In reply to your worthy letter from 2 of this month. I am sorry ~~to say~~ not being able to give you the composition of the various luminous subst. as I do not know it myself. Such illuminating powders cannot be prepared following a well defined scheme; if such would be the case I myself would be ready to prepare them even today. For to obtain such products it is necessary to ~~use~~ employ sulfodes (Sulfiden) ~~with~~ glowed with a sligh admixture of neutral substances and the product so obtained ~~[illegible]~~ according to its illuminating capacity, demands sometime a new admixture; it has then to be glowed again (geglüht) and so forth until the intensity of light and the required color to be attained.

In general this powder are compounds of Barynm, Calcium, Strontiumsulfide, with small quantities of Alluminium, Bismuth, Chrom, Uran, Mangan, Oxydes etc.--

As you did not obtain from me the powder you have had formerly so you can be sure they are not identical with these about which we are speaking at present. (I do not quite understand that phrase.) CDK.-

I have to communicate you that besides the blue violet I have recently obtained another of green light which I can send if required., although as yet only in small quantities at the price of MK 5 pro 10 gr. or MK 35 pro 100 gr.

The Lenard tube for the production of Cathode rays with all the accessories I could offerd you at the cost of MK 45. —

The Press Club, Salisbury Court, E.C.
London, England.

Dear Mr Hammer,

Among the many things I have always keep on my work desk all these years is your letter of September 15, 1911, and from time to time I have saved one or two things that might interest you. They are now enclosed. Sometwo years ago I posted you a book called "Phosphorescence, or the Emission of Light by Minerals, Plants, and Animals," by T.L. Phipson, Ph.D., F.C.S., London, 1862, but somehow I must had addresssed it wrongly as it came back after many months, , having been advertised, and marked "Not in Directory." However, the book is yours if you wld like it now.

Besides the clippings the following notes may interest you:

On the Light from Certain Fishes. Paper by N. Hulme, in the Phil. Trans, 1800, Vol 90, page 161 and continued in Vol 91, page 403. This shd be in the N.Y Library.

References to phosphorescence in Trans. Jenner Institute, Second Series, 1899, p. 98 et seq.

A Zirconium lamp mentioned in the London Electrical Review, August 31, 1906.

A new Austrian lamp, 30 c.p. for one tenth of a cent per hour. L'Electricien, August 25, 1906.

The selective radiation of rare earths. Rep of Brit Assoc. August 1906. By J.Swinburne.

There is a book by Dolbears with an Appendix entirely devoted to phosphorescence.

The story of the alleged first carbon lamp is told in The Mechanical World, Oct 2nd, 1891, p. 141 Filament from a spool of cotton.

Amongs some phosphorescent substances are pale green fluorite, ozocentite, and some petroleums.

An account of the phosphorescent organs of the Pyro. Noct. is in the Comptes Rendus, Vol 77, 1873, p. 511.

I lost my job as editor of "Advertising" last March and since then have been grubbing along without getting into debt, but with no perman ent work. The war made things look serious, but the London office office of Chicago "System" took me on for some temporary work, and I am this week fixing up with a Scottish author for work at the British Museum, and am to spend a few days every month in Scotland with him. He has a "System of Energy" which is very interesting. His chief point is that there is no ether, and that no energy comes from the sun. He is a thoroughly practical engineer and is in such a big way that five hundred of his men have listed for the front! My problem is to present his system in a scientific and acceptable way to the world. So we are getting out a book about the light and heat of the sun. If you happen to have anything about ether (anti) in your notes and clippings I would be ever so interestd to have enough references to look them up in our Libraries. We have got ready a typewritten précis of the "System" which I am getting people like yourself to be good enough to run through and criticise: may I send it along. There has been a vaudeville show over here with phosphorescent effects on a darkened stage. Was it yours?

Yours faithfully,

Dudley W. Walton.

I see Mr Mottelay frequently. I'm sorry to say that none of his ideas seem to get taken up by publishers, though they are all of wonderfully good <u>quality</u>. I suppose they are thought too expensive to get out. He keeps well to all appearances. D.W.W.

by William J. Hammer.

I have been much interested in Dr. Baskerville's lecture and wish to take the liberty of calling attention to several matters which occur to me. Referring to the Willemite screens which Dr. Baskerville has shown I wish to state that my friend Mr. W. S. Andrews made such screens, employing both natural and artificial Willemite, a long time ago, and I have in my possession several such screens which he gave me several years ago. I wish to take exception to Dr. Baskerville's statement regarding the specimen of Willemite which he has shown as having been the first specimen stimulated by the rays of radium. I believe I was the first person to take up actively in this country the work with radium and I had the honor of delivering a lecture upon radium and other radio-active substances ultra-violet light etc. at the first joint meeting of the American Electric Chemical Socy and the American Institute of Electrical Engineers, as far back as Apr. 17th, 1903, and about this time I had made up various mixtures of radium with phosphorescent and fluorescent substances, using willemite, sulphides of zinc, calcium and many other substances. I had the pleasure of showing certain of these mixtures to Dr. Baskerville at my laboratory before he and Mr. Kunz took up this work, and I have therefore been interested to note that Mr. Kunz has recently taken out a couple of patents on mixtures of radium with phosphorescent and fluorescent substances. A combination of radium and sulphide of zinc which I secured at the Curie Laboratory was shown at my lecture before this society as well as many phosphorescent and fluorescent substances which I stimulated with both the mercury arc lamp and the ultra-violet light produced by Dr. Piffards form of lamp which is anmodification of the gorl, Bang, Finsen, and other lamps made abroad. Dr. Piffard's lamp is a very useful device, but it might be stated that the study of minerals with the spark gap is some forty years old and anyone desiring to study Willemite and other substances with ultra-violet light can do so most successfully by using iron wire as the electrodes of the secondary of an induction coil shunting or bridging the spark gap with a Leyden jar or condenser. The mercury arc is a wonderfully convenient stimulant for phosphorescent substances, but a note of warning should be given to those utilizing lamps of quartz such as the Haereas lamp as the ultra-violet light which penetrated glass very slightly passes readily through the quartz tube, and I know of two persons who have been incapacitated for months after examining the quartz tubes for only a very short space of time. I am interested in what Dr. Baskerville says about the importance attached to the examination of the minerals produced by the New Jersey Zinc Co. as I offered, nearly three years ago, to take my ultra-violet outfit into their mines at Franklin and make a study of the Willemite and other deposits in the mine but at that time the matter seemed to be of little interest to them, although I was given permission to visit the mine with a view of procuring ppecimens of Willemite of which I have a large collectian.

