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ORIGINAL COMMUNICATIONS.

ON THE PHOTO-FLUOROSCOPE.

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[Original Communication to the Royal Academy of Medicine and Surgery of Naples, Italy, For 1896.]

The idea of seeing by human device through many inches of solid matter is no longer a chimera—although still considered one only a few months ago—to men advanced in cathode ray analysis and experiments.

What is the advantage discerned by us in this latest discovery of science? To what limit does our expectation of its practical use in our science run? Our latest experiments with these unknown rays have enabled us to reach, and have actually revealed to our eyes, the human heart, lungs, skull, bones, larynx, accessory cavities of the face, and in fact most of the internal and hidden parts of the body. This is an extraordinary fact. To our ancestors it would have appeared a miracle, ascribable only to some supernatural agency, preferably that of the devil, for in the gloomy mood which they carefully cultivated the devil appeared to be a more potent agent in mundane affairs than Divinity itself. Even to us of the present who have carefully eliminated the supernatural, either in the form of God or devil, and who have been calloused to the marvels of the natural world by

the thick-coming sensations that day by day, and even hour by hour, crowd upon our senses, this is an event altogether out of the common. But we are still little more reasonable than our progenitors. After the first stunning effect of an announcement of this sort we rebound into an unreasonable state of expectancy. We are not content with the marvel of the moment. We anticipate the future. We would outstrip nature and plunge into the supernatural. We exaggerate, we augur the utmost. We are disappointed if our fondest anticipations are not immediately realized.

The most appropriate remarks are those uttered by Mr. Denshaw, one of the few remaining followers of Zoroaster, who identifies the unknown light as one manifestation of what has been known to eastern scientists as astral light, or the seventh dimension of matter.

“As we touch the borderland between the known and the unknown, we just begin to comprehend in the shadows which float around us how matter and spirit flow into each other, and we reach out with still more eager hands to fathom the great mystery of life and evolution.

“The analysis of the akasa or ether by the Vedas thousands of years before Christ, the transmission to the eastern Hindoo sages, receiving from them clearer illustrations and greater force as they came down through the ages, no longer shut up in the mountain monasteries, are springing into life and strength at the magic touch of Science.”

“The Roentgen light, before which the invisible and the opaque become transparent, is the clairvoyance of science, standing perhaps in the same rank, in some way not now understood, but reaching the same results as the mental or spiritual clairvoyance, which has long been a mysterious but demonstrated fact. Another disciple of this school, Dr. Guernsey, applied such terms as the ‘cathode rays of clairvoyance,’ and the ‘all-seeing light;’ he said it was impossible at this early state of development to form more than the faintest conception of the revelation of hitherto closely guarded secrets of nature to which it opens the door.

“In studying the molecules of matter in the attenuated ether of the high vacuum bulb, which, propelled by the cathode pole, strike out with such fierce energy as to pass through flesh, metals, bone, wood, and in fact all opaque objects, to the photographic plate beyond, we seem to have within our grasp, and subject to our control, those physical particles which are supposed to constitute the physical basis of the universe. These little particles of radiant matter which exist everywhere through the atmosphere—so minute that a quadrillion of them roam with freedom in a bulb some four inches in diameter—are in some of their properties as material as the floor upon which we

stand, while in other properties they almost assume the character of radiant energy, moving with such rapidity as to permeate all bodies and all space, not simply penetrating unoccupied space between the atoms and molecules, but filling the entire domain of the physical from atom centre to atom centre and from space to space, as one indissoluble soul.

"Without the omnipresent atmosphere or ether of nature the phenomena would cease. Communication of energy from sun to planet, from constellation to constellation, could not be maintained unless it be conceded that motion, which is an inseparable factor of all energy, can travel through abyssmal voids without any medium of transmission.

"Every step in this discovery along these physical lines approaches nearer and nearer to the spiritual ideal and the demonstration of physical energy which bridges the chasm between mind and matter."

I make these quotations simply to show that this school of philosophy has also taken up the subject of X rays—from their point of view—which they claim demonstrated many of their beliefs of the unseen. This question, however, is to be disputed on many lines of thought by non-believers. It will be curious nevertheless to learn what the great psychologists and other logists will teach us when they finally reach conclusions.

Sufficient of the practical value of the application of the Roentgen rays to medicine and surgery is already known for us to pronounce them and the wonderful screen that reflects them as among the greatest triumphs won in the modern history of invention.

