**The new photography / by Arthur Brunel Chatwood.**

# THE NEW PHOTOGRAPHY

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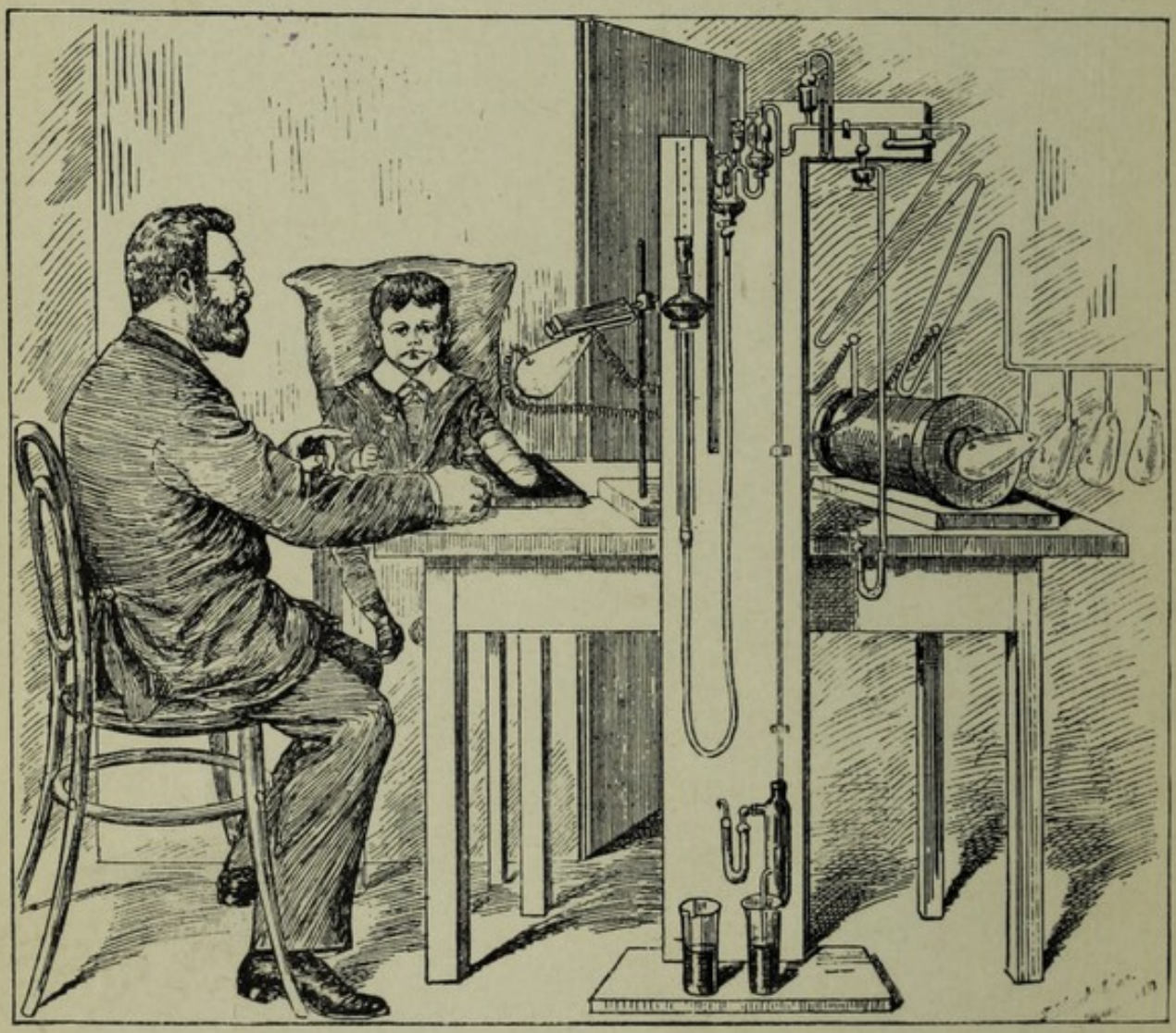

PROFESSOR GAERTNER EXPERIMENTING WITH THE RÖNTGEN RAYS.

*(By permission of the proprietors of the "Daily Graphic.")*

# THE NEW PHOTOGRAPHY


BY

ARTHUR BRUNEL CHATWOOD

JOINT AUTHOR OF "PHOTOGRAPHY ARTISTIC AND SCIENTIFIC"

WITH TWENTY ILLUSTRATIONS

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# PREFACE.

A FEW weeks ago we were startled by accounts in the daily press of the discovery by Professor Röntgen, of Wurzburg, of a new light capable of penetrating almost all substances. I propose in this book to give a popular description of this discovery, as well as of other recent introductions in connection with photography. In doing so, I do not lay any claim to original work; I am simply attempting to supply a description more full and intelligible than those that have appeared in the daily press, and to avoid the difficulties which the unscientific must encounter in trying to understand those which have appeared in technical publications. I must here acknowledge indebtedness to the press in general, to the "Photogram," the "Photographic Review," and the "Amateur Photo-

grapher," not only for much of my information, but for the use of blocks in the illustration of my text. For that portion of the work treating of colour photography I am indebted chiefly to Mr. F. E. Ives, of Philadelphia, who, though not claiming the title of "discoverer," has developed the best solution of the problem of colour photography which has up to the present time been seen, and this not by any happy accident, but by the patient and laborious application of scientific principles which have been before the world for many years. I have also to thank Mr. J. W. Gifford for much valuable information and suggestion, as well as for some of the photographs which I have reproduced.

A. B. CHATWOOD.

THORNTON HEATH,
SURREY.
*February*, 1896.

# THE NEW PHOTOGRAPHY.

## Part I.

### X-RAYS.

BEFORE trying to explain the discovery of Professor Röntgen—that photographs can be taken through what are commonly called opaque substances—it is essential that I should put before the reader some preliminary facts connected with light and undulatory movements in general. According to the theory of the propagation of light which is at the present time generally accepted, known as the undulatory theory, light consists of wave-like motions taking place in a medium, called the luminiferous ether, which, as far as we know, pervades all space and all sub-

stances. It bears a very close analogy to sound, which is undulatory movement taking place in air or other gases, as well as in many cases in solids. Heat also consists of an undulatory movement in the ether similar to that of light, but of less rapidity.

Everyone is familiar with the action of a prism of glass on which bright light falls in throwing colours on surrounding objects, the most familiar example perhaps being that of the old glass chandelier with triangular hanging lustres. It has been found by experiment that white light, such as that of the sun, consists of a mixture of light of all colours, and it has also been found that the various colours are due to rays vibrating at different speeds, although propagated longitudinally as far as we know at the same rapidity. If we apply a prism to a beam of light passing through a narrow slit, we find a strip of coloured light is projected on, for example, a piece of white paper on the other side of the prism. This strip will have at the side nearest

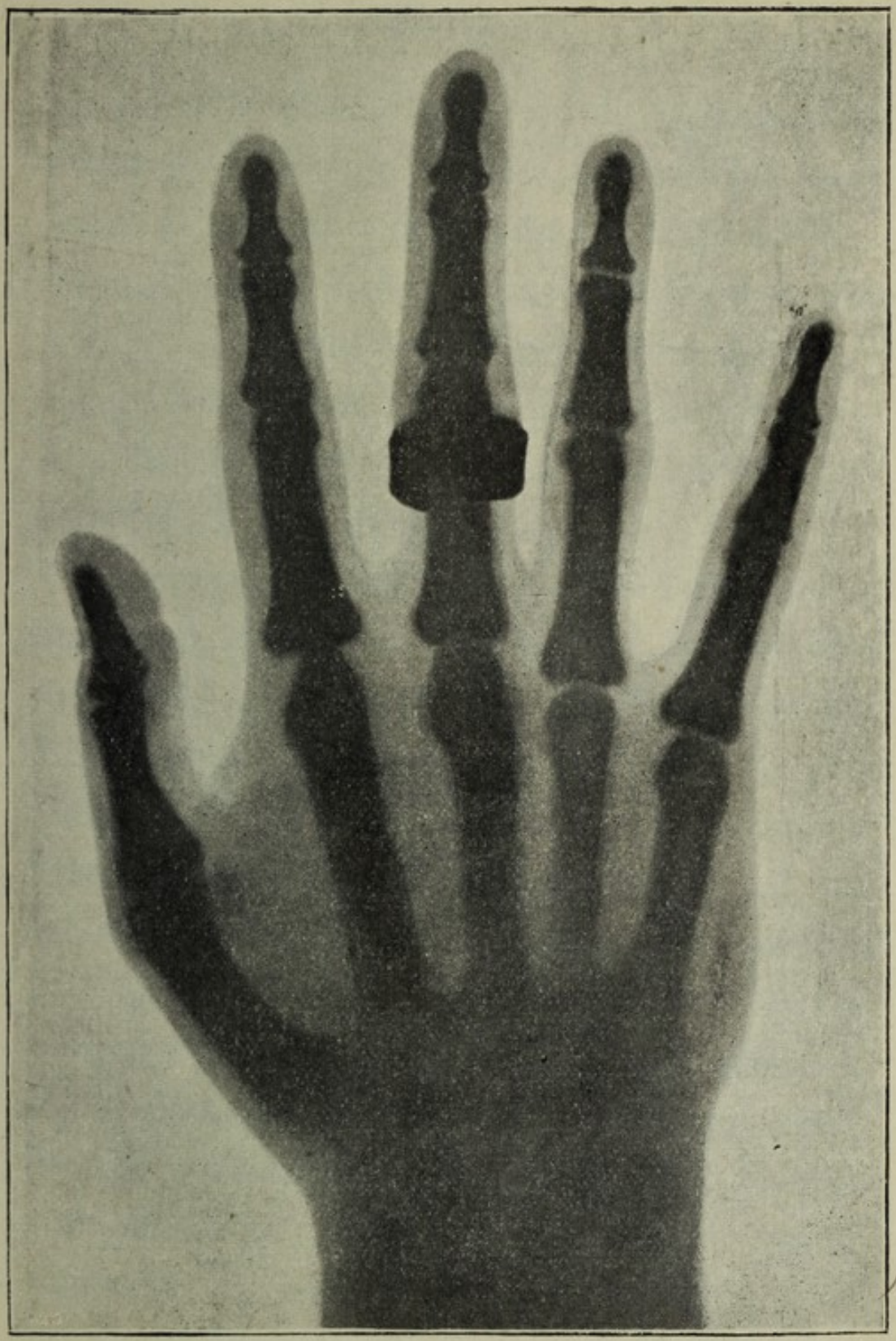
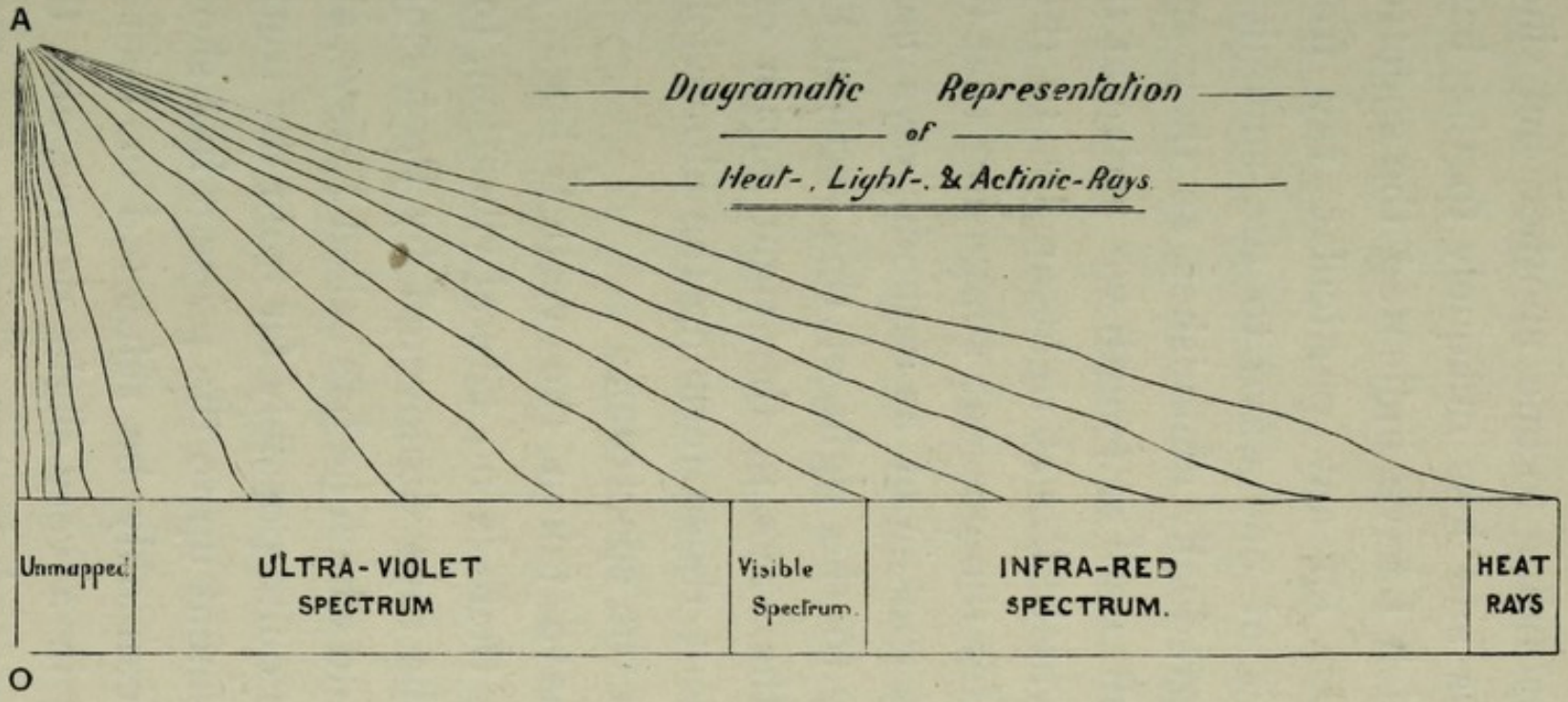


Fig. 1. HUMAN HAND. By Dr. SLABY.
(*From the "Amateur Photographer."*)

the point of the prism a red colour passing gradually to orange, yellow, green, blue, and violet, but beyond this violet coloration other rays fall which, although invisible to the eye, can be examined by means of photography. Again, too, in that part of the spectrum lying outside the red coloration we know from experiment that there are also rays.