Wm. J. Hammer

William J. Hammer

PHOSPHERESCENT MIXTURES. The following are approved formulae for phospherescent mixtures which will produce light of various colors, so that after exposure to bright light all the colors of the rainbow may be shown in the dark. The mixtures must be sealed up in glass tubes and kept in the dark. If exposed for a few seconds to direct sunshine or to the light of burning magnesium and then taken into the dark they will be luminousfor a considerable time, sometimes for half an hour.

No. 1. Pulverized oyster-shells, 12 parts, flowers of sulphur 4 parts, oxide of zinc, 0.5 part.

No. 2. Pure calcium carbonate 12 parts, flowers of sulphur 4 parts, realgar 0.5 part.

No. 3. Strontium nitrate 12 parts, flowers of sulphur 4 parts, sulphide of antimony 0.5 part.

No. 4. Barium sulphate stirred into a paste with white of an egg and ignited in an open coal fire for 1 hour.

No. 5. Strontium carbonate 12 parts, sulphur 4 parts, oxide of zinc 1 part.

No. 6. Strontium carbonate 12 parts, sulphur 4 parts, sulphide of antimony 0.5 part.

No. 7. Strontium carbonate 12 parts, sulphur 4 parts, sulphide of barium 2.2 parts.

No. 8. Pure calcium carbonate 12 parts, sulphur 12 parts.

All these mixtures with the exception of No. 4, require to be ignited or exposed to a red heat for 1/2 hour. A little practice will show the temperature and time best adapted for their preparation.

6 2 1/4

PHOSPHERESCENT (ILLUMINATING) POWDER. Mix 100 parts each of calcium carbonate and phosphate (obtained by burning shells, especially those of tridama and sepia), add unslaked lime 100 parts, calcined salt 25 parts, and 25 to 50 per cent. of the entire mass of sulphur. This powder illuminates barometers, compasses, etc., and becomes especially phospherescent when acted upon by an electric current. (The well-known "luminous paint" is composed substantially of the same materials. It remains faintly luminous for a some time after being exposed to the light, and is used for match-safes, etc. (W.))

PHOSPHERESCENT ENAMEL. Commercial phospherescent paint in powder is intimately mixed with 2/3 of its weight of very finely-pulverized fluorspar or cryolite, and 1/5 of calcium borate. The mixture is made into a paste with water, and applied in a uniform layer to the articles to be enamelled by means of a brush. They are then burnt in the usual manner.

Substances Radio-Actives.

		le gr.
Carbonate de Baryum, Activite' initiale.	40	3
(Lumineux) Chlorure de Baryum et de Radium,	100	6
(Lumineux) Chlorure de Baryum et de Radium,	240	12
(Lumineux) Chlorure de Baryum et de Radium,	1000	100
(Lumineux) Chlorure de Baryum et de Radium, les 2 decigr.		25
		le gr.
(non lumineux) Chlorure de Radium, activite' initiale:	3000	300
(non lumineux) Chlorure de Baryum et de Radium,	7000	500
Sous-nitrate de Bismuth et de Polonium, activite' initiale,	300	30
Bismuth Polonium metal,	300	35

Societe' Centrale de Produits Chimiques,
44 & 42 rue des Ecoles,
Paris, France.

Wm J Hammer

FLUORESCENCE and PHOSPHORESCENCE.

Sir George Stokes has given the name of "Fluorescence" to the phenomann which certain substances have of absorbing the very short waves of ultra-violet light, which are invisible, and transforming them into waves of longer length so that they become visible to our eyes.

In electrical parlance a fluorescent substance might be termed a step down transformer for light waves. Stokes as a result of his investigations framed this law,"When the refrangibility of light is changed by fluorescence it is always lowered and never raised",- in other words the waves emitted during fluorescence are always longer than those which are absorbed thus causing fluorescence. There are in fact cases where the frequency of the radiations is increased; but where there is such an exception to Stokes' law some sort of chemical reaction occurs.

The lowering of the frequency of certain ultra-violet radiations so as to render them visible was known to Brewster and Herschel in 1848, the former terming it internal and the latter surface dispersion; but it was first explained and the name given to it by Stokes in 1852 after a form of fluorspar.

In the case of fluorescence the emission of the light lasts only so long as the substance is stimulated by the incident beam; but in the case of the phosphorescence the emission of light continues or persists after the stimulation has ceased, or the original source has been removed. The word Phosphorescence is from the Greek "Phosphorus"meaning light bearer.

Professor E. Wiedemann has suggested the name "luminescence" to cover fluorescence, phosphorescence and phenomena of that character possessed by many substances whose light emissions are unaccompanied by flame or by the temperature of ordinary light waves; but this term can hardly be made to cover the Becquerel rays emitting from radio-active substances.