I am happy to say that after much experimenting in this field I have been enabled to produce the photo-fluoroscope.*

This invention enables the eye and the photographic sensitive plate to record simultaneously images as we are desirous of putting them on record.

The photography of luminous objects has been for some years an important factor in astronomical studies, as, for example, in the mapping of the stars, and the recording of solar and stellar spectra and the phenomena of eclipses, but of late it has been made to embrace a broader range of subjects. Several of the most reputable photographers and scientists have of late given this special branch much thought and study; and among them I cannot pass by without mentioning a most beautiful set of pictures made by Wallace A. Levison and by Nicola Tesla, whose illustrations of luminous objects have given me much pleasure and fruitful recompense. I owe to the study

*I am indebted to A. Hamerschlag and to Mr. F. J. Harrison (editor of *Anthony's Photographic Bulletin*) for most valuable suggestions during the progress of this investigation.

of them the invention of the instantaneous photo-fluoroscopic photography of luminous objects taken directly from the fluorescent screen.

The invention bears my name (Bleyer's Photo-fluoroscope), and is very simple. It is practically an adaptation of the fluoroscope to the needs of the physician and surgeon, and consists in the combining of direct and instantaneous photography of the shadow thrown on the fluorescent screen. In other words, it is simply a combination of an ordinary copying photographing camera and a fluoroscopic screen of special size, carefully fitted into the camera. Several other types of cameras can be adopted also for this purpose. The screen receives the object fully outlined in all its detail, while the camera is so arranged as to take time exposure of the object made visible on the screen. By this means the object can also be seen and studied and the trouble located before the photograph is taken. Then the proper focus is taken by means of the camera arrangements, and a direct photograph is obtained. The sensitive plate is then removed to the dark room and is there prepared like any other photograph.

The photo-fluoroscope has the advantage over other inventions of revealing the object on the screen, either to be seen directly by the eye or to be reproduced on a sensitive plate. This renders it of peculiar advantage to physicians and surgeons for positive diagnosis. The photograph is necessary only for recording purposes, as the object can be seen plainly by the naked eye, the phosphorescence making it possible to see the object plainly in darkness. Necessarily, this is more advantageous to physicians than the general method of shadow-graphing by the ordinary plate-holder, with the object placed thereon, without the assistance of the camera.

As far as we know at present in regard to the Roentgen rays, the laws applicable to light are entirely disobeyed, and consequently no lenses or camera can be taken into consideration. This light does not admit of being, so to say, refracted or reflected in the same manner as ordinary light, so that there is no possibility of direct use of the camera with the Roentgen rays. But the onward march has added the fluorescent screen, by means of which the eye can follow the rays through hitherto impenetrable substances, and with its assistance I have succeeded in establishing the method illustrated, which for the uses of physicians and surgeons is simpler and gives infinitely more satisfying results than any other method of which I know at present. The difficulty in accomplishing this can be appreciated only by those who have followed up the subject, and worked in the laboratory side by side with companions in the race for priority, and with full knowledge of the thousands of difficulties that beset the endeavors of the experimenter.

One of the most important advantages that the photo-fluoroscope presents over the Roentgen method of photography is, that curves, corners and angles are no obstacles to it, while an object in the Roentgen photography must always be in direct contact on a flat plate containing the sensitized plate; the reason being that the Roentgen rays must be applied directly on the surface of the object, while with the photo-fluoroscope it may be taken at a short distance. This is due to the fact that the laws of light applicable to photography have been applied by photographing the luminous shadow from the screen, and by the use of lenses.

A paper containing an abstract of my lecture, which will be found printed in the *New York Medical Journal*, April 25, 1896, contains an account with much detail on the invisible light of the spectrum, and therein I showed partly its relation to the present status of Roentgen shadowgraphy. Here I take up some of the physical phenomena noted in connection with direct photography by ordinary light rays, which obey the laws known to us. This will make the subject matter herein spoken of more intelligible to my readers.

It remains a demonstrated fact that a ray of light can be separated into its proximate or ultimate colors. These various portions of colored light have certain distinct properties, which have been most carefully investigated by different physicists. The illuminating power of of the spectrum, as might be imagined, exists in the most luminous portions of the band of colors, viz., in the yellow light; and experiments carefully conducted by Herschel and Fraunhofer confirm this fact, and show that the greatest amount of light exists nearer the red than the violet end of the spectrum. The colorific power of the spectrum increases gradually from the blue color; it rises to its maximum in the red; but what is the most curious, it reaches its greatest elevation beyond the limit of the visible red ray, or red end of the spectrum. The invisible rays of heat are, therefore, more powerful than the other heat, giving rays of the spectrum accompanied with light, as in the yellow, orange or red colors; the luminous radiations do not give as much heat as the non-luminous ones; and Tyndall, speaking of this remarkable circumstance, says: "In the region of dark rays beyond the red the curve shoots up in a steep and massive peak, a kind of Matterhorn of heat, which dwarfs by its magnitude the portion of the diagram representing the luminous radiation."