Experiment has also led us to the conclusion that heat rays, even proceeding from a hot substance which emits no light, are bent by the action of the prism, and that the spectrum obtained is practically continuous, and ranges from the dark heat rays through red and the other colours above-mentioned far beyond that portion which is visible. This latter portion beyond the violet has been christened the "ultra-violet." Some years ago, after Professor Crookes had published many curious phenomena in connection with discharges of electricity *in vacuo*, what was then a new light was discovered. It was found that what are now known as Crookes' vacuum

tubes emitted light which was found to pass through thin layers of many substances supposed to be opaque; these rays were named "cathodic" rays. In electro-plating, the objects that are to be plated are attached to one of the wires from a battery, a plate of metal being attached to the other. One of these is called the anode, the other the cathode, and it was from this that these rays derived their name. The rays which Professor Röntgen has discovered resemble in many points the previously known cathodic rays, and although their nature has not yet been satisfactorily ascertained, there is, I believe, no reason why they should not occupy the same place with regard to cathode rays which cathode rays occupy with regard to the ultra-violet rays of the spectrum. It is from this assumption that I have designed a diagram on the opposite page. I have taken a point A from which I have drawn wavy lines, to represent the undulatory movement of heat and light rays, which you will notice have their summits


A
Diagramatic Representation
of
Heat-, Light-, & Actinic-Rays
Unmapped
ULTRA-VIOLET
SPECTRUM
Visible
Spectrum.
INFRA-RED
SPECTRUM.
HEAT
RAYS
O

B

corresponding to one another, but since they lie less and less obliquely to the base line, on which I have indicated the spectrum, the distance on any particular ray from the summit of one wave to the summit of the next gradually diminishes as they approach the left, until at length we arrive at the line AO, which lies at right angles to the base. I am for the present supposing that the rays I have spoken of as cathodic rays lie immediately to the right of this vertical line, and that the rays to the right again of these represent those forming the ultra-violet portion of the spectrum.

I have taken the vertical lines AO, in which there is no lateral vibration, to represent the rays discovered by Professor Röntgen, and which he has called X-rays, although this is quite possibly far from the truth, since experiment up to the present has shown that they can only be refracted or bent by the prism in a very slight degree, and the rays represented in our diagram are more and

more refracted out of their course as they approach the left.

When the first accounts of Professor Röntgen's discovery, which, by-the-bye, was accidental, were published in this country, a great sensation was caused. The discovery was announced in manifold and various forms; some papers announced it as the discovery of a new light, some as a new conductor of light, and in various other ways.

The announcement was very variously received. Among scientific men it was largely discounted or discredited, whilst among the general public it was supposed that it was a new source of light producing light by which a photograph of anybody, or even of their skeleton, could be taken by the ubiquitous amateur "through a flight of stairs and a deal door"; in fact, that the "pair of patent double million power gas microscopes of hextra power" of which our old friend Sam Weller spoke, were now an accomplished fact, and the more modest among us were

seriously contemplating the advisability of ordering suits of metal under-wear, which would, it was said, be opaque to the new light. These alarms were soon set aside when a correct report of the Professor's discovery together with a description of his apparatus came over, and his experiments were repeated by several scientists in this country, amongst whom I must mention Mr. Campbell Swinton and Mr. J. W. Gifford, some of whose photographs I have been permitted to reproduce here. The discovery was entirely an accidental one. The Professor was making experiments with a Crookes' tube covered up in a cardboard case, and had left some sensitive photographic paper on the bench near by. After passing a powerful current through the tube, he found that the paper had been acted upon and a dark mark produced. This started, as is often the case, a new train of thought and experiment, the result of which was that he found that rays were being pro-

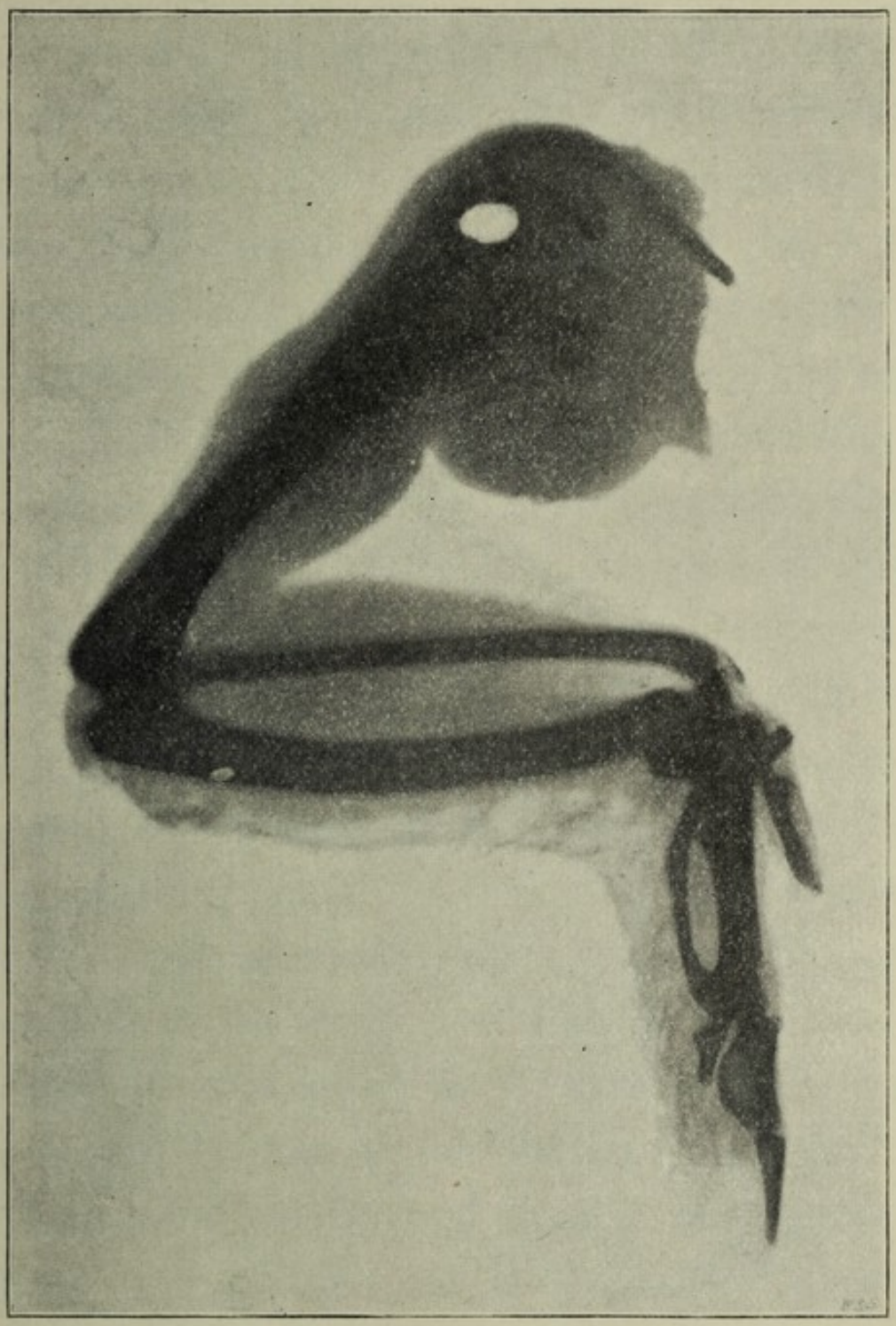


Fig. 2. WING OF A FOWL. By Dr. SLABY.

(*From the "Amateur Photographer."*)

duced which could act on a sensitive plate even through flesh, and many thicknesses of cardboard or paper, and were more powerful than the cathode rays with which he was very well acquainted. Further experiment convinced him that he had discovered some new kind of rays which he has since called X-rays, and some of the chief characteristics of which have already been determined. It is at present almost too soon to try and forecast the uses to which the discovery may be put, but when further developed it is quite possible that they will be extremely valuable in locating malformations of the bones, calcareous deposits, bullets or other foreign matters in the body, and they may thus become of great utility to the surgeon. It was reported in one of our daily papers that a Viennese physician had already made use of them, and by their aid had detected a calcareous deposit in the bladder and kidneys of a patient; but without confirmatory evidence, I much doubt the truth of this statement,

since flesh is not entirely transparent to these rays, and it is difficult to believe that a photograph, or rather shadowgraph, could be obtained through the whole thickness of the body during the time that a patient could possibly be submitted to experiment. They may also be of use in determining the nature of mixtures of metals and in detecting flaws, but as I have already said, it is rather too soon to discuss the question of utility.

It has been found that the X-rays resemble light in causing fluorescence, which, as is well known, is a property inherent in certain substances of appearing luminous after having been excited by light and placed in darkness. Perhaps the most familiar example is furnished by Balmain's luminous paint, or by the glow-worm, although this is more correctly a case of phosphorescence. "The different spectral rays are not equally well fitted to render substances phosphorescent. The maximum effect takes place in the violet rays, or even a little

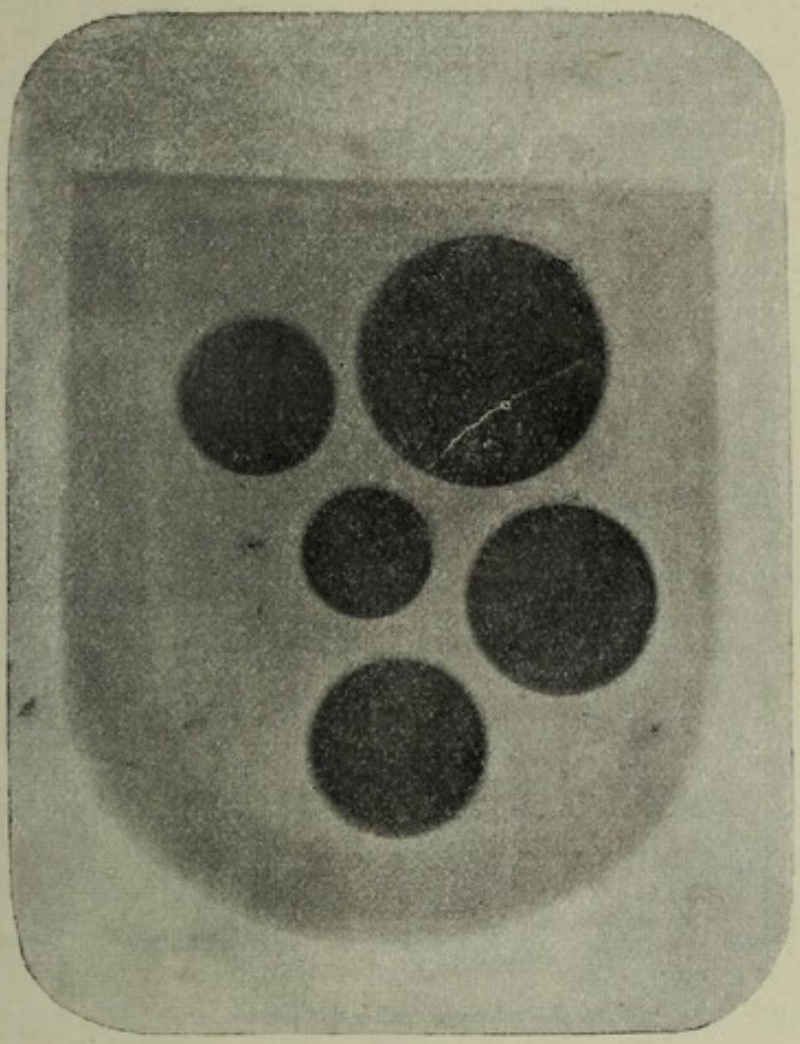


Fig. 3. Coins in Leather Purse.

By Mr. Campbell Swinton.

(*From the "Photogram."*)

beyond, while the light emitted by phosphorescent (fluorescent ?) bodies generally corresponds to rays of smaller refrangibility than those of the light received by them, and giving rise to the action." * The X-rays are, like cathode rays, powerful causes of fluorescence even in substances which are not generally classed as fluorescent, and the fact of their producing fluorescence points to their belonging to some portion of the spectrum which lies beyond the ultra-violet, probably beyond the position which would be occupied by the cathode rays.

With these introductory remarks, I shall proceed to quote portions of Professor Röntgen's own paper for the translation of which I am indebted to "Nature," January 23rd, and for the permission to reproduce which I must here tender my most cordial thanks to the editors.

1. A discharge from a large induction coil is passed through a Hittorf's vacuum

* Ganot's Physics.

tube, or through a well-exhausted Crookes' or Lenard's tube. The tube is surrounded by a fairly close-fitting shield of black paper; it is then possible to see, in a completely darkened room, that paper covered on one side with barium platino-cyanide lights up with brilliant fluorescence when brought into the neighbourhood of the tube, whether the painted side or the other be turned towards the tube. The fluorescence is still visible at two metres distance. It is easy to show that the origin of the fluorescence lies within the vacuum tube.

2. It is seen, therefore, that some agent is capable of penetrating black cardboard, which is quite opaque to ultra-violet light, sunlight, or arc-light. It is therefore of interest to investigate how far other bodies can be penetrated by the same agent. It is readily shown that all bodies possess this same transparency, but in very varying degrees. For example, paper is very transparent; the fluorescent screen will light up when placed

Fig. 4. Living Frog through Sheet of Aluminium, Exposed Twenty Minutes. By Mr. Campbell Swinton.

(*From the "Photogram."*)

behind a book of a thousand pages ; printers' ink offers no marked resistance. Similarly the fluorescence shows behind two packs of cards ; a single card does not visibly diminish the brilliancy of the light. So, again, a single thickness of tin-foil hardly casts a shadow on the screen ; several have to be superposed to produce a marked effect. Thick blocks of wood are still transparent. Boards of pine two or three centimetres thick absorb only very little. A piece of sheet aluminium, $15^{mm.}$ thick, still allowed the X-rays (as I will call the rays, for the sake of brevity) to pass, but greatly reduced the fluorescence. Glass plates of similar thickness behave similarly ; lead glass is, however, much more opaque than glass free from lead. Ebonite several centimetres thick is transparent. If the hand be held before the fluorescent screen, the shadow shows the bones darkly, with only faint outlines of the surrounding tissues.

Water and several other fluids are very

transparent. Hydrogen is not markedly more permeable than air. Plates of copper, silver, lead, gold, and platinum also allow the rays to pass, but only when the metal is thin. Platinum $\cdot 2^{mm.}$ thick allows some rays to pass; silver and copper are more transparent. Lead $1 \cdot 5^{mm.}$ thick is practically opaque. If a square rod of wood $20^{mm.}$ in the side be painted on one face with white lead, it casts little shadow when it is so turned that the painted face is parallel to the X-rays, but a strong shadow if the rays have to pass through the painted side. The salts of the metals, either solid or in solution, behave generally as the metals themselves.