I have here to-night a collection of tubes containing fluorescent liquids, such as petroleum, quinine, Magdala red, eosine, uranine, saffronine, paviine, aesculine, amidophthalis acid, fluorescine, rhodamin, etc. . . . all of which show most beautiful changes in color when viewed by direct and transmitted light.

I also have some of the fluorescent hydro-carbon "thalleen", prepared by the late Professor Henry Morton, and some of those most beautiful fluorescent substances resorcorufin and resorcin blue, for which I am indebted to Dr. Geyer of Steven's Institute. Fluorescent substances are particularly beautiful in the ultra-violet light,- for instance, the yellow fluorescine becomes a most beautiful green; the orange colored eosine becomes gamboge; the crimson color of Magdala red a bright scarlet; the straw colored aesculine becomes a pale blue; the transparent and colorless quinine gives its characteristic blue surface tint; the parrafine oil a beautiful blue; and the various other substances giving a beautiful surface color quite different from that of the interior of the solution.

Small pieces of horse-chestnut bark or bark of the ash tree placed in a dilute ammoniacal solution produce a most beautiful fluorescent effect, as the dyeing material descends slowly through the liquid.

Flowers painted with these fluorescent substances on cardboard produce a most beautiful effect when light screened by dark blue or violet glass is thrown upon them.

Sodium vapor fluoresces brilliantly in sunlight.

I also have here samples of tung-state of calcium, platino-barium cyanide, sulphide of zinc, and similar preparations which have been extensively used in the fluorescent screens for X-ray work.

Here is a specimen of Willemite which when exposed to the ultra-violet light produced by the bright snappy condenser spark between these iron electrodes shows a magnificent fluorescence.

Here is a card with words written with a solution of platino-barium cyanide which fluoresces magnificently when exposed to the ultra-violet light of the iron arc, especially when shielded by the accompanying colored glass plates.

I have also one of Professor R. W. Wood's interesting ultra-violet screens, consisting of four plates of cobalt glass between which are gelatine films containing nitroso-dimethyl-analine with copper oxide, which screen when employed in front of the arc lamp renders beautifully fluorescent a lump of uranium nitrate held in the focus of the invisible rays.

Through the courtesy of Dr. Von Recklinghausen I am enabled to show you a Cooper-Hewitt tube which is enclosed in a screen soaked in rhodamin, the only substance which thus far has been found fluorescent in the light of the mercury arc.

It is well known that many bodies become red hot at a temperature of between four and five hundred degrees Centigrade, and to make them white hot a temperature of between eight hundred and a thousand degrees is necessary; but there are many substances which are phosphorescent and which possess the property of giving off considerable light without sensible heat.

I have here some samples of two phosphorescent substances which have been known for many years,- one of them a sulphide of barium or Bolonese phosphorous, and the other a sulphide of calcium or Canton's phosphorous. The former was discovered in 1602 by Casciarlo a shoe-maker in the city of Bologna, who prepared it by the partial calcination of a certain powdered heavy spar mixed with a little flour meal, which he roasted in the furnace; and found afterwards that when exposed to sunlight it would shine in the dark. This preparation was succeeded by the discovery of John Canton, who calcined oyster shells with charcoal and meal in a closed crucible, thus producing a brilliant phosphorescent substance called after his name.

Phosphorescence by insolation or exposure to sunlight has been extensively investigated by Professor A. E. Becquerel.

Practically all substances in nature are phosphorescent, and although some of them remain phosphorescent for only one ten-thousandth of a second, others retain their phosphorescence for hours.

One may expose sulphide of calcium to sunlight, and after placing it in a dark room for six weeks it will still affect a photograph plate.

Phosphorescence may be stimulated in many ways,- by combustion, pounding, rending, friction, by the vibrations from sources of heat, light or electricity; and these various phosphorescent substances are very susceptible to temperature changes.

Various substances also phosphoresce while undergoing crystallization.

I have here a large sheet of cardboard which has been prepared for me by Messrs. DeVoe & Company, which is covered with seven coats of Balmain's Luminous Paint or poly-sulphide of calcium, with perhaps a trace of bismuth; and it has been put through hot calender rollers. You will note that this phosphoresces most beautifully when excited by burning this piece of magnesium wire before it, or by focusing the arc light upon it. This phosphorescence soon dies out, however; but upon placing my hand against the sheet the heat of my hand has caused the card to brilliantly phosphoresce. A cold object placed against the cardboard will very much lessen the phosphorescence at that point.

Professor Dewar has shown that egg shells, feathers, ivory and paper become brilliantly phosphorescent if they are cooled to about 200 degrees below zero by use of liquid air, and then exposed to light. Many bodies seem to possess this power of absorbing energy at low temperatures and giving off light at higher temperatures.

in fact Dewar has ~~also~~ observed that at a temperature approximately that of the boiling point of oxygen (184 degrees C) all bodies, even living tissues, become phosphorescent.

I have here a collection of forty or more glass tubes containing various phosphorescent substances which, when I burn this magnesium before them, you will note they become brilliantly phosphorescent, and showing red, yellow, green, blue, and in fact all the colors of the spectrum. The sulphides of calcium, barium, strontium, zinc, etc. largely enter into their composition. I also have here some fine particles of fluorspar, which, when scattered on this hot plate, glisten like fire flies.

A similar effect may be produced by quinia or its sulphate which when spread on a sheet of paper and laid on a hot metal plate in a dark room shows a remarkable phosphorescence which develops at the edges and spreads to the centre.

I have prepared for your consideration a number of objects coated with phosphorescent substances. When I burn this piece of magnesium wire in front of this card, or hold it before the arc light, you will note the initials of the A. I. E. E. and the A. E. S. the two societies before which I have the honor of appearing tonight shine out most beautifully. I also have a number of incandescent lamp bulbs, coated internally and externally with phosphorescent substances, which you will note give a most beautiful light when stimulated by the burning magnesium; or by turning on the electricity supplying certain of the lamps.