What is of most value to us just now is the consideration of the chemical influence of the spectrum. The chemical influence of the spectrum, unlike the heating and illuminating rays, is at its minimum at the red end, and rises gradually in intensity towards the violet. Light, as we

know, acts as a chemical agent only with certain portions of its luminous rays, but, like heat, with its non-luminous rays. Ritter, of Jena, discovered that chloride of silver was acted upon and blackened beyond the violet end of the spectrum. Dr. Hentschel and Dr. Wallaston confirmed these facts. These chemical or actinic rays have been carefully studied and most industriously employed, so that a new art has been created, which is now called photography, and to-day we have made it one of the most subservient of additions to the requirements of industries and sciences. This late addition of instantaneous photo-fluoroscopic photography is most invaluable to the medical and scientific world. Moser has solved for science a valuable truth, by showing that certain rays have the power to set up chemical change; and this once begun may be continued with other colored rays that could not in themselves produce chemical decomposition. He shows this experiment by taking an iodized plate, with an engraving placed over it, and exposed it to light until the action had commenced; if this plate was then placed under the violet glass the picture was soon obtained, while a very long time elapsed and the result was imperfect when the same plate after exposure to sunlight was placed under a red glass. If, however, the prepared plate was first exposed in a camera to a blue light and then placed under the red glass, the picture was speedily obtained. In my article on "New Rays of Roentgen, the new photography," etc., *New York Medical Journal*, 25th April, 1896, I gave some detailed accounts, which were found to be most appropriate at this stage of the study on shadowgraphy by means of the fluorescent screen, etc. In these remarks phosphorescence has been considered; and here it may be mentioned that Becquerel calls the rays capable of setting up or commencing chemical action "exciting rays," and others which only possess the power of continuing a chemical change "phosphoregenic" or "continuing rays," and has identified the latter with the power possessed by light of rendering certain bodies luminous. Of these I had also spoken in the same article. It is the phosphoregenic rays, extending from the indigo to beyond the violet ray, which render certain bodies phosphorescent by insulation. Becquerel has invented a most ingenious instrument, called the phosphoroscope, by which substances as the tungstate of calcium and all others which have the same property of giving off fluorescence, can thereby be viewed directly after exposure to light and the time of the duration of the phosphorescent power accurately determined. Thus several bodies which are only phosphorescent for some fraction of a second have thereby been added to the long list of substances affected in a similar but more decided manner.

Prof. Stokes has investigated with the greatest care the phenomena which he titles fluorescence, or internal dispersion; figures or letters painted with a strong solution of sulphate of quinine in tartaric acid became curiously self-luminous when the rays passed through blue or, better still, violet glass, are allowed to fall upon them.

A tube of uranium glass conveying the coil-discharge in vacuo is similarly affected by this electric light. It was ascertained that prisms made of glass appeared to absorb a larger number of the more refrangible rays; and Prof. Stokes found that by using prisms made of quartz he could obtain with the electric light a spectrum six or eight times as long as the ordinary one; and his experiments indicate that the chemical, the luminous, the phosphoregenic rays, as rays of high refrangibility, are intimately connected with each other, and are only so many effects of one and the same cause. These experiments were based on the facts that when bright rays from the electric lamp are passed through blue glass, and then permitted to fall upon a plate of glass colored yellow by the oxide of uranium, the latter becomes self-luminous and emits rays which are altered in their vibratory power; the original rays have undergone a change in refrangibility.

Only a few days have swept by, and hardly have we recovered from the surprise that the Roentgen discovery gave us, we are again startled with another discovery of a variety of light called by M. Le Bon "*La Lumière Noire*."

There can be no doubt about the fact that a new field has been opened for research since the recent labors of Hertz, Lenard and Roentgen have given us an idea of the discoveries that are still to be made in the study of light, and the extreme delicacy of the photographic plate. These facts prove each day to us how confined are the limits of our powers of sight. It appears to be absolutely demonstrated that the vibrations of light can manifest themselves at least in two separate ways, and that there is a visible and an invisible light, as is the case with heat.