3. The preceding experiments lead to the conclusion that the density of the bodies is the property whose variation mainly affects their permeability. At least, no other property seems so marked in this connection. But that the density alone does not determine the transparency, is shown by an

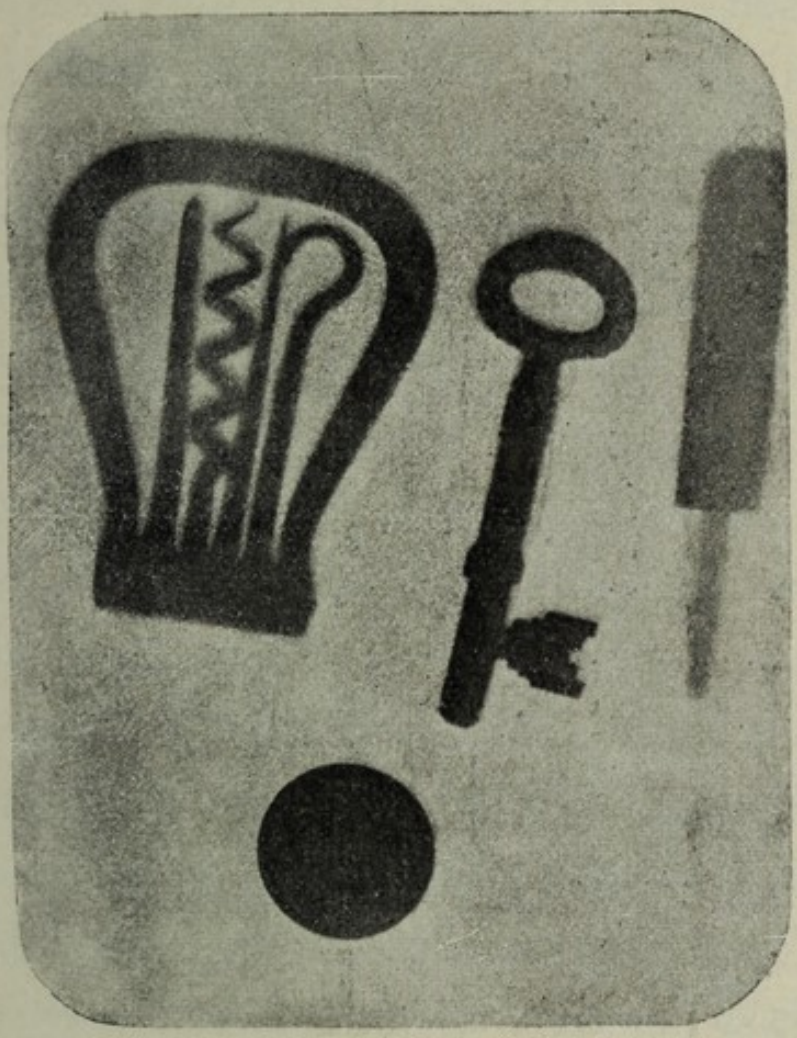


Fig. 5. Metal Objects through Calico Pocket and Sheet of Aluminium, exposed Four Minutes.
By Mr. Campbell Swinton.

(*From the "Photogram."*)

experiment wherein plates of similar thickness of Iceland spar, glass, aluminium, and quartz were employed as screens. Then the Iceland spar showed itself much less transparent than the other bodies, though of approximately the same density. I have not remarked any strong fluorescence of Iceland spar compared with glass.

4. Increasing thickness increases the hindrance offered to the rays by all bodies. A picture has been impressed on a photographic plate of a number of superposed layers of tinfoil, like steps, presenting thus a regularly increasing thickness. This is to be submitted to photometric processes when a suitable instrument is available.

6. The fluorescence of barium platinocyanide is not the only noticeable action of the X-rays. It is to be observed that other bodies exhibit fluorescence, e.g. calcium sulphide, uranium glass, Iceland spar, rock-salt, &c.

Of special interest in this connection is

the fact that photographic dry plates are sensitive to the X-rays. It is thus possible to exhibit the phenomena so as to exclude the danger of error. I have thus confirmed many observations originally made by eye observation with the fluorescent screen. Here the power of the X-rays to pass through wood or cardboard becomes useful. The photographic plate can be exposed to the action without removal of the shutter of the dark slide or other projecting case, so that the experiment need not be conducted in darkness. Manifestly, unexposed plates must not be left in their box near the vacuum tube.

It seems now questionable whether the impression on the plate is a direct effect of the X-rays or a secondary result induced by the fluorescence of the material of the plate. Films can receive the impression as well as ordinary dry plates.

The retina of the eye is quite insensitive to these rays; the eye placed close to the

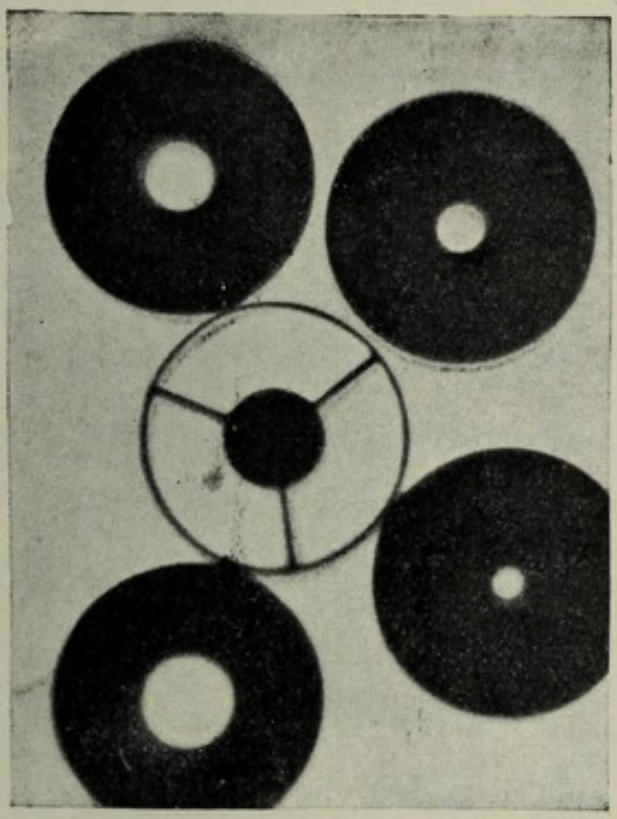


Fig. 6. Metal Discs through Two Sheets of Cardboard and a Sheet of Aluminium, exposure Ten Minutes.

By Mr. I. W. Gifford.

(*From the "Photogram."*)

apparatus sees nothing. It is clear from the experiments that this is not due to want of permeability on the part of the structures to the eye.

7. After my experiments on the transparency of increasing thickness of different media, I proceeded to investigate whether the X-rays could be deflected by a prism. Investigations with water and carbon bisulphide in mica prisms of 30° showed no deviation either on the photographic or the fluorescent plate. For comparison, light rays were allowed to fall on the prism as the apparatus was set up for the experiment. They were deviated 10$^{mm.}$ and 20$^{mm.}$ respectively in the case of the two prisms.

With prisms of ebonite and aluminium, I have obtained images on the photographic plate, which point to a possible deviation.

On account of the importance of the question it is desirable to try in other ways whether the X-rays are susceptible of refraction. Finely-powdered bodies allow in

thick layers but little of the incident light to pass through, in consequence of refraction and reflection. In the case of the X-rays, however, such layers of powder are for equal masses of substance equally transparent with the coherent solid itself. Hence we cannot conclude any regular reflection or refraction of the X-rays. The research was conducted by the aid of finely-powdered rock-salt, fine electrolytic silver powder, and zinc dust, already many times employed in chemical work. In all these cases the result, whether by the fluorescent screen or the photographic method, indicated no difference in transparency between the powder and the coherent solid.

It is hence obvious that lenses cannot be looked upon as capable of concentrating the X-rays; in effect, both an ebonite and a glass lens of large size prove to be without action.

8. The preceding experiments, and others which I pass over, point to the rays being incapable of regular reflection. It is, how-

ever, well to detail an observation which at first sight seemed to lead to an opposite conclusion.

I exposed a plate, protected by a black paper sheath, to the X-rays, so that the glass side lay next to the vacuum tube. The sensitive film was partly covered with star-shaped pieces of platinum, lead, zinc, and aluminium. On the developed negative the star-shaped impression showed dark under platinum, lead, and, more markedly, under zinc; the aluminium gave no image. It seems, therefore, that these three metals can reflect the X-rays; as, however, another explanation is possible, I repeated the experiment with this only difference, that a film of thin aluminium foil was interposed between the sensitive film and the metal stars. Such an aluminium plate is opaque to ultra-violet rays, but transparent to X-rays. In the result the images appeared as before, this pointing still to the existence of reflection at metal surfaces.

If one considers this observation in connection with others, namely, on transparency of powders, and on the state of the surface not being effective in altering the passage of the X-rays through a body, it leads to the probable conclusion that regular reflection does not exist, but that bodies behave to the X-rays as turbid media to light.

Since I have obtained no evidence of refraction at the surface of different media, it seems probable that the X-rays move with the same velocity in all bodies, and in a medium which penetrates everything, and in which the molecules of bodies are embedded. The molecules obstruct the X-rays the more effectively as the density of the body concerned is greater.

10. It is known that Lenard, in his investigations on cathode rays, has shown that they belong to the ether, and can pass through all bodies. Concerning the X-rays the same may be said.

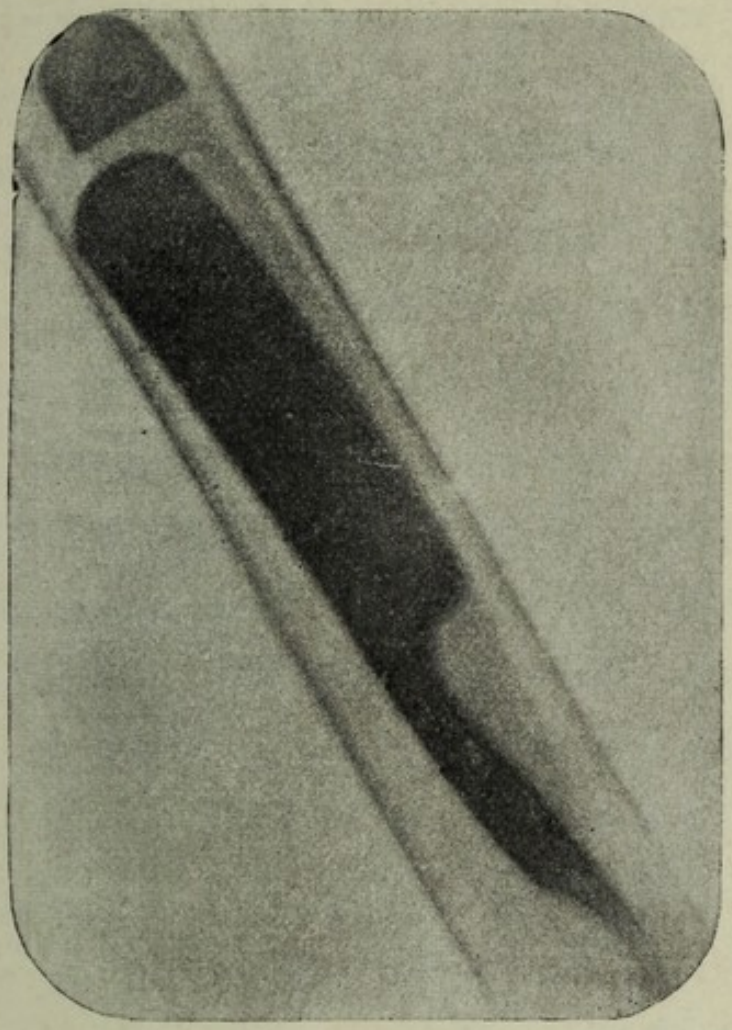


Fig. 7. Razor closed and in Cardboard Case, exposure Four Minutes. By Mr. Campbell Swinton.

(*From the "Photogram."*)

11. A further distinction, and a noteworthy one, results from the action of a magnet. I have not succeeded in observing any deviation of the X-rays even in very strong magnetic fields.

The deviation of cathode rays by the magnet is one of their peculiar characteristics. It has been observed by Hertz and Lenard, that several kinds of cathode rays exist, which differ by their power of exciting phosphorescence, their susceptibility of absorption, and their deviation by the magnet; but a notable deviation has been observed in all cases which have yet been investigated, and I think such deviation affords a characteristic not to be set aside lightly.

17. If one asks, what then are these X-rays; since they are not cathode rays, one might suppose, from their power of exciting fluorescence and chemical action, them to be due to ultra-violet light. In opposition to this view a weighty set of considerations presents itself. If X-rays be indeed ultra-

violet light, then that light must possess the following properties :—

(*a*) It is not refracted in passing from air into water, carbon bisulphide, aluminium, rock-salt, glass, or zinc.

(*b*) It is incapable of regular reflection at the surfaces of the above bodies.

(*c*) It cannot be polarized by any ordinary polarizing media.

(*d*) The absorption by various bodies must depend chiefly on their density.

That is to say, these ultra-violet rays must behave quite differently from the visible, infra-red, and hitherto known ultra-violet rays.

These things seem so unlikely that I have sought for another hypothesis.

A kind of relationship between the new rays and light rays appears to exist ; at least, the formation of shadows, fluorescence, and the production of chemical action point in this direction. Now it has been known for a long time, that besides the transverse vibrations which account for the phenomena of

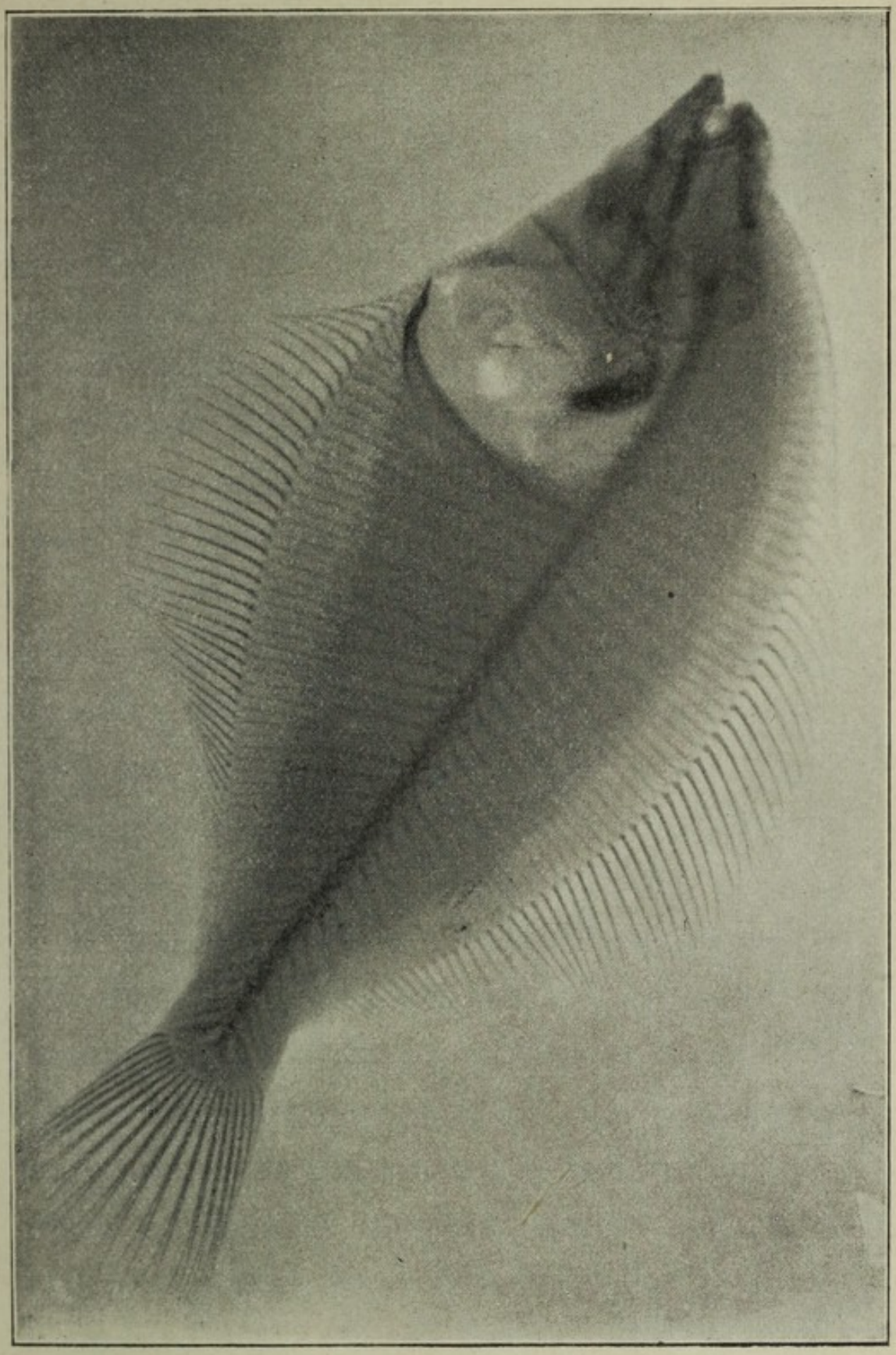


Fig. 8. Flat Fish. By Mr. J. W. Gifford.

light, it is possible that longitudinal vibrations should exist in the ether, and, according to the view of some physicists, must exist. It is granted that their existence has not yet been made clear, and their properties are not experimentally demonstrated. Should not the new rays be ascribed to longitudinal waves in the ether ?