Boracic acid fused and allowed to cool breaks into small pieces, and along the cracks phosphorescent light appears. Potassium sulphide fused with cream of tartar shows the same phenomenon.

Phosphorescent ether may be prepared by digesting phosphorous in ether for some days in a tightly corked bottle, and when a lump of sugar is dipped into this and dropped into a glass of water the surface appears quite luminous.

Here are a couple of postal cards which I secured in Europe showing the Blue Grotto at Capri. They are printed with phosphorescent paints; and on exposing them to the light you will see they are exceedingly pretty.

I remember nearly twenty years ago having cut out tiny stars from cardboard and painted them with luminous paint, and arranged them on the ceiling of my bed room to represent certain of the principal constellations in the heavens. These stars would absorb the light during the day time, and at night would represent an appearance as though the roof had been removed and one was looking at the stars in the sky.

I have here a phylosophical toy which I made years ago with which I can show the varying phases of the moon. I have taken a 25¢ globe, and painted half of it with black Japan, as representing the dark side of the moon which is never seen; the other half I have painted with a number of coats of luminous paint; and by exciting the phosphorescence of this half by the burning magnesium you will see that by slowly turning the globe around a perfect representation of the varying phases of the moon occurs.

I hold in my hand here a long tube coated inside with sulphide of calcium, which makes a beautiful wand, which an orchestra leader might use in a dark scene. I remember years ago fixing up a vacuum tube and coil for use as a baton in the dark scene in Gilbert + Sullivan's Opera of Ruddegore, and trembling lest the complaisant leader be some day knocked off his stool by the 8 inch coil.

The stream of particles, so thoroughly investigated by Professor Crookes, was given the name of "Cathode rays" by the Germans, as a protest against Crookes' theory of molecular streams propounded by him at the British Association meeting of 1879; Lord Kelvin has told us that the smallest particle which can be observed by the most powerful microscope contains 18 to 20 million atoms, and although until recently the smallest particle we could conceive of was the atom of hydrogen, this being the lightest of gases, Prof. J. J. Thomson has now shown us that these atoms may constitute a thousand fragments, or, as he calls them "corpuscles", and Villard of Paris has recently demonstrated that the Cathode rays consist of a stream of these corpuscles negatively charged and moving at a speed approximating 70,000 miles per second; and as illustrating the complexity of an atom I, am reminded that the late Prof. Henry Rowland once said that a Steinway grand piano was a comparatively simple piece of mechanism compared with an iron atom.

Professor Crookes has shown many beautiful experiments in which substances have been caused to phosphoresce inside of the Crookes' tube by the molecular bombardment of "Cathode rays"; and I have here some fine Crookes' tubes containing red and white coral, rubies, calcite, lava, etc., which you will note phosphoresce finely.

Professor Crookes has made a diamond so phosphorescent inside of a Crookes' tube, as to give a full candle power of light. Rubies, emeralds, corals, fluorspar, lime, and many other substances phosphoresce beautifully in the Crookes' tube.

I have here a Crookes' tube containing calcined sea shells, which, ~~you will note~~, on connecting ~~the tube~~ to the induction coil, is caused to give off a most brilliant light, and the globe and contents to phosphoresce long after the current is shut off.

Here again I have a tube containing four separately exhausted sections, which are filled with phosphorescent substances, and a tiny tube passing through all of the partitions of the tubes, and being connected with the electrodes at the end. On connecting this to the induction coil a luminous gaseous stream is seen in the tiny tube, and the discharge accompanying it affects powerfully the phosphorescent substances which, you will note, are beautifully colored green, yellow, and blue, after the current is shut off. Here also we have Crookes' tubes containing white and red coral, rubies, etc.

I have here also a Crookes' "radiometer", the vanes of which are painted with phosphorescent substances, and on connecting the radiometer to the coil the electricity rotates the vanes and causes them to become beautifully phosphorescent.

At a meeting of the Institute on January 3rd, 1902, I had the pleasure of presenting some of Mr. Edison's tung-state of calcium lamps which had been called Edison X-ray lamps. These lamps were Crookes' tubes, the interior walls of which were coated with fused crystals of tung-state of calcium, which were caused to phosphoresce most beautifully when they were connected to the coil. Through an accident to my large coil I was unable to show these tubes working as perfectly as I should have liked; and to-night I will show you as an evidence of good faith some of them operating as they should operate, and giving a most powerful light. Incidentally I am going to show you that this cannot properly be called an X-ray lamp; as it is the ~~Crookes' rays~~ or cathode rays inside of the tube which produce the phosphorescence. This tube which I have here and which I have coated with tung-state of calcium and platino-barium-cyanide on the outside I will now place underneath an ordinary Crookes' tube that it may be exposed to the X or Roentgen rays; and you will see that while the coated surface fluoresces, as any fluorescent screen will when exposed to Roentgen rays, the moment these rays cease there is absolutely no phosphorescent effect, there being no persistence of the luminescence.

Now, another thing which I think I can show you is that, while ~~[illegible]~~ cathode rays produce by their action on the interior wall of the glass tube a secondary effect of ether pulsations on the exterior which are Roentgen or X-rays, I can now produce the converse of this by bombarding the outside of the Edison tube by the Roentgen rays from the Crookes' tube, as you will see then that I have caused cathode rays to be stimulated in the interior of the tube, causing the tung-state of calcium to become brightly phosphorescent; and you will note that I can deflect them with a magnet. I believe this is ~~perhaps~~ the first time this conversion of Roentgen rays into Cathode has been accomplished, and is rendered possible by this form of tube. ~~It is impossible here to go more fully then~~ There are many commercial applications which may be made of this curious property. Life buoys have been painted that they may be seen when thrown overboard; sheets of cardboard, such as I have shown you, have been used to give light in powder magazines; phosphorescent clock and watch dials have been made in large numbers, and it has been suggested to make house numbers, door knobs, and escutcheons for key holes of such materials, and even paint the houses with luminous paint.