The human eye is only adapted for impressions from visible light, whereas the photographic plate is affected by the obscure form of light. It may be that certain animals have the power of seeing this form of light, which may explain some of their habits that have hitherto seemed a mystery; but at the rate at which discoveries are now being made there is no necessity for speculating about the future. For the time being, one fact is much to be regretted—namely, that to understand each other we have to use the terms visible and invisible light, as though the words did not more or less destroy each other's sense; but until our vocabulary shall have undergone the necessary

modifications we shall be obliged to make use of the terms to which we are accustomed.

There is, therefore, a visible and an invisible form of light, and the characteristic of the latter is that it has the power of passing through opaque bodies. Invisible light may come from cathodic rays, or even from an ordinary luminous body. Professor Roentgen has revealed to us some of the properties of the variety that comes from the electric effluvium, and now M. Le Bon calls attention to the peculiarities of that originating in luminous bodies. His demonstrated experiments, as presented to the Academie des Sciences de Paris in a communication, are as follows: In an ordinary positive photographic frame is placed a sensitive plate, and over it an ordinary photographic negative, which is covered in turn by an iron sheet the size of the anterior face of the frame. The whole apparatus thus covered by a metallic sheet is exposed to the light of a petroleum lamp for about three hours. Energetic and prolonged development of the sensitive plate carried to complete blackness will then give a faint image of the negative, which can be clearly seen by transparency.

Without changing at all his preceding arrangement, M. Le Bon places behind the sensitive plate a thin sheet of lead and folds its edges over in such a way that they slightly cover the sides of the iron sheet. The sensitive plates in the negative are in this way imprisoned in a sort of metallic covering, of which the anterior part consists of iron, and the posterior and lateral parts of lead. After three hours exposure to petroleum light an excellent image is obtained, instead of a very faint one, as in the preceding case.

M. Le Bon thinks that the contact of the two different metals gives rise to a slight electric current, whose action is combined with that of the luminous radiations that have gone through the iron sheet. Solar light is said to give the same results as petroleum without being in any way more active—carbon, iron, copper and other metals are easily pierced by it. The most transparent metals for this black light are aluminum and copper, after which comes iron. Zinc, silver and tin, and particularly black paper, are much more resistant; but whereas the cathodic rays pass easily through black paper, black light cannot do so. M. Le Bon showed the academicians at their meeting a negative obtained through an aluminum plate, which was as clear as if it had been prepared in the ordinary way. These experiments have been successfully reproduced by several of his colleagues and proven to be of value to the photographic science and, perhaps, to ours. I have satisfied myself of his important work, and there is no telling what uses *La lumière noire* may be put to soon.

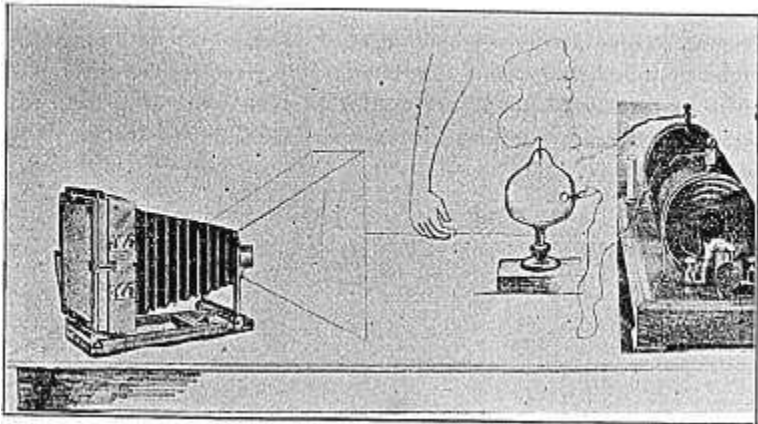


FIGURE 1. Dr. J. Mount Bleyer's Photo-Fluoroscope.

EXPLANATION OF THE MOUNT BLEYER PHOTO-FLUOROSCOPE.

To the left of this illustration is seen the camera fully equipped and its accessories mounted on a table, and its fluoroscope attached, showing on its screen a hand ready to be photographed by this process directly from its luminosity. The screen is arranged so that any size object can be taken in. The fluoroscopic box is very light, made of cardboard and fitted close on to the camera, and encircling the lens with zinc, thus preventing stray Roentgen X rays from reaching the sensitive plate through the wood portion of the camera. On the right side is a Crookes' tube attached to a Ruhmkorff coil, which is operated either by a spring vibrator, or preferably by a break wheel. The entire picture shows the full operation of photo-fluorographing. The latest model has many other detail attachments; this one is the first experimental model. This apparatus is now made by Hamerschlag & Co.