I must confess that I have in the course of this research made myself more and more familiar with this thought, and venture to put the opinion forward, while I am quite conscious that the hypothesis advanced still requires a more solid foundation.

Writing in the "Amateur Photographer," Mr. Hugo Muller describes the experiments made by Dr. Slaby in confirmation of Professor Röntgen's discovery. The apparatus which he used consisted of a powerful battery of accumulators exciting a large induction coil, such as is used at fairs in this country to give electric shocks, but of course much more powerful. The vacuum tube which is

simply a glass tube or globe into which two platinum wires are melted, and which is connected to an air-pump, is gradually exhausted of its air, and when the platinum wires are connected to the induction coil, and the current allowed to pass, a faint light is produced. This light is known as Geisler light, and is that which is so frequently exhibited in the well-known *geisler* tubes. As the air in the tube becomes more and more attenuated, the light gradually fades until it becomes invisible. The tube itself now appears luminous; the luminosity being caused by a transformation into the form of fluorescence of the invisible cathode rays. If the vacuum be carried any further, the rays, which Professor Röntgen has provisionally named X-rays, are produced. Mr. Muller says:—"Professor Conrad Röntgen was born at Lennep, March 27th, 1845. In December, 1870, he became an assistant at the Physical Institute at Wurzburg, where he remained till May, 1872, and then went as

assistant at the Physical Institute at Strassburg. A year later he was appointed Professor at the Academy of Hohenhiem. In 1876 we find him at Gieysem, and in 1888 he became director at the Physical Institute of Wurzburg. He has published many scientific essays which are the result of much study and research."

In the last paragraph but one of Professor Röntgen's paper which I quoted, page 49, he speaks of longitudinal vibrations as well as transverse vibrations in ether. As far back as 1888, Herr G. Jaumann published a paper of great importance in connection with longitudinal vibrations of the ether, that is to say, of vibrations consisting of alternate rarefaction and compression as distinguished from vibrations such as those produced on the surface of a pond when a stone is thrown in. The rings formed in this latter case gradually spread outwards, although the actual particles of water simply move up and down, and do not travel outwards. It is said that Professor

Sylvanus Thomson has discovered that X-rays are generated in the ordinary electric arc. The idea of a light which should penetrate our flesh for surgical purposes, is upwards of thirty years old. As long ago as 1868, a paper was read before the British Association at Norwich "On the transmission of light through animal bodies." The light used being that of burning magnesium. The process of obtaining shadowgraphs, as well as the arrangement of the apparatus is well shown in the frontispiece. No camera is used; the sensitive plate is placed in the ordinary dark slide or in a cardboard box, and the object of which the shadowgraph is desired is simply laid upon it. The Crookes' tube is then placed above at a distance varying from one to eighty inches, and the electric current passed through it for some minutes. On development, in the case of a hand, for example, the sensitive plate blackens first in those parts which have not been covered by the hand.

It also blackens in lesser degree where it is obscured by the flesh ; but the bones oppose the X-rays much more perfectly, so that the portion of the plate on which the shadow of the bones falls remains practically unacted upon by the developer. After fixing in the ordinary way photographic positives can be printed by any of the well-known processes, and show the skeleton in black and the flesh in grey, resting upon a more or less white background. I have reproduced some of these results, figure 1 being from the shadow-print of a hand ; figure 2 being that of a fowl's wing, the feathers as you will see having been removed. Figures 3, 4, and 5 are shadowgraphs by Mr. Campbell Swinton, and need no special explanation. Figure 6 shows metal discs photographed through two sheets of cardboard and a sheet of aluminium. These discs were of sufficient thickness to be opaque to the rays. The hand, of which the skeleton is reproduced on the cover, is, I believe, that of a workman

employed in a factory, and has been damaged by the machinery.

This morning a report appears in the press that an Italian scientist has found means of making substances ordinarily considered as opaque, transparent to the X-rays; if this were so, objects could be placed on one side of a sheet of lead, for example, and a shadow-print produced on the other side; but it is impossible at present to say whether the Italian has discovered anything, or if he has, what he has discovered. It is to be hoped in the interest of hundreds of sufferers, that these new rays which have been developed so rapidly, may be thoroughly studied, and their power, as far as possible, increased, so that for medical purposes, all parts of the human machine may be graphically shown upon the sensitive plate.

During the last month the opinion that the X-rays were a kind of light probably belonging to some region of the spectrum in the ultra-violet has been tentatively disputed.

Whilst in the earlier experiments there are several things which would point to this conclusion, yet there are other things which would tend to negative it; for instance, we know that light belonging to the lower or red end of the spectrum is not so much refracted by a prism as that belonging to the blue and violet, and that as we proceed further and further beyond the visible spectrum into the ultra-violet this refrangibility increases; also all light that is at present known obeys the same laws of reflexion. Yet the X-rays are shown by experiment to be only very slightly refrangible, and not to conform to the laws of reflexion. Another hypothesis has been put forward, and is, I believe, due to Mr. Gifford, that is, that what Professor Röntgen has called the X-rays, are electrical rather than optical phenomena. This hypothesis takes us back to the time of Hertz.

Clerk Maxwell put forth the theory that light itself is a phenomenon of electro-magnetism, and that waves of light are rapid

electric displacements taking place in the ether. Professor Sylvanus Thomson is of opinion that all the phenomena of light could be explained by the development of this theory. Hertz showed experimentally that electricity is a wave-like action—he reflected it and refracted it similarly to light waves. The fact that the rays of light caused in a vacuum tube by the passage of an electric current can be deflected or turned out of their course by an electro-magnet tends to show the very close relation that exists between electricity and light. Starting from this hypothesis (that the X-rays were electrical), Mr. Gifford has experimentally shown that electrical waves can produce, in a greater or less degree, the same results that have been obtained by the so-called X-rays. He placed a box containing a sensitive plate, portions of which were protected by metal discs, between the plates of the Apps coil whilst the discharge points were within the sparking distance, and found that after a pro-

longed exposure the sensitive plate had been acted upon in exactly the same manner as if the Crookes' tube had been used, although the result was less marked. Mr. Gifford has, I believe, formed a very definite opinion as to the nature of these rays, but I do not feel justified in forestalling him by publishing his theory at the present time.

This change of opinion strikes me forcibly on looking at the current number of the "Photographic Review," where Capt. Abney's opinion is quoted as follows :—"There is no new principle involved. That is, it has been long known that by the radiation of heat rays (to employ a popular term) substances opaque to rays of ordinary light can be penetrated, and photographic images are taken thereby. Röntgen has discovered that the same thing holds good in the case of rays at the other extremity of the spectrum"; thus showing that he considered the X-rays as ultra-violet light, whereas at a meeting of the Royal Photographic Society a few evenings ago he

raised exception to the term *photograph*, and suggested that of *electrograph*.

A passage of very considerable importance in this connection occurs in a letter from Mr. David E. Packer, of Birmingham :— "From innumerable experiments made during the last six months it has been found that metallic plates, foils and films are relatively transparent to solar radiance of high refrangibility, and that photographic plates screened by such media during exposure to direct sunlight are affected in proportion to the thinness and electrical conductivity of the interposed screen. This interesting discovery has been successfully employed in photographing the solar corona—the photographs show that nearly all the electrical energy radiating from the sun has its source in the corona.

# Part II.

## COLOUR PHOTOGRAPHY.

Every now and then announcements are made that the problem of photographing in natural colours has been solved, and we are disappointed to find that in almost every case the announcement is fraudulent, or the solution extremely imperfect. Let us consider for one moment what we mean by colour photography. Do we limit ourselves to the production of prints on paper, which we can hang up in our houses like pictures, by the use of a direct colour negative, or are we willing to accept some less convenient solution of the problem? Up to the present no means are available for producing coloured prints on paper in the actual tints of nature with absolute fidelity. If we are willing to accept a different kind of solution,

we may consider the problem as having been solved.

There are only three methods as far as I know by which colour photographs could be produced without the intervention of hand work. Firstly, by the production of a photograph in coloured pigments, a process which has not yet been invented, and which I venture to predict never will be, at any rate during our time or that of our children. The second method is by making use of what are known scientifically as interference colours. This method has received very great attention from Lippmann, but the results which he has produced must be viewed at a particular angle, and although a few examples produced some years ago are pleasing and have a certain resemblance to nature, the best of them cannot be considered as the reproductions of natural colours. I believe further, that out of some thousands of exposures made, only a dozen or two passable results have been produced. The Lippmann

process is based upon the theory that if the light which forms the image passes through the sensitive film to a perfect mirror which is in contact with it, the reflected rays, encountering the direct rays, produce the phenomena of interference within the film—the rays of light propagating in opposite directions causing the vibrations at certain intervals to be neutralized, while at others they are intensified, with the result that the photographic image is made up of strata of black silver deposit separated by clear spaces, the separation of the strata everywhere depending upon the wave lengths of light acting upon that part of the film. At the critical angle such a photograph will reflect light the colour of which depends upon the thickness and separation of the silver laminæ, as the colours of the soap bubble depend upon the thickness of the soap film. In practice "a structureless" film of bromide of silver in gelatine or albumen is used, backed with mercury. Very long exposures

are necessary. The third method, that of making records of colour by means of three or more monochrome photographs, and afterwards combining them by optical or other means into a single result, giving to each part its appropriate colour, is undoubtedly the process from which we can at present look for the best results. This method of reproducing natural colours was first suggested by J. Clerk Maxwell in a lecture delivered at the Royal Institution, on May 17, 1861. Maxwell, after stating that all the colours of the spectrum, and therefore all the colours in nature, are equivalent to mixtures of three colours of the spectrum itself—red, green, and violet-blue—projected such coloured lights upon a screen by means of three separate magic lanterns, and showed how they can be mixed and blended so as to reproduce other spectrum colours to the eye. He went further, by showing three photographs of a coloured ribbon which had been made through the three coloured filters,

and which when projected through the same coloured filters, and superposed on the screen, showed an imperfect reproduction of the coloured ribbon. Further suggestions, relating chiefly to the production of colour prints, were made by Henry Collen and Baron Ransonnat in 1865, by Ducos Du Hauron and Charles Cros in 1868 and 1869, by Dr. H. W. Vogel in 1885, and by others.

But none of the methods were successful, owing to wrong theory. The first success was achieved by the definite application of the Young-Helmholz-Maxwell theory of colour. This theory assumes that colour has no physical and material existence, but is a physiological phenomenon dependent upon the construction of the eye. It assumes that there are three fundamental colour sensations, which may be due to three sets of nerves which are excited by light of different wave lengths, or what we should call different colours, one set representing the red sensation, another the green, and the third the

blue-violet, and that other colours are produced by the simultaneous excitation of two or more sets of these nerves in greater or less degree. A very similar phenomenon in connection with sound serves to familiarize this idea. If three tuning forks corresponding to different notes are placed upon the piano, and the note of one of them struck thereon and damped, it will be found to have set one fork vibrating, but the other two forks will still be silent. If two notes corresponding to two of the forks are sounded together, each of the two forks will be set vibrating, and so on. Dr. Stolze, of Berlin, appears to have been the first to recognize the importance of this theory to the question of colour reproduction, but it remained for Mr. F. E. Ives to devise and carry out a precise and strictly scientific method giving really satisfactory results.

Collen's idea was to make three negatives of an object, one by red light, one by yellow, one by blue—the so-called primary colours of Brewster—to print from each pair of these

negatives (superposed as one) a transparent positive having the colour (in the shadows) of the light that produced the third negative, and to superpose these coloured positives on a white surface.

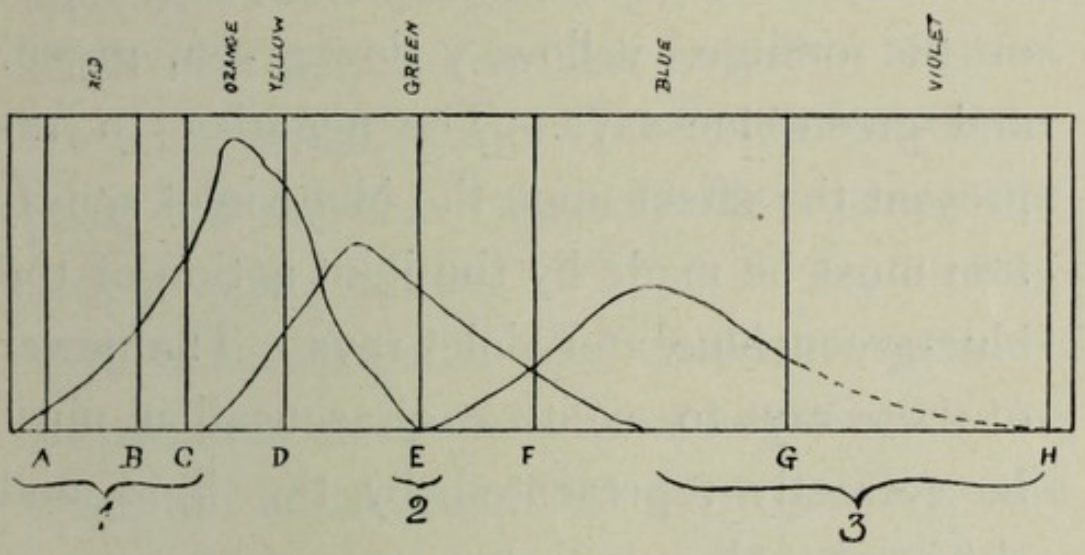
The same idea was patented in 1868, by Du Hauron, who however, instead of superposing two negatives, allowed two primary colours to act together in producing each negative. A modification was published soon after by Chas. Cros ; Poirée and others also suggested modifications upon Collen's process. These processes were impossible, because they were founded on an entirely erroneous conception of the nature of colour, and also because the photographic plates of that time were not sensitive to some of the colours. In 1873 Dr. Vogel, of Berlin, discovered that the photographic plate could be sensitized by treatment with various organic dyes, for different colours. Soon after this Du Hauron made use of colour-sensitive plates in his experiments, and produced improved

results; other experimentalists also took advantage of Vogel's discovery.

I have just stated that according to the Young-Helmholz theory of vision there are three fundamental or primary colour sensations; the probability of this explanation of colour being correct can be shown by a simple experiment. In the first chapter of this little work I gave a rough description of the spectrum. I must now point out that besides being a band of light of various colours, the spectrum is interrupted by gaps or what appear as dark lines running across it. It is from these dark lines, which always occupy the same relative positions, that all measurements are made. If the spectrum be examined by means of a good spectroscope, two dark lines close together will be seen at the extreme end of the violet portion ($H_1$ $H_2$), another well-marked line, known as G, lies between the blue and violet, and so on. Clerk Maxwell made a careful analysis of the spectrum, and determined which

portions of the spectrum most exclusively excited each colour sensation and in what degree; he plotted out in the form of a diagram the results of his experiments, which I here give, and which shows by the height of each curve at any point the intensity of the colour.