The taps or keys of incandescent lamp sockets and switches might be made of glass containing phosphorescent material, or the cases painted as I have here done, so that they could be readily seen in the dark; and doubtless certain phosphorescent substances might be used to considerable advantage in connection with various types of vacuum tube lighting and for wireless telegraph tubes.

I hold in my hand a tiny tube which I secured in Paris which contains probably one of the most brilliant phosphorescent substances that has yet been discovered. It is a special preparation of sulphide of zinc. Here is a second tube containing some of the sulphide of zinc, which also has mixed with it some radium.

A tube of this mixture may be put away in the dark for years and the radium will act on the zinc, causing it to phosphoresce brilliantly.

Here I have a tube which I have made on the suggestion of Professor Curie, consisting of two bulbs with a stop cock between, in one of which may be placed sulphide of zinc, or similar substances, and in the other radium; and in this manner the radioactivity of various substances may thus be investigated.

Who will say that we shall not some day find a substance which will be so powerfully acted upon by the emanations from radium that it may be used as a source of light.

A tube containing chloride or bromide of silicon and exhausted to 12 or 15 m m, and sealed, will when rubbed briskly with silk glow in one case a rose color and in the latter a greenish yellow.

I hold in my hand here two Geisler tubes, each containing an inner tube with beaded surfaces. In each of the outer tubes is a small amount of quicksilver; and in one tube nitrogen gas, and in the other carbonic acid gas. By shaking these tubes rapidly the friction of the quicksilver against the glass produces electricity, which causes the gas to become beautifully luminescent. Various other gases may be thus employed, producing different color effects.

It has been suggested that life buoys could be equipped with number of mercury tubes, circular or otherwise, and set in different positions so that the rolling of the buoy in the sea would constantly agitate the mercury and render the tubes luminous.

Here is a tube containing mercurial salts, which changes greatly the color of its phosphorescence by heating the tube in alcohol flame.

I have here a bottle containing phosphorous and olive oil, which you will see becomes most brilliantly phosphorescent when I withdraw the stopper, and allow the air to enter the bottle. The phosphorescence in this case is due to combustion, or to the oxidation of the liquid. I can also write phosphorescent characters on this ground glass plate wet in hot water with this stick of phosphorous. Other forms of phosphorescence are caused by chemical changes or the slow combustion of decaying vegetable matter or decaying fish.

Occasionally clouds show a phosphorescent light ... snow is phosphorescent after exposure ... substances retain during ... by the ...

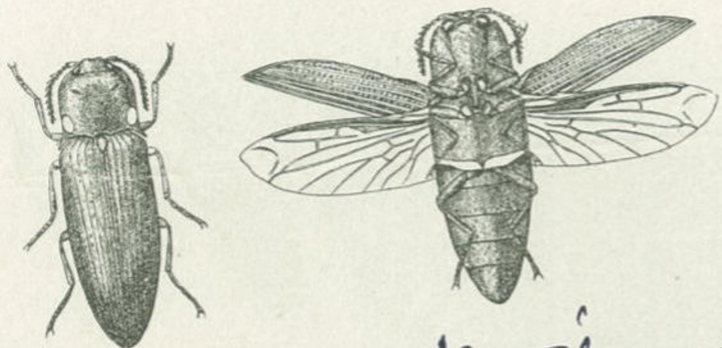

Fig. 1 — "Pyrophorus Noctilucus" (life size) the producer of the cheapest form of light known

... panded ... the secret of the fire fly was known ... crank could furnish sufficient energy to light an ...re electric circuit.

And Professor Langley says "There seems to be no reason why we are forbidden to hope that we may yet discover a method (since such a one certainly exists and is in use on the small scale) of obtaining an enormously greater result than we now do from our present means of producing light".

Langley believes the light of these insects is due to chemical action as it is decreased by nitrogen which checks combustion, and is increased by oxygen which increases combustion, and furthermore the product is apparently carbon dioxide.

We also may produce phosphorescence by rubbing crystals together, or by friction of other bodies, or by cleavage, such as fracture of lump sugar in the dark.

Among plants phosphorescence was first recorded by A. Linnaeus, whose daughter discovered it in the nasturtium. Phosphorescence or flashes of light are often observed in the common red and yellow marigold, the tuberose, sunflower, pock weed, martagon-lilly, the poppy, the root stock of khus-khus grass, and the sap of certain tropical vines and subterranean plants, in some liverworts, ferns, mosses, fungi and algae, and the mycelium of fungi in decaying wood. This phosphorescence is said to be due to slow decay and oxidation, either in the mycelia or fructifications of the fungi. Heat and dryness soon dissipate it.

Having now considered certain of the phenomena of Phosphorescence and Fluorescence I wish now to call your attention to those remarkable substances, which have recently been discovered, which give off light the moment they are created, without having to be stimulated by any form of heat, light, electrical or other vibrations, so far as we are at present cognizant of, and these substances are attracting a great deal of attention, and are likely to teach us more about the constitution of matter, and the co-relation of the vital and physical forces, than any substances which have been created since the world began. I refer to "Radium, Polonium and Actinium".

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Occasionally clouds show a phosphorescent light at night; snow is phosphorescent after exposure to sunlight, and no doubt many substances retain during the night the phosphorescent light imparted by the sun's rays during the day.

There are also many insects, such as fire flies and glow worms, and many deep sea fishes which have the properties of producing phosphorescence. Phosphorescence is exhibited among animals by the infusorian noctiluca, marine radiates, polyps, etc., which are the principal causes of phosphorescence of the sea.