THE PRACTICAL POINTS IN PHOTOGRAPHING BY MEANS OF THE PHOTO-FLUOROSCOPE.

Above all things in photo-fluorography a dark room is required for good results. Here the object to be photographed should first be located with the fluoroscope, in order to fix its exact position. This done, the screen on the photo-fluoroscope must light up the object until every detail shows clearly. Now shut off the X rays before introducing the sensitized plate into the camera, to avoid any possibility of fogging the plate.

After these preliminary steps have been attended to, the X rays are turned on, and an exposure ranging from one to two minutes is allowed, and that depends upon the density of the object. Good strong X rays are required, and it will be found that a coil giving a spark of from six to eight inches will answer all purposes for ordinary work. In

fact, all accessories should be in first-class working order. Much experience is also necessary, and the best teacher, for obtaining good results by this method as by the Roentgen. A focus tube is the best.

The plates should not be removed until the X rays have been shut off. Upon these few and simple injunctions depend the success of the photo-fluoroscope.



FIGURE 2. Photo-fluoroscopic picture of a larynx with an intubation tube in position, illustrating a foreign body in the larynx.

I succeeded as early as April 7th in locating a tube in the larynx, and another that had slipped down into the trachea, and recorded them, as shown in the accompanying picture, in the early trials and undeveloped stages of my photo-fluoroscope, and before the Crookes' tubes were brought up to standard make. I, nevertheless, present them herein, knowing that they will create curiosity and induce others to follow my footsteps in the use of the X rays in laryngology.

In my lecture, April 15th, 1896, before the Medico-Legal Society, I referred to this fact, notes of which were also published at the time. I refer to these dates now in confirmation of the priority of the objects located and photographed by me over those recently obtained by Dr. Levy, of Berlin, and others in England, and mistakenly accorded the priority in several of our dailies.

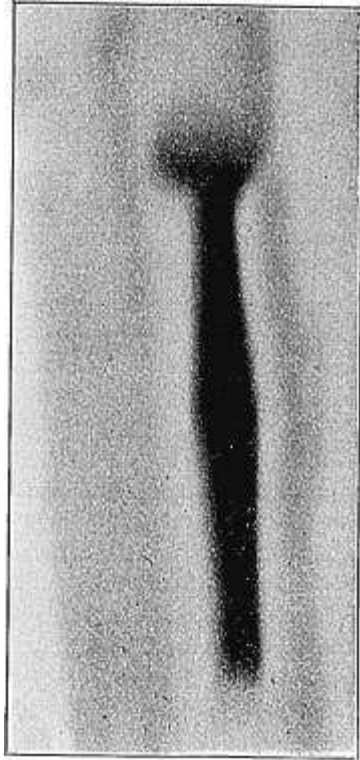


FIGURE 3. Illustration of a lost intubation tube found in the trachea.
Removed April 2, 1896.

At present much of my time and work with the photo-fluoroscope is being spent in shadowing out tumors, growths, foreign bodies, and various diseased conditions of the larynx and bones of the face and their accessory cavities, and the lungs with their many complicated ailments. In these experiments I have so far been very successful in obtaining first-class definitions of the varying shadows, illustrating many interesting clinical conditions of these organs. Many fine specimens which I made are in my possession, which the above testifies to.

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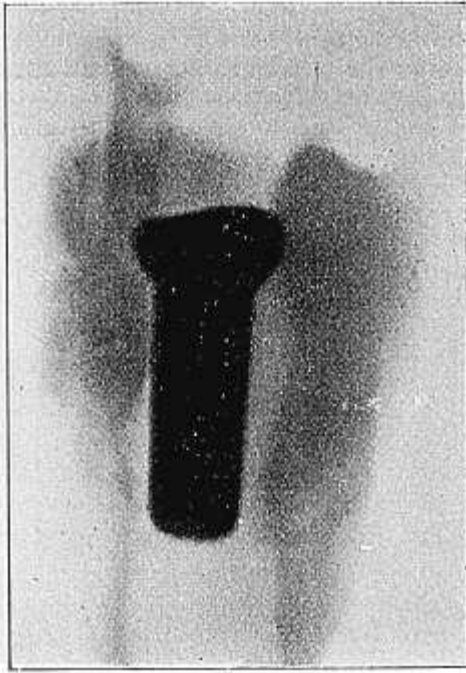


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