DIAGRAM.




The first remarkable fact to be gathered from the study of this diagram is, that the rays that represent a fundamental colour sensation are in no case the ones that most powerfully excite that sensation. The red sensation is excited by all the spectrum rays from red to green, but most powerfully by

the orange, and any photographic negative which is to represent the effect upon the fundamental red sensation must therefore be made not through a red glass or by the red rays, but by the joint action in definite proportions of the red, orange, yellow, and yellow-green rays. The negative to represent the green sensation must be made by the joint action of the orange, yellow, yellow-green, green, and green-blue rays. The negative to represent the effect upon the blue-violet sensation must be made by the joint action of the blue-green, blue, and violet rays. The power of these rays to excite each sensation must be correctly represented by the light and shade of each negative.

By measurement of the density of the various parts of a spectrum negative the relative amount of action by the different spectrum rays may be found. It is therefore necessary to use such a combination of sensitive plate and colour screen as will yield three negatives whose densities, when plotted

out, will give three curves similar to those in the above diagram.

I may point out here that although, as I previously said, by the application of dyes to the film the plate may be sensitized for various colours, its sensitiveness to blue, violet, and ultra-violet light, which is, in its normal state, excessive cannot be destroyed, but a coloured glass may be put into the lens or in front of the plate which will not allow these colours to pass, and will also help towards causing this proportionate action.

If sensitive plates and colour screens are so prepared as to yield three negatives of the spectrum whose densities correspond to the above diagram, a permanent record of all the colours of nature can be obtained by producing with their aid three photographs. These, of course, are not colour-photographs, but by certain devices which I shall presently describe, they can be made equivalent to an actual coloured photograph. This can be done by printing ordinary monochrome trans-

parencies and illuminating each by its proper colour, the one representing the red sensation by red light, the one representing the blue-violet by blue-violet light, and the one representing the green by green light, and then superposing them in any suitable way. For this purpose they may be placed in three magic-lanterns, each in front of a piece of glass of the proper colour, and throwing them upon the screen in superposition, or they may be placed in some special instrument (the photochromoscope), or each print, which must in this case be made by some gelatine process such as the Woodburytype or the carbon process, may be dyed with its appropriate colours and the three superposed. Each of these processes has its special difficulties. This process, as far as I have sketched it, is possible with an ordinary camera, which every amateur photographer possesses, but the most expert photographer, working in this way with his ordinary instruments, would probably not produce one decent result in

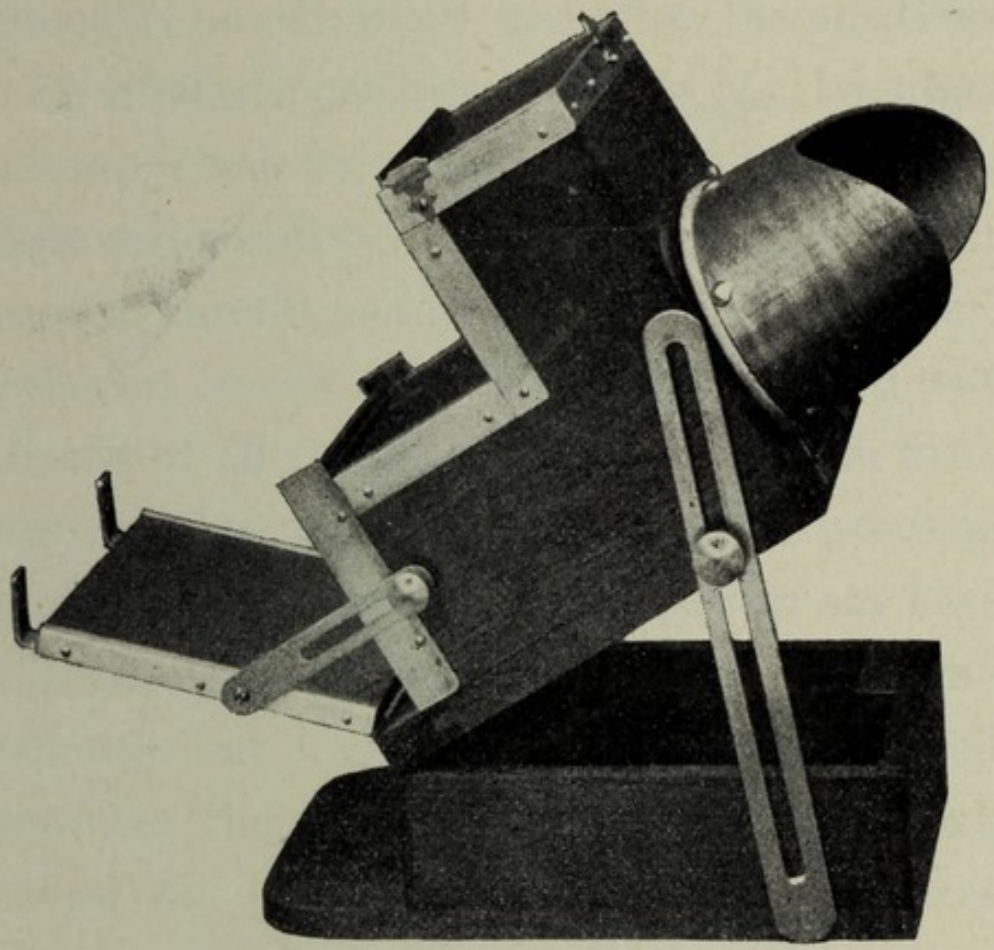


Fig. 9. The Photochromoscope.

a hundred, since it is almost impossible to produce three negatives of exactly similar quality except by special appliances which permit all three negatives to be made simultaneously on one plate, and allow the positives to be similarly produced. This Mr. Ives has accomplished by means of what he calls his photochromoscope camera. He has, after years of careful and well-directed experiment, produced colour screens which will give true records of all the colours of nature with little more trouble than that required to produce an ordinary photograph. I ought to say here that the diagram above given is not quite accurate, but Captain Abney, who is so well known to the amateur photographer, among others, has by experiment improved these curves of Maxwell's, and that Mr. Ives has availed himself of the results of these experiments. He devoted most of his time, after perfecting the camera for the production of the three negatives simultaneously, to the production of lantern slides and other trans-

parent pictures; but finding that these could not give so true and so pure a result as could be got by optical superposition, he temporarily abandoned this line of experiment and set to work to produce an instrument in which the three monochrome transparencies could be placed without any difficulty, and which, whilst being simple and inexpensive, should superpose them satisfactorily, and this I can say from my own experience he has accomplished with marked success. The process is now so simple that, given the necessary camera and the photochromoscope for viewing the pictures, any amateur photographer of ordinary intelligence can produce these colour photographs for himself.

The photochromoscope consists of a box the place of two adjacent sides of which is occupied by a kind of step-ladder arrangement, as seen in our illustration. The transparency from the triple negative is cut into three strips and mounted upon a special cardboard frame, so that it can be easily

folded up and stored away. In order to view it in the photochromoscope it is placed on the step-ladder-like arrangement, which is so arranged that each slip of the photograph naturally falls into its right position. Each of the steps is fitted with its appropriate colour screen, and an arrangement of mirrors inside the box causes all the images to combine and appear as one. The result, seen in the instrument, is so perfect that were a vase, for example, placed upon the table near the instrument and its photograph in the instrument, you would almost involuntarily move the vase to assure yourself that you were not looking at an actual reflection; the appearance is rendered so real in form as well as in colour by the adoption of the stereoscopic principle.

Mr. Ives, speaking at the Camera Club a short time ago, thus describes his photochromoscope: "The form of the new photochromoscope suggests steps of stairs. It was first made with three steps, and on the

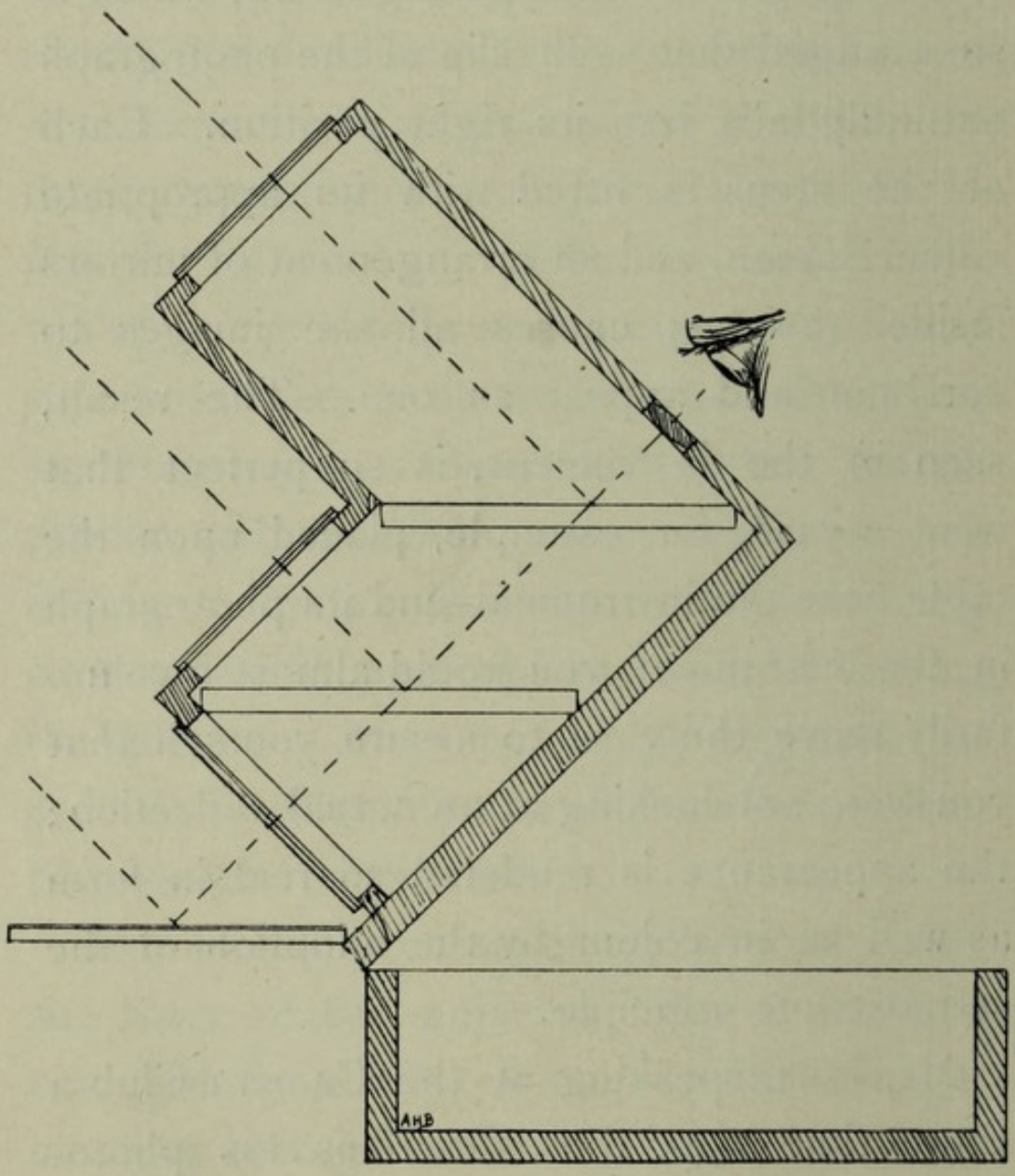



Fig. 10. THE PHOTOCHROMOSCOPE.

top of each step was placed one image of the chromogram (the triple photograph), which is made in sections, hinged together, so as to fold up. The model was afterwards reduced in size and made more powerful by having only two steps, the third image being viewed directly instead of by reflection. The red image lies horizontally upon the top step, and is seen by reflection from the first surface of a cyan-blue coloured glass, which stands underneath it and in front of the eye, inclined at an angle of 45°. The blue-violet image lies upon the second step, and is seen *through* the cyan-blue coloured glass by reflection from the first surface of a yellow or green glass, which is also inclined at an angle of 45°. The green image stands upright against the lower step, and is viewed directly through the cyan-blue and yellow or green glasses, both of which transmit the green light. By this means the three images are so blended as to appear as one to the eye. The reflectors are of coloured glass,

to avoid outlines, it being only necessary to use glasses the substance of which absorbs light of the colour which they are intended to reflect from the first surface."

The camera required for the production of the triple negative is a little more complicated than the photochromoscope. It consists of a box divided into three parts, having at the back the usual arrangement for carrying the sensitive plate, and at the other end the three colour screens. To this is attached a case carrying a set of mirrors so arranged that the light entering the lens is divided into three parts, and each part is, of course, made to travel the same distance before arriving on the sensitive plate; were this not so, the images would be of different sizes, and therefore useless. The value of these inventions can be well appreciated when it is remembered that they will enable us at a very small expense to have in our drawing-rooms copies, true not only as regards light

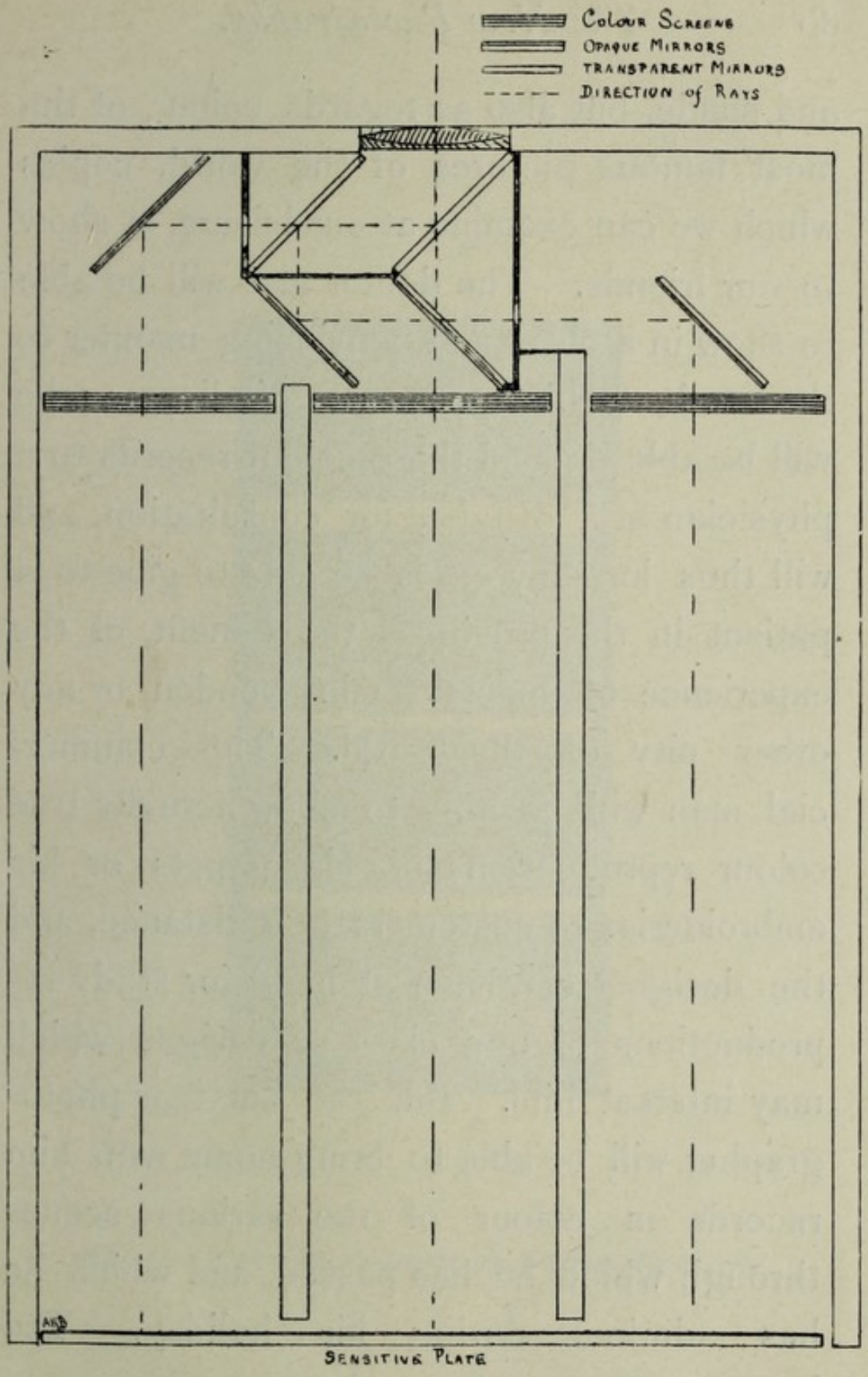



Fig. 11 THE PHOTOCHROMOSCOPE CAMERA.