In Figure 1. is shown an illustration of the "Pyrophorous Noctilucus". This tropical beetle has been most carefully studied by Professor S. P. Langley and F. W. Very, and the efficiency of the light given off tested by the Langley bolometer; and they have demonstrated that practically all the energy which its phosphorescence represents appears as light; and the light given off by this insect is the most efficient light known, it being produced at about one four hundredth part of the cost of the energy which is expended in the candle flame.

Sir Oliver Lodge says if the secret of the fire fly was known a boy turning a crank could furnish sufficient energy to light an entire electric circuit.

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We also may produce phosphorescence by rubbing crystals together, or by friction of other bodies, or by cleavage, such as fracture of lump sugar in the dark.

Among plants phosphorescence was first recorded by A. Linnaeus, whose daughter discovered it in the nasturtium. Phosphorescence or flashes of light are often observed in the common red and yellow marigold, the tuberose, sunflower, pock weed, martagon-lilly, the poppy, the root stock of khus-khus grass, and the sap of certain tropical vines and subterranean plants, in some liverworts, ferns, mosses, fungi and algae, and the mycellum of fungi in decaying wood. This phosphorescence is said to be due to slow decay and oxidation, either in the mycelia or fructifications of the fungi. Heat and dryness soon dissipate it.

Having now considered certain of the phenomena of Phosphorescence and Fluorescence I wish now to call your attention to those remarkable substances, which have recently been discovered, which give off light the moment they are created, without having to be stimulated by any form of heat, light, electrical or other vibrations, so far as we are at present cognizant of, and these substances are attracting a great deal of attention, and are likely to teach us more about the constitution of matter, and the co-relation of the vital and physical forces, than any substances which have been created since the world began. I refer to "Radium, Polonium and Actinium".

FLUORESCENCE AND PHOSPHORESCENCE:

Sir George Stokes; fluorescence, step down transformer; chemical reaction where exception occurs;
Brewster and Herschel; internal and surface dispersion;
Emission of light lasts only when stimulated by incident beam;
With phosphorescence emission continues or persists after source is removed;
Phosphoros (light bearer);
E. Wiedemann (Luminescence);
Tubes of petroleum, quinine, eosine, suffranine, uranine, pavine, aesculine, rhodamine, thalleen, etc.; resorcorufin, resorcin blue;
Dr. Geyer, Prf. Morton;
Horse-chestnut bark,
Flowers painted;
Tung-state of calcium;
Platino barium cyanide;
Sulphide of zinc;
Willemite;
Show experiment; show card with writing;
Show Wood's screen; lamp of uranium nitrate, etc.;
Cooper-Hewitt tube;
Temperature of bodies 400 to 500°, and 800 to 1000° Centigrade
Bolonese phosphorus, 1602 (sulphide of barium);
Canton's phosphorus (sulphide of calcium);
Everything in nature phosphorescent;
Dewar 200 degrees below zero;
Egg shells, feathers, etc;
184 degrees C. boiling point of oxygen leaving tissues, etc.
Balmain's luminous paint; DeVoe & Co. ;
Bottle sulphide of calcium;
Bust of Franklin;
Sign. A. I. E. E.;
Star constellation;
Phosphorescent globe; hand, baton, postal cards, show 40 glass tubes;
Geyer's sulphuric anhydride tube;
Crookes' radiometer;
Incandescent lamps;
Tiny tube sulphide of zinc and radium;
Tubes suggested by Curie;
Geisler tubes with quick silver;
Life buoys; house numbers, wall paper, paint, key holes, switches, socket taps, etc.
Crookes and Germans, cathode rays;
Lord Kelvin, microscope and atom;
Halleck and Rowland, Steinway piano;
Crookes tubes, Queen & Co.;
Edison's tungstate of calcium;
Show cathode rays stream;
Langley pyrophorous noctiluca; Lodge and Langley;
Decaying wood;
Fish;
Show phosphorus and olive oil;
Phosphorescent fishes; flowers; (marigold, nasturtium, sunflower, tuberose, tropical vines, etc).

RADIUM, ETC.

Work of Varley, Hittorf, Crookes, Lenard, Hertz, Roentgen, et al
Henry, Niewenglowski;
Becquerel 1896: double sulphate of uranium and potassium;
double sulphate of uranium and ammonium (Chandler);
Metallic uranium; uraninite or pitch blende; Bohemia, Saxony, Cornwall and Colorado;
Polonium (bismuth) 1898; show tubes, sub-nitrate and metallic (nickel); radioactivity 300; loses power more rapidly than radium; undeviable, except Giesel's and in vacuum; rays do not pass through glass; readily absorbed by minerals and thin paper; pass through aluminum better than uranium rays;
Radium (barium) 1898;
Actinium (Thorium) 1899, Debierne;
Extraordinary interest; likely to teach us more about the constitution of matter and the co-relation of the vital and physical forces than any substance which has been discovered since the beginning of the world;
Stupendous interest; puzzling characteristics;
Newton's corpuscular theory of light;
Lord Kelvin's statement to Bowker;
Curie and Laborde statement, radium maintains its own temperature at 1.5 Centigrade above its surroundings, constantly throwing off heat without combustion or chemical change;
Loss of weight in radium; quote Thomson, Becquerel, Crookes, Kelvin, Heydweiller;
Pouring down waste pipes;
Radium, polonium, actinium, new elements;
Tiny brown tube; 100,000 francs;
Atomic weight of radium 225, barium 157; show tubes 40 to 7000; price 30,000 francs per gramme ($6000.);
Call attention to error in price given; should read cost per pound $2,721,555.90;
One pound of radium in three years;
Far more gold in sea water than XXXX radium, etc. in pitchblende;
Curie and diamond ring;
German radium, French radium, price;
5000 tons uranium residues make 1 kilo, and cost $2000. per ton;
Electrical method detects quantity 1/5000 of that necessary to show in spectroscope; thousands of times more sensitive than spectrum analysis, and millions of times more sensitive than chemical analysis;
Electrometer and electroscope;
Imparted radioactivity, clothes, walls of room, etc.
Difficulty of making tests;
Cardboard box; Stimulation of radioactivity;
Leaves, lightning rods, rain, snow, and wires electrified;
Elster and Geitel,
McLennan,
Rutherford's experiment with thorium (ThX); show Th. 99%;
Crookes' UrX, and actinium;
Radioactive gas from radium and thorium; condensed by Rutherford;
Physiological effects;
Curie in room containing kilo of radium;
Hidden's experiments;
Electric fish experiments in Naples;
Three classes of rays; "A" major portion of rays; easily absorbed even by gases; principal ionization of gas; Strutt and Crookes suggest "A" rays positively electrified particles; supported by Rutherford; similar to Canal Strahlen of Goldstein, shown by Wien to be positively charged particles; Rutherford shows "A"

