e. g., onion bulbs) a much greater extent of tissue was sympathetically affected.

The Royal Society recently gave its annual conversazione. It was attended by Lord Lister, the Earl of Rosse, Lord Kelvin, Sir John Lubbock, Prof. S. P. Thompson, Prof. Roberts-Austen, Dr. Ludwig Mond and many others. The exhibition of scientific apparatus included a few excellent novelties, among which were some illustrations of the Dansac-Chassagne process of producing photographs in color. Mr. F. C. Atkinson exhibited an indicator made to register the power exerted by an oarsman. An ordinary indicator diagram is recorded on a strip of paper on the drum by a pencil rotating with the oar and moving vertically as the pressure of the oar compresses the spring. During the "swing forward," after a stroke has been recorded, automatic gear winds the diagram strip into a new position, while other gear permits of obtaining a diagram, if desired, of only every fifth stroke. With this instrument details, both as regards style and horse power, can be secured of a course of five hundred strokes. Mr. Wimshurst exhibited the largest electrical influence machine in the world. It is to go shortly to the Victorian Exhibition at Earl's Court. Between the terminals it gives a spark of thirty-four inches. This machine is about three times as powerful as that made by Mr. Wimshurst for the Crystal Palace Exhibition. Prof. Roberts-Austen showed the microphotographic camera as used by him for producing the pictures of the sections of alloys. Prof. Oliver Lodge showed a very delicate demonstration of Zeeman's discovery of the broadening of spectrum lines by the action of a magnetic field on the source of light. Prof. Silvanus Thompson and others showed interesting experiments.