and shade, but also as regards colour, of the most famous pictures of the world, copies which we can examine at our leisure, or show to our friends. The doctor also will be able to show in a clear and convincing manner to the student the appearance of disease; he will be able to send these colour records to a physician at a distance for consultation, and will thus in many cases be able to give to a patient in the provinces the benefit of the experience of specialists in London or any other city of the world. The commercial man will be able to show actually true colour reproductions of his carpets or his embroideries to customers at a distance, and the designer can have at hand for study reproductions of any class of designs which may interest him. But the amateur photographer will be able to bring home with him records in colour of the various scenes through which he has passed, and which he has admired during his holiday. The lecturer will be able to show in colour upon

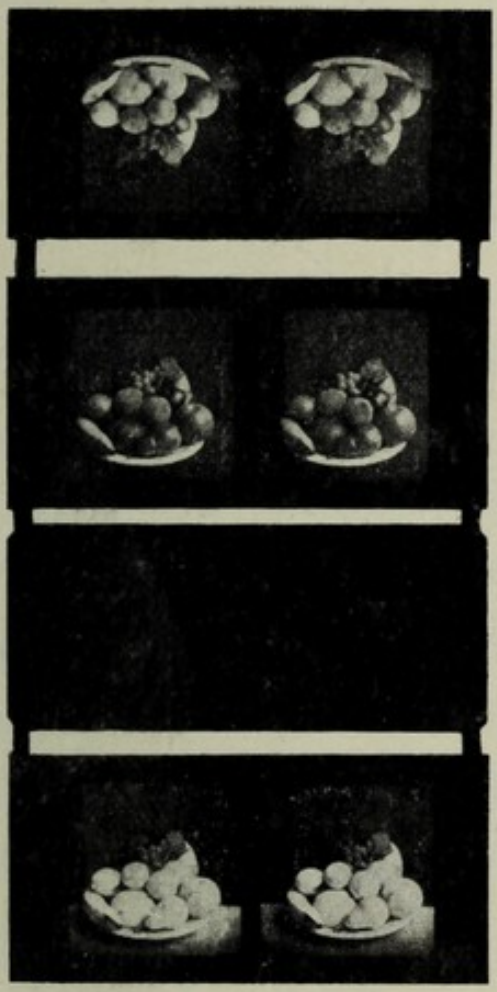


Fig. 12. The Chromogram or Triple Positive.

the screen the various views which he can now only exhibit in monochrome.

The *Daily Graphic* says:—"Nothing so perfect in its resemblance to nature has before been seen, and the instrument promises to become as popular as the stereoscope was once on a time. Let it be noticed, too, that a production of these pictures in colour will be well within the power of the ordinary amateur photographer. The operation of producing the multiple negatives will not be essentially different from the methods now in vogue, save that the exposure of the plate will amount to perhaps a couple of minutes, instead of a fraction of a second. What is called 'instantaneous' work is therefore, for the present, barred, due to the presence in the camera of the coloured light filters, a difficulty which may possibly be surmounted in the future. But amateurs and others will have to wait some time before the special cameras are placed upon the market. Suffice it to say that they have some-

thing to look forward to which is calculated in great measure to revolutionize their work. No one who has once seen the marvellous effects produced by the perfected photo-chromoscope will rest content with the ordinary product of the camera."

I have spoken of the production of lantern-slides by means of a gelatine print from the triple negative, cut up, and each portion dyed to its appropriate colour, and then the three portions superposed, but there is another application of probably greater importance, namely, that to producing coloured prints by the thousand in the printing-press. As the reader is probably well aware, until lately the larger proportion of the coloured prints seen have been produced by lithography. In that process the drawing is placed upon a number of stones, often twenty or thirty, and the colours are laid on the stones in the positions they are to occupy in the finished print by hand, one colour to each stone. Most of the colours in the original are obtained by mixing

ink to the right shade, although some tints are got by printing one colour over another. Until quite recently, nothing of any moment was done in connection with colour printing in the typographic press, but since the perfection of what is known as the "half-tone" process, much more has been possible, and prints in a very large number of colours have been produced by printing from three, or as many as eight, half-tone blocks (blocks similar to that used for printing fig. 1 for example). In printing from more than three blocks no regard has been paid to any theory of colour vision; it has been an entirely arbitrary proceeding, and the results have in very few cases been desirable. What is known in this country as the "three-colour" typographic process has depended less upon hand work, but the results have been uncertain, because, firstly, of the difficulty of producing three well-balanced negatives by separate exposure and development; secondly, by the use of imperfect inks; and

thirdly, by the almost impossibility of keeping the ink distribution regular in printing machines as at present constructed.

The process I have been describing applied to three-colour printing will overcome some of these difficulties, those chiefly which are incident to the production of the blocks. Mr. Ives' work settles clearly and distinctly the colours to be used in the inks. It remains for the ink-makers to manufacture the inks without mixing them as they do at present with a dirty brown varnish which destroys the purity of their colours; for the machinery-makers to design an efficient ink-distributing arrangement, so that when once it has been set to produce a proper result, the copies, however numerous, will not vary by reason of variations in the ink supply. It is not possible to produce in the press results which can in any way compare with those obtained in the photochromoscope, since the broken shading essential to printing at press, materially injures the colours; but the advan-

tage of being able to produce thousands of copies at small expense, which will be distributed among a class of people who cannot afford to keep a photochromoscope at home, and thus putting before them results which are at any rate near approaches to nature, instead of the frightful monstrosities which are to-day produced by cheap lithography (the greater part of these horrible things coming, I believe, from Germany), will probably outweigh the disadvantages of a degraded colour scale.

A new process for producing photographs in colour has just been published, and although I do not think that it will be of any practical value, its ingenuity certainly entitles it to description here. Whether Dr. Joly, its inventor, has attempted merely to evade the patent rights of Mr. Ives, or has thought that the advantages of only requiring one negative instead of three would outweigh the many disadvantages of the process, I cannot say. If it is intended as a short cut to Mr.

Ives' results, I am afraid it would compare very closely with going from the Bank to Hyde Park, *viâ* Manchester. It is founded, like that of Mr. Ives, entirely on the Young-Helmholz theory of colour vision, but instead of taking three negatives, one for each fundamental colour sensation, Dr. Joly takes one negative of which narrow strips (about $\frac{1}{300}$th part of an inch) are acted upon through a special colour screen, every third strip corresponding to the same colour sensation.

The screen is prepared by ruling narrow coloured lines side by side, the first line allowing all light to pass which can act upon the red sensation, for example; the second line that which acts upon the green sensation; the third, that which acts upon the blue-violet sensation; the fourth is similar to the first, and so on. The sensitive plate is placed immediately behind the screen, exposed and developed in the ordinary way. A transparency is printed from this negative,

and must be viewed in contact with a yellow, pink, and blue-violet screen which must be ruled in exact *fac-simile* of the screen through which the negative was taken. The result is a series of light and dark-coloured lines, which are so close together that when viewed in the ordinary way they coalesce, and their intensity is such that the combination of the coloured lines running across any object do represent very closely the natural colour of the object. This process is one which appears to possess remarkable simplicity, but there are several difficulties to be encountered in practice. The difficulty of ruling a screen with coloured lines touching one another, but not overlapping, and keeping the strength of each colour not only equal in all parts of the screen, but equal also to a predetermined standard, is one which I think will hardly be solved in practice. The difficulty in connection with the screen for viewing the positives is the same, together with the enormous difficulty of making this

screen exactly match that for the production of the negative.

The cost of these screens can hardly be estimated, but I should think that a 10″×8″ screen would be worth at least £50. Assuming, however, possession of two screens such as I have described, the registration of the screen under the positive will require to be very exact, since a $\frac{1}{300}$″ of an error would place every line of the positive over a wrong line on the colour screen, and the production of complementary colours throughout, red for green, &c., would result.

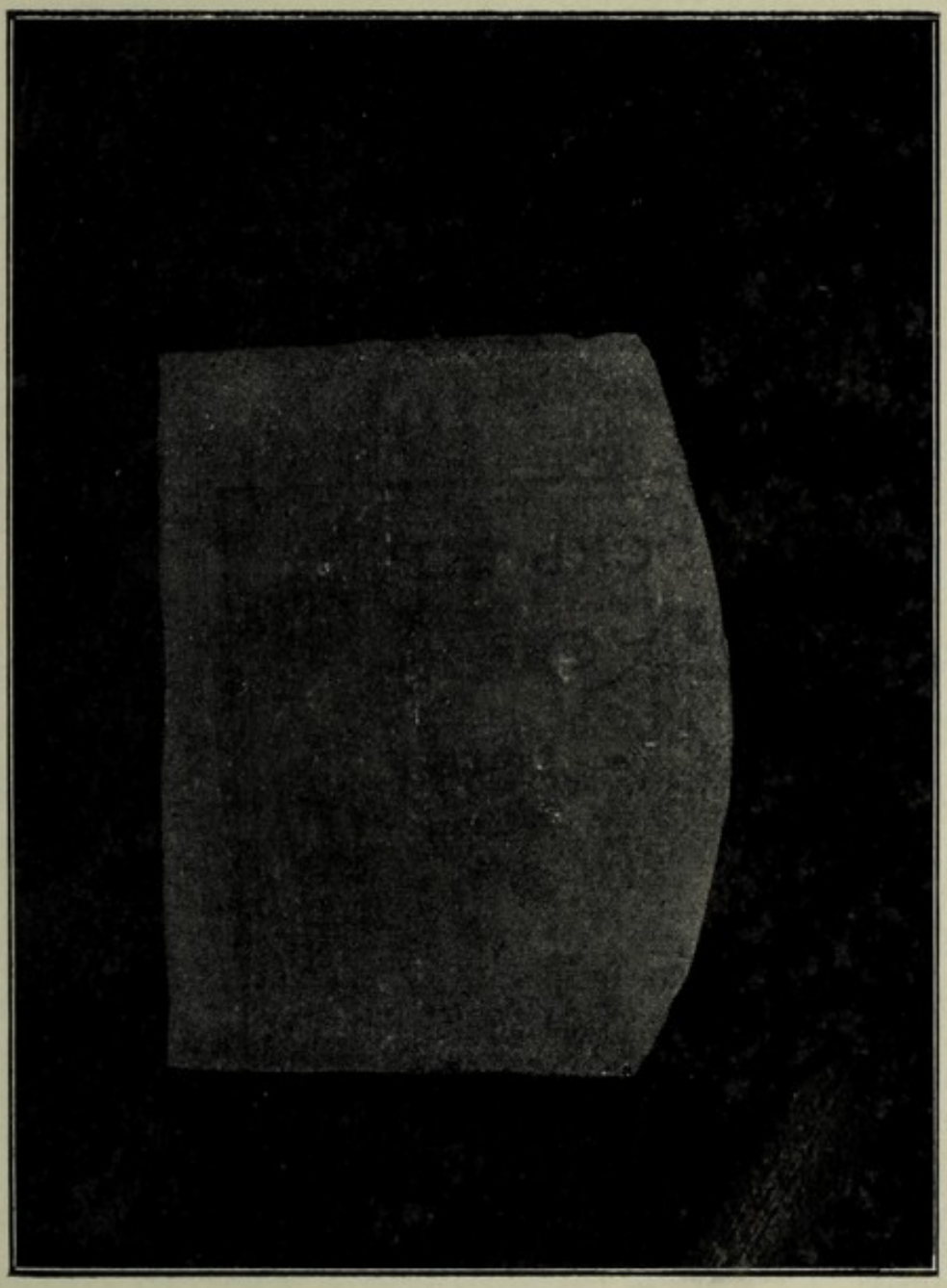


Fig 13. Retinal Impression. Piece of Paper printed both Sides, and viewed by Transmitted Light. By The Author.

# Part III.

## PSYCHIC PHOTOGRAPHY.

### RETINAL IMPRESSIONS.

LAST November the idea that the image of objects on the retina of the human eye might so affect it that a photograph could be produced by looking at a sensitive plate, in total darkness, immediately after the excitation of the retina by light, was published by Dr. Ingles Rogers, together with a couple of illustrations. Dr. Rogers claims the discovery, but some ten years ago I myself made experiments in this direction, and even at that time I believe the idea was not new; at any rate, it was suggested to me, and most of the experiments which I made were not at all on my own account or for my own purposes. The process is remarkably simple; the operator stares

steadily for a short time at some brightly illuminated object, and then, the room being suddenly darkened, at a sensitive plate. No lens or camera is necessary; after staring at the plate in a steady manner for from five minutes to half an hour, it is developed. The results that have been published are somewhat vague and fluffy, this fluffiness probably being caused by a difference in distance from the eye to the object and to the sensitive plate. Assuming for the moment that the retina can in some way or other retain light for a short time, and remembering that the eye is a kind of little camera, the retina being substituted for the ground glass, it is evident that if the eye be focussed on any particular object at a short distance away, and that then a sensitive plate be substituted for the object, an image of the object will be thrown upon the plate. This image will, provided the focus of the eye does not vary in the meantime, be sharp. That the eye does retain light in some way or other is clearly

proved by the production of an image at all on the sensitive plate, but the means whereby it does so are not quite so clear; the probability is, I think, that the retina becomes fluorescent or phosphorescent under the excitation of light. I reproduce on page 91 a photograph of this sort recently taken by myself, which will be found perfectly sharp, although extremely feeble. I would advise any one, however, who has not remarkably strong eyes to forego experiment in this direction. I can safely affirm that nothing will persuade me to experiment personally again.