rays higher velocity; and that all radioactive substances and excited bodies, and the emanations give out "A" rays; somewhat similar to X-rays; Rutherford deflected 30% "A" rays by magnet, and 40% by electric field; first supposed to be undeviable;
"B" rays in all respects like cathode rays; discharge bodies, affect photographs; deflected by magnet; ionize air, etc.; very penetrative, and much longer. Villard proved cathode rays to be.
γ— Gamma rays; great penetrative effect; excite or produce radioactivity in air at distance of 3 or 4 feet or more; penetration with 1/2 loss of intensity;
"A" rays 5/10,000cm. aluminum; .0005 cm.
"B" rays 5/100 cm. ——— .05 cm.
"C" rays 8 cm.
8.. cm.

Radium rays reduced 1/2 value in passing through 1 cm. of lead, 1 inch of iron, and 8 inches of water; reduced to 1% of original value through 7 cm. of lead, 7 inches of iron, and 56 inches of water:
Lantern slides;
Show tubes.

FINSEN:

Copenhagen last July,
Photographs, books and portrait from Finsen;
Sunlight;
Arc light;
Iron electrodes;
Lupus vulgaris; Koch, Tubercle Bacillus, 20,000 cases tuberculosis, 8,000 deaths New York;
Red rays; chameleon, worms, small-pox, birthmarks, moles.
Genl. Pleasanton;
Nobel Prize;
Quartz vs glass; show Waite & Bartlett lamp;
X-ray;
Lupus case;

SELENIUM

Berzelius 1817,
Selene (moon); Tellus (earth);
Hittorf, 1851;
Temperature;
Willoughby-Smith, February 12th, 1873; Mr. May;
Cells, Bidwell, Giltay, Sale, and Lord Ross, Draper & Moss,
Adams & Day, Mercadier, Fritts, Ruhmer, Webb, Minchin;
Bell's radiophone;
Talking over a beam of light,- Simon, Ruhmer, Bell, Duddell,
Hayes;
Selenium buoy;
Ruhmer's photographophone;
Protection of safes; Refer to my suggestion at Rochester 1896;
Operating electric lamp, bell, horn, cannon, phonograph, and
3 h.p. motor;
Photometric use;
Eclipse, comets, meteorology;
Manometric telephone;
Crookes' Radiometer experiment;
Seeing by electricity:

[illegible] of its energy for light

Carbon lamp 43/100 of 1% of its total energy given out

$2.50 bill for Elec light represents only 86 cents worth of elec. actually used for light.

With a tungsten lamp he would get $2.00 worth of elec

With a mercury arc lamp 76 worth

With the firefly method he would get $1.93 worth of light for $2.00.

The firefly produces light at 1/400 the cost of illumination by candle.

To make a light equal to the ~~efficiency~~ brilliancy of the firefly by our present methods would require a temperature of 2000.

The absence of heat in the light of the firefly is due to the fact that there is no infra red radiation.

The Photurus Pennsylvanica one of the commonest fireflies in the U.S gives pure white light.

The Cucuyo or Pyrophorus Noctilucus Emits a light estimated at ~~one~~ 1/160 of a candlepower.

Langley found it more intense in the green band of the spectrum than sunlight.

891

2404

Ohio

800

Ohio Paper Co

Inter

3 Ml

P. H. Stott

Ryan

McAdoo.

Bros.

New Aub – 150 Miles

Wood

22 1912

A. C. Brown

W. S. Andrews.

Triboluminescent Material
(Artificial Sphalerite)

Water Glass calcined
equal parts of chloride of
zinc with trace of sulphate
of magnesia

Calcine mixture &
wash thoroughly

Chloride of Sodium 2 Grains
Cyanide of Potassium 2 Grains

TELEPHONE, 251 CORTLANDT. CABLE ADDRESS, "REMMAH NEW YORK."

WILLIAM J. HAMMER,

CONSULTING ELECTRICAL ENGINEER,

1406 HAVEMEYER BUILDING,

26 CORTLANDT STREET,

NEW YORK, January 28th, 1903.

Messrs. Eimer & Amend,
18th Street & Third Ave.,
New York City.

Dear Sirs:-

Will you kindly inform me whether you can manufacture for me a small quanity of each of the substances named herein (a few ounces will suffice); and also kindly inform me what the cost will be, and how long it will take to secure the same.

New French Self-Luminous Mixture.

20 Parts dehydrate sodium carbonate
5 parts of sodium chloride
1 part of magnesium sulphate
500 parts of strontium carbonate, and
150 parts of sulphur;

these to be well mixed and kept at a white heat for three hours in a muffle from which the air is carefully excluded.