It struck me during the course of the above experiments that if light can so excite the retina as to produce brain action, there was a possibility that brain action or thought might produce such excitation of the retina as would enable it to project an image which could be photographed, but that it would be probably more easy to, as it were, transform an excitation already existing. I

made experiments on the subject by staring at a sheet of grey paper in a strong light, and at the same time doing my best to concentrate my mind upon some well-known object, and trying then to produce a photograph in the same way as in the case of the ordinary retinal impression, and also by the use of the special apparatus described below.

In the "Amateur Photographer" of February 20th, 1896, Dr. Ingles Rogers, in the course of a long article, states that he found it necessary to produce a vacuum in the space between the eye and the plate, and that the problem of photographing thought is solved. So great importance is given to the matter, that I feel compelled to give some further particulars of the methods and apparatus which I employed, and whilst I do not in any way claim the honour of first discovery for myself, I think it right to limit the claim which Dr. Rogers puts forth to first publication and not first discovery.

The matter was originally suggested to me

in connection with the causes of the persistence of images on the retina. The apparatus which I constructed consisted of a brass tube about $1\frac{1}{2}''$ in diameter and 10″ long, filled at one end with a rest like that used with a telescope eye-piece, and attached at the other to a small camera carrying a holder, one-half of which contained a plate and the other a transparency or a piece of glass to which objects were attached, and viewed by transmitted light. The transparency was illuminated by a powerful lamp or by the limelight, and after fixedly regarding this with the eye well against the end of tube, the slide of the camera was shifted rapidly, so as to substitute the sensitive plate for the transparency.

Experiments were made with different lengths of tube, but the images were always of the same size as the object.

I believe that in the results obtained as above there was no manifestation of brain action; that they were dependent entirely on

the chemical nature of the retina of the eye and on well-known optical laws.

I made experiments also in the region of psychic photography by concentrating all thought on a well-known object, and looking down the tube of the above apparatus at an illuminated piece of ground glass, and then shifting the slide.

The results which I obtained proved conclusively the possibility of photographing thought, provided a feeble light excitation had very recently fallen on the retina.

Whether brain action could be photographed without the preliminary general and even excitation, I was not tempted to try.

I am not aware whether any one else has experimented in the same line, but if not, would suggest the advisability of such experiment.

# SPIRIT PHOTOGRAPHY.

THE idea that it is possible to photograph spirit forms is one which almost all men of common sense will ridicule. It is not a new idea by any means, but lately it has been revived, and has given rise to a large amount of discussion, not only among spiritualists, and in spiritualistic journals, but even in photographic publications. It is a kind of epidemic which seems to recur from time to time; whether or not there is any foundation in fact for the statement of the spiritualist that spirit-forms are sometimes present among us, and capable of impressing their image on the sensitive plate, cannot be decided at present. But as any such subject has an undoubted scientific value, it were well to look on all sides of the question. Firstly, if spirit-forms are to impress their

image on the sensitive plate, they must, whether visibly or invisibly, be present. The advocates of spiritualism allege that they are present, but that only certain human beings are possessed of what could certainly be classed as a sixth sense. These beings alleged to possess this sense are naturally spiritualists, and are interested in the promulgation of their doctrines; they are therefore not impartial witnesses. Let us look for one moment at the various ways in which an image can be impressed upon the sensitive plate. Firstly, by the action of light, *visible light;* secondly, by the action of ultra-violet light, *invisible light;* thirdly, by the action of heat; fourthly, by pressure; fifthly, by friction; sixthly, by electricity, and again, by vibration. From this it is seen that a spirit form must manifest itself in one or other of these ways in order to impress its image upon the photographic plate. Of these various methods we may exclude visible light, heat, friction, and pressure as being

practically impossible. There therefore remain only two methods which we need to consider; they are, the action of ultra-violet or invisible light, and that of electric waves. It has been proved many times and often that electricity is capable of decomposing the sensitive silver salt of the photographic plate. Mr. Preece has demonstrated the possibility of telegraphic communication with points not directly connected by wires. It is therefore an easy step to realize the possibility of the decomposition of this salt by electricity communicated without wires. We have now therefore to consider, firstly, whether spirits in the sense in which the spiritualists use the term are present in the studio, and secondly, whether, if so present, they can be photographed. In considering these points we can neglect hypnotism, mesmerism, and allied phenomena which are often associated with them, but which have no possible connection. The questions of thought-reading and thought-transference are closely allied with our sub-

ject. We know that, to a certain extent at any rate, some people can read the unspoken thoughts of others. Mr. Stuart Cumberland has, I think, sufficiently demonstrated this by submitting to all the conditions proposed by sceptics, and has proved that it can be done without trickery or fraud. This would undoubtedly be an example of thought-transference; but of the connecting links between the one mind and the other, of the means whereby one man's thoughts are transferred to another man's brain even when some part of their bodies is in contact, we are absolutely ignorant, and whether this gift or power of thought-reading can be exercised at a distance is not known. There are many instances which would lead us to believe that beings closely bound by ties of affection do have presentiments of what is happening to those dear to them, who are perhaps thousands of miles away. But these instances are neither so numerous nor so accurate as to entitle us to found a conclusion thereon.

The spiritualists allege that a spirit can collect together luminous atoms, and arrange them to form a mould, not necessarily in its own likeness, and that it is this mould which is visible to the initiated known as "mediums," it is this mould which they allege can be photographed. I have examined large numbers of photographs of so-called spirits, but I propose now only to discuss those published in the July and October numbers of "Borderland" (a spiritualistic journal) for last year.

Ten pages are devoted to a discussion, or rather wrangle, about the authenticity of a psychic photograph known as the Cyprian Priestess. This image seems to have appeared upon the plates of spiritualist photographers in various parts of the world, and at various times, but the medium who is most closely connected with it declines to offer any statement as to the manner in which it was obtained. The image is that of a beautiful, partly-draped female figure. Its

value to the spiritualists as evidence of the truth of their doctrines was undoubtedly great, because the only means of "dodging" to get the image on the plate would necessitate a drawing or picture having been previously made, and as it is drawn with remarkable artistic talent and skill, and the photographers on whose plates it has appeared were absolutely incapable of drawing it, they were able to put it forward as a piece of almost incontestable evidence; but the discovery in the house of an Edinburgh solicitor of a photograph identical in every detail of form and of light and shade with the alleged spirit, which was known to be a copy of a picture painted by a German artist (more probably, I should say, French artist, by the style of it), shattered this evidence, and I think there is little doubt that the spirit-photographs in question have been obtained by cleverly copying the picture or a reproduction of it. Turning now to the October number, a series of ten alleged

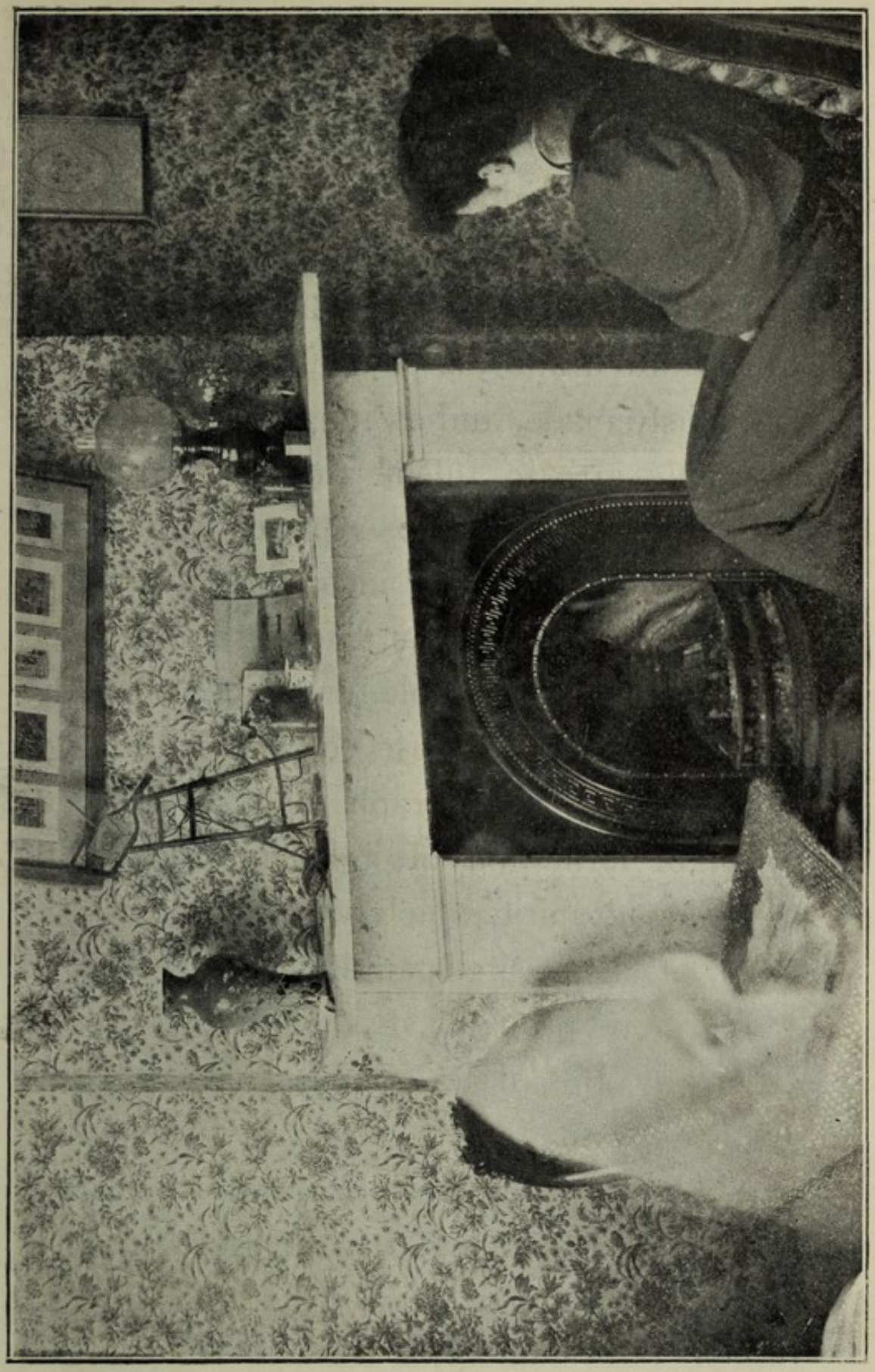


Fig. 14 FRAUDULENT SPIRIT PHOTOGRAPH. By THE AUTHOR.

spirit photographs are shown. In Nos. 1, 9, 10, and 11, the spirit ends abruptly at the bottom of the background, which I think sufficiently indicates that these have been produced by special arrangements in connection with the background. But before going further in the analysis of these photographs, let us consider the photographic side of the question, and the various ways in which spurious results may be obtained. Firstly, by painting the spirit form upon the background in such a way that it will photograph without being visible; this, for example, can be done by keeping the brush-strokes in the first instance all in one direction, and then crossing these strokes by strokes of a clean brush in just those parts where the spirit form was to appear. The second method would be by double exposure of a plate. Many of the photographs which we have seen of men playing chess with themselves, and sitting upon two opposite sides of a table at one and the same time, are produced

in this way. Thirdly, by painting the desired "spook" in luminous paint or some other phosphorescent medium upon the back of a plate, or upon a piece of cardboard which is then placed in the dark slide, or in the bottom of the developing dish. Fourthly, by cutting out the spectral form in metal, and applying it in a heated state to the back of the plate, or by pressure on the face of the plate; by taking an ordinary photographic negative of the sitter, and also a negative of the spook, and printing together on one piece of paper by what is known as combination printing. Or lastly, by painting the spook upon the negative after it is completed.

According to the spiritualist's own theory, that of self-luminous particles invisible to the ordinary eye and therefore absolutely transparent, the possibility of any portion of the spook being darker than the objects immediately behind that portion is precluded; yet in No. 2 of the photographs of the October number there is a patch of shadow upon the

hair of the ghost which is darker than any portion of the background; the same remark applies generally to No. 3 and No. 4, as well as to No. 7 and Nos. 9 and 10.

Of the remainder, No. 5 shows the portrait of the sitter and what is alleged to be the ghost of Amy Robsart. Amy Robsart happening to have died before the date of my birth, I am naturally not personally acquainted with her, but if this photograph is like her, I can only say that history has taken the trouble to flatter in the most barefaced way. Then, again, why should Amy Robsart's spirit visit this particular sitter in an obscure London studio? This is another example which could easily have been produced by double exposure, combination printing, or by the employment of luminous paint.

No. 6 shows a coloured boy, fantastically clothed, having a "confab" with the sitter. It is perhaps hardly fair to point out small details in the block, but I have not seen the

original photograph. I notice down the left arm of the sitter what would certainly be considered, in the case of a combination print, a bad join.

No. 11 is hardly worth criticism, since the evidence of the presence of spirit forms is extremely vague. There appears to be a curtain behind the sitter, on which there are confused light markings, which might, by a very lively stretch of imagination, be considered as a male, female, or animal figure.

No. 7, about which I have already remarked, appears to me to be by far the cleverest example, looking at it first without regard to No. 8, which is, by-the-bye, not a spirit photograph; I have already noticed the presence of shadows deeper than the background behind them. In this case, as in No. 6, I find traces of what might be bad joining. The photograph is that of a sitter almost in profile, with his left arm resting upon the head of a couch. At the head of the couch stands an ordinary round pedestal

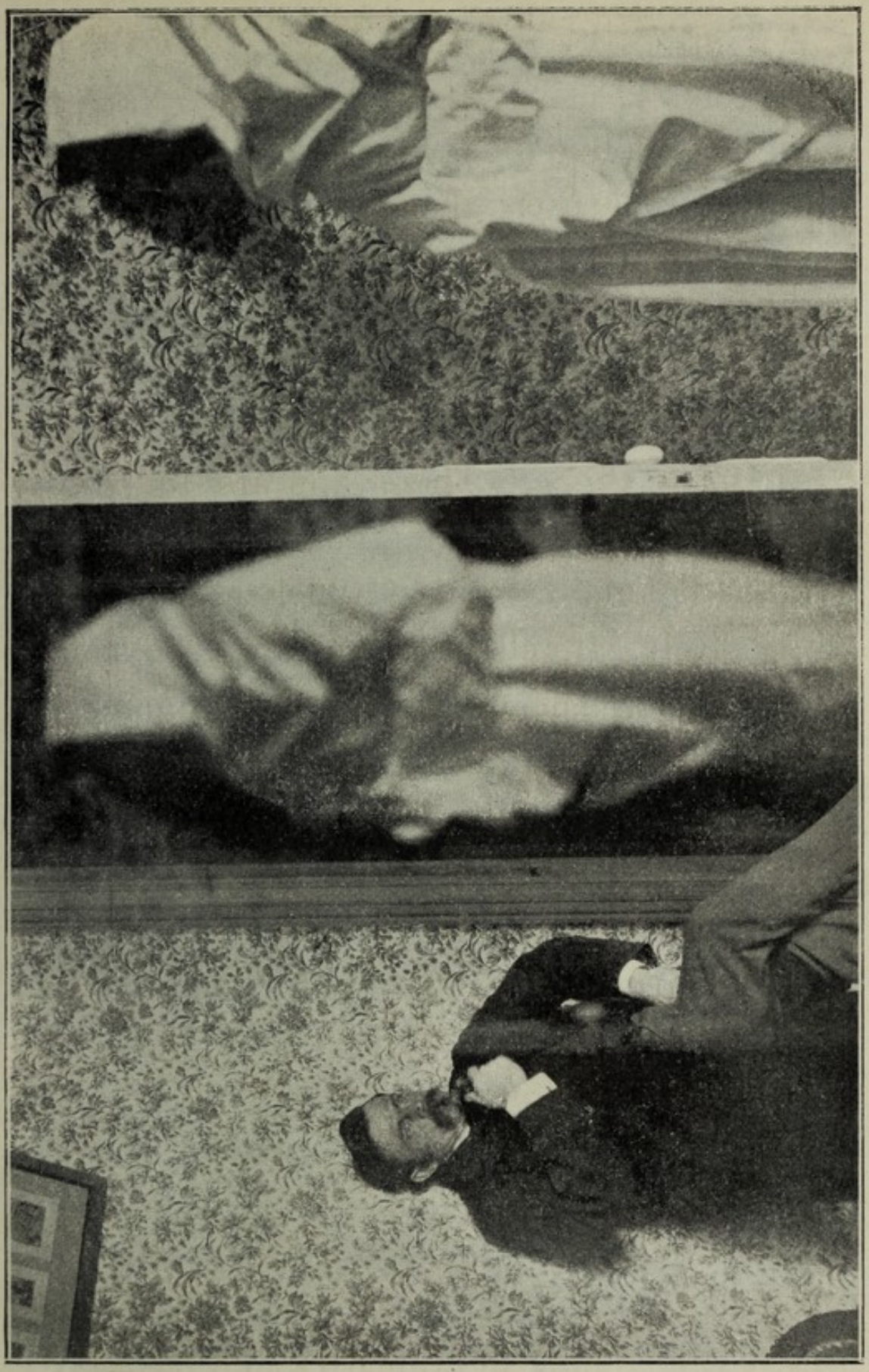
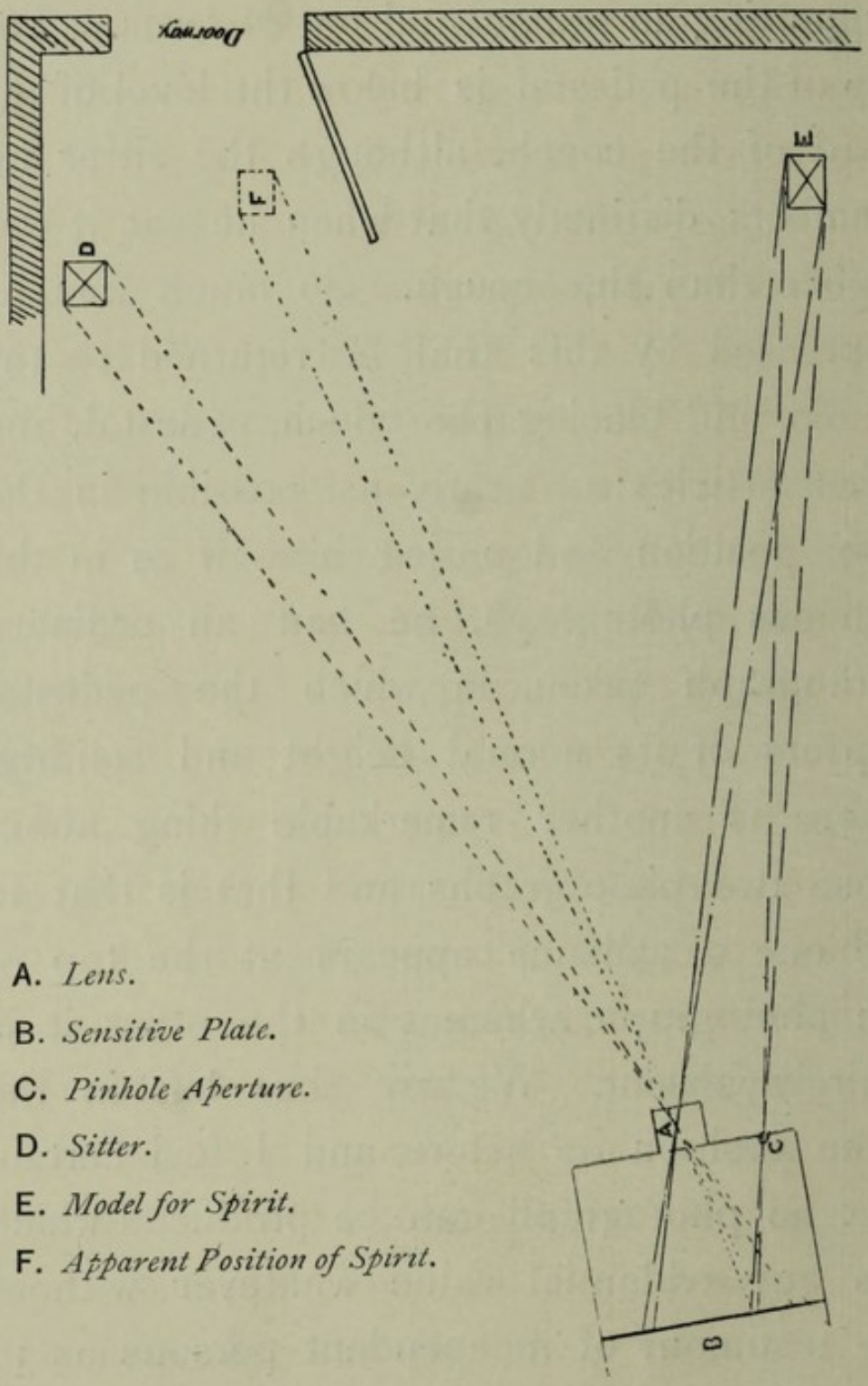


Fig. 15. Fraudulent Spirit Photograph, showing Method of Production. By The Author.

supporting an ornamental pot of ferns. The top of the pedestal is below the level of the head of the couch, although the sitter remembers distinctly that when he sat it was higher than the couch. So much was he impressed by this that he returned to the studio, and placing the couch, pedestal, and other articles as nearly as possible in the same position, and posing himself as in the previous photograph, he had an ordinary photograph taken, in which the pedestal appears of its normal height and solidity. There is another remarkable thing about these two photographs, and that is that in the one a vallance appears at the top of the photograph, whereas in the other it is entirely absent. We are thus left in the same position as before, and I feel certain that no photograph can be produced which has any evidential value whatever without the testimony of independent persons as to the circumstances under which it is taken. I have seen and examined a large number of




A. *Lens.*

B. *Sensitive Plate.*

C. *Pinhole Aperture.*

D. *Sitter.*

E. *Model for Spirit.*

F. *Apparent Position of Spirit.*

DIAGRAM SHOWING METHOD OF TAKING SECOND SPIRIT PHOTO.

alleged psychic photographs, and although I cannot go so far as to say that these photographs were all fraudulent, yet I do say that I have not seen one which could not with great facility be so produced.

The late Mr. J. Traill Taylor, Fellow of the Royal Photographic Society, and editor of the "British Journal of Photography," a man generally respected, and who would undoubtedly be acquainted with all possible methods of producing these photographs fraudulently, said, only as long ago as last May, "There are some rays which, when reflected on an object on which they fall, are visible, so called because they enable the normal eye to see such object, but there are other rays which, if thus employed, would fail to render an object visible, but would still cause photographic action. These are popularly termed invisible rays, because their effects are not perceived by ordinary vision. If anything or entity—call it a spirit, if you like—emitted rays of this nature only, most

assuredly it could be photographed by one possessing even rudimentary knowledge only of photography. Although such figure could not be seen, it would be amenable to the laws of optics by which the image will be projected by the lens on to the plate, and to those of chemistry by which that image will subsequently be developed." He also states: "After hearing the testimony of eminent experts in whose presence certain experiments have been conducted, men who I knew were at the head of professional and experimental photography in America, and the personal acquaintance of some of whom I subsequently made, I felt impelled to forego the rash judgment I had given as to fraud in the production of these abnormal figures which appeared on the plates. And since then I have been privileged to dictate the conditions under which a certain series of strictly test *séances* for psychic photographs were some time since held, and in which there was not left a single loophole

for fraud to enter, yet during which I myself, using my own camera and plates, beyond the control of not only the medium but of the other spectators, obtained numerous psychic figures so fraudulent-looking and so shockingly inartistic, as to induce the use of unparliamentary language. Here, however, is the point: these pictures were true and genuine throughout—so far, at any rate, as concerned any of those that were present; my tests were too good to admit a doubt of this."

One of the exponents, or rather the upholders, of spiritualistic photography, who was the sitter for some of the photographs referred to above, is candid enough to admit that he took a "Kodak" with him on some occasions, but with this camera both he and the medium himself failed to secure any abnormal result.

The editors of the "Photogram," in writing to the editor of "Light," say among other things, "For our own part we have always

been prepared to publish, as fully as possible, any evidence that seemed likely to be of use to photographers, but have carefully abstained from stating any opinion as to the genuineness or otherwise of alleged psychic photographs. The attitude of most photographers with regard to this subject we believe to be thoroughly irrational and unscientific, though we must admit that the way in which the evidence has generally been put before them is largely responsible for this attitude. We cannot conceive of any psychic photographs that could in themselves have any evidential value whatever, apart from the supplementary evidence as to the conditions under which they were taken. Therefore it is useless for believers to show results and expect by this means to convert sceptical photographers."

Dr. Hall Edwards, referring to the photographs which I have criticized above, says, "That no convincing proof is conveyed by the photographs published by Mr. ***** is

evident to every one who takes the trouble to examine them carefully. Any and all of them could be produced by a photographer who knows his work without any supernatural aid. For my part, I have no scruples in dubbing them frauds of the deepest dye, and am willing to challenge Mr. Z. (the photographer in this case) to produce anything like them under conditions which I am willing to place before him. I am patiently investigating the so-called Spiritualistic phenomena, and so far I have never known anything to happen which in the slightest degree has pointed to the existence of spirits."

There is only one way in which the question can be set at rest, and it is advisable that it should be set at rest as soon as possible, not only in the interests of the general public, but, in that of the spiritualists themselves, for if these photographs are fraudulent, and they are therefore making an absurd claim, they are at the same time prejudicing their claims—whatever value they

may have—in other branches of psychical science. I should propose that one or two gentlemen of sufficient social standing to guarantee their integrity should be present at a *séance*, that they should take the advice of a competent photographic expert as to the various ways in which fraud could be introduced, and that they should take any ordinarily professional photographer chosen by themselves with them without allowing him to know that he was connected with anything more abstruse than the taking of a few photographs for them, and that he should in their presence take photographs of sitters when psychic apparitions were supposed to be present, that in doing this he should arrange the accessories and the lighting as well as pose the sitter, and that he should photograph the backgrounds, accessories, &c., both immediately before and after making his exposure on the sitter. Or if the presence of these three persons should, as it is sometimes alleged that it would, interfere

with the psychic influence, I would suggest that some amateur photographer should go alone to take the photographs, that the plates to be used should be placed in the dark slides by independent persons—for example, Messrs. Snowden Ward, Walter Welford, Horsley Hinton, and Thomas Bedding; that one of these gentlemen should supply the camera to be used, that the dark slides should be so sealed by them that whilst the shutter could be drawn the plates could not be removed, and that their surfaces should be coated with some soft composition in order to prevent them being operated on by pressure, heat, or friction, and that after exposure the plates should be handed over to these gentlemen for development. In this way two possibilities of fraud only would remain, that of double exposure and manipulated accessories. It is probable, however, that out of a series of, say, a dozen photographs taken under these conditions, if psychic manifestations are genuine, there would be some which

would practically show evidence of the impossibility of fraud by this means. Fraudulent backgrounds could be guarded against by photographing them alone as above explained. But surely some amateur could be found of sufficient probity, ability, and independence to leave no loophole for any suspicion of fraud. It is high time, at any rate, that the question should be set at rest, and I think that if the advocates of spiritualism are not willing to allow decisive tests to take place, they have little right to feel aggrieved if they are classed as humbugs and cheats.

I have left for separate description another method of producing fraudulent spirit photographs, which I believe has never been published, and my knowledge of which is due entirely to accident. I was photographing my wife in the garden, and had arranged a slight screen for keeping off the direct rays of the sun ; I made two exposures with an ordinary landscape camera, and on developing the

plates found that my wife was most gracefully balancing a chair on her head. This apparition appeared on both plates, and it was only after a little ponderous thinking that the cause struck me. I examined the camera, and found, as I expected, that the little block glued inside the camera to prevent light entering through the screw hole belonging to the rising front had become detached. From this to the use of a pinhole for producing "spook" photographs was an easy step, and as the method would probably be the easiest to follow without detection, I have reproduced two photographs taken by it. The first is in the state in which I should exhibit them if I wished to pass them off as photographs of real live "spooks." The second I have taken specially to illustrate the method, and have placed the model for the spook in such a position, that besides acting through the pinhole to produce the spook, he has been photographed through the lens as well. I

have also given a diagram of the necessary arrangement, which I think sufficiently explains itself.

Photographs of this nature might also be taken by the use of a transparent mirror in front of the lens, but as this method would be difficult to carry out without detection, I have not described it.

# Part IV.

## ANAGLYPHS.

The principle of stereoscopic vision rests on the separation of the two eyes, so that the view seen by one eye differs slightly from that seen from the other eye and of the mind to amalgamate these two views.

The only means of applying the advantage of this principle to flat pictures until lately was by means of the stereoscope, and by the use of special photographs. It was impossible to produce stereoscopic effect except with very small pictures. This difficulty has lately been overcome by what is called the anaglyphic method.

It is well known that a piece of red glass, for example, transmits red light because it absorbs all the other components of white

light. Therefore, if we have a picture printed in red, and we look at it through a red glass, we shall be able to see it, but if we look at it through a blue glass which will not transmit red light it will be absorbed by the glass, and fail to reach the eye. If a photograph be printed in red, and a *fac-simile* be printed in blue side by side, we shall by using a pair of glasses with one red eye and one blue eye be able to see them both, but one only with each eye. If these photographs are taken stereoscopically—that is to say, from points of view two or three inches apart—and be printed almost in superposition, they will to the unaided vision present nothing but a jumble, but if the red and blue spectacles are applied to the eyes, each eye will see only one photograph, and if they are sufficiently nearly superposed, the eyes or the mind, whichever it may be, will combine them to produce one picture which will appear in relief, and be much more realistic than the ordinary flat photo.

It might probably be said that it is as little trouble to carry about a stereoscope as a pair of red and blue glasses, and this is probably true, so that for small photographs the anaglyph method has no advantage over that in use for so many years—in fact, it has the disadvantage of requiring the two prints to be printed in different colours; but large photographs may be viewed stereoscopically by this method, or by putting each half of the stereoscopic photograph in one of a pair of magic-lanterns, and projecting them upon the screen together, each with its proper coloured glass behind it. A stereoscopic picture thirty feet in diameter can be shown, provided it is looked at with the special spectacles. The process can also be adapted for projection on the screen with a single lantern by printing the two halves of the photograph, one in red, and the other in blue carbon tissue, and placing them together to form one slide.

It will of course be obvious that if the

spectacles are made with red left eyes and blue right eyes, the photograph which would form the left-hand one of a stereoscopic pair must be printed in red to be seen by the left eye, and not *vice versâ*.



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