Barium Sulphide.

Barium sulphate (C. P.)	32 parts
Magnesium carbonate (C. P.)	1 part
Sulphur (C. P.)	1 part
Gum tragacanth	q. s.

This mixture is formed into balls with the gum tragacanth; the balls dried at a moderate temperature, and then placed in a crucible with a luted cover, and kept at red heat for one hour. They are then allowed to cool slowly, and while still warm are transferred to glass stoppered bottles.

Strontium Sulphide.

Strontium sulphate (C. P.)	22 parts
Sulphur (C. P.)	1 part
Gum tragacanth	q. s.

Prepare as in the case of Barium Sulphide.

Chloride of Calcium.

Fuse chloride of calcium in a crucible, and pour it out on a clean iron plate. As soon as it becomes cold enough break it into good sized pieces, and transfer to well stoppered bottles.

Calcium Nitrate.

Dissolve chalk or marble dust in nitric acid, evaporate to dryness, and fuse in a porcelain crucible.

Boracic acid fused and allowed to cool, and break into small pieces. Also potassium sulphate fused with cream of tartar. In both of these a phosphorescent light appears along the cracks, which appears in the daytime.

Yours very truly,

Wm. J. Hammer

Metallurgical & Analyt. Laby
52 Beaver St
Mr. Mather

Contribution
à l'étude de l'excitation de la phosphorescence
par le Radium

Les diverses substances chimiques susceptibles d'avoir leur phosphorescence excitée par des rayons différents, n'acquièrent pas une égale saturation lumineuse avec toutes les sources d'excitation.

C'est ainsi qu'exposés au soleil, on aura par ordre progressif d'intensité :

1° Sulfure de calcium, vert	}	faibles
2° – d° – orange		
3° – d° – indigo		
4° Sulfure de Zinc, jaune-verdâtre	}	intensif
5° Sulfure de calcium, violet		

en contact avec un sel de Baryum Radifère, à activité déterminée et la même pour chacun d'eux, on retrouve les trois premiers sulfures dans leur ordre précédent et presque sans différence appréciable, mais le Sulfure de Zinc présente une intensité au moins trois fois plus forte que celle du Sulfure de calcium violet, lequel est à peine supérieur au Sulfure indigo.

Cette propriété du Sulfure de Zinc d'acquérir la plus grande saturation lumineuse, par excitation radifère, l'a fait choisir pour les expériences d'intensité et de durée lumineuses.

Il est regrettable que ce sulfure soit souvent d'une grande rareté, parfois même introuvable ; les communications faites jusqu'ici par Sidot[1], Ch. Henry[2], Giesel, etc, n'indiquent pas de méthode certaine, de description précise des conditions

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(1) Comptes-rendus, 1886

(2) Comptes-rendus, 1892

physiques et chimiques nécessaires à la préparation du Sulfure de Zinc phosphorescent à intensité lumineuse maxima.

Des manipulations opératoires identiquement semblables, fréquemment répétées (3), n'ont donné que des résultats occasionnels, (les derniers en date absolument nuls), sans qu'il soit possible de déterminer le point critique de l'opération ni la cause des insuccès.

Excitation de la phosphorescence. — Le Sulfure de Zinc peut être obtenu en masse dans un creuset, en grains et en poudre ou tout petits cristaux. Dans le premier état la partie du culot voisine des parois du creuset n'est pas phosphorescente; la masse intérieure peut présenter des phosphorescences variant du jaune citron au vert vif dont la luminosité s'atténue fortement par pulvérisation. En poudre et mélangé à un vernis ou à une colle, on en peut faire des écrans à la façon de ceux à base de platinocyanure de baryum employés en Radioscopie.

Le Sulfure de Zinc devient lumineux:

1° Sous forme d'écran qu'on approche d'une certaine quantité de Radium, libre ou enfermé

2° En mélange avec le Radium; les deux produits étant à l'air libre, ou mieux, enfermés dans un tube de verre scellé à la lampe.

3° Par radioactivité induite (4)

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(3) La Société Centrale de Produits chimiques, à Paris, compte des expériences de plusieurs années.

(4) P. Curie, Mme Curie, Debierne; Comptes-rendus -- 1899. 1901

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Intensité de la Phosphorescence. — Faites avec des quantités égales de Sulfures de Zinc susceptibles d'une égale saturation lumineuse et avec des substances radioactives de même nature, employées en mêmes quantités pour tous les essais, mais d'activités différentes les expériences indiquent que l'intensité du mélange croît en même temps que l'activité augmente.

La phosphorescence est différente dans deux mélanges de quantités semblables de Sulfure mais de quantités inégales de sels radifères à même activité

Pour une quantité quelconque de Sulfure de Zinc on obtiendra une phosphorescence plus forte avec une quantité n de Radium à activité de x qu'avec une quantité quatre fois plus forte d'un radium quatre fois moins actif.

Durée de la Phosphorescence. — En contact avec le Radium à l'activité de 1000, les sulfures de Calcium et de Zinc conservent l'état lumineux pendant un temps qui ne saurait être actuellement déterminé. J'ai placé en complète obscurité, le 23 février 1900, un mélange à proportions déterminées de sulfure de Zinc et de Chlorure radifère, renfermé dans un tube de verre scellé au chalumeau. — Ce mélange n'a été exposé depuis à aucune autre source lumineuse que celle avec laquelle il est en contact : la phosphorescence de ce mélange est restée sensiblement égale à celle qu'il émettait le jour de sa préparation.

Mais cette durée de phosphorescence paraît être inversement proportionnelle à l'activité excitatrice :

un mélange du même sulfure avec le Radium à l'activité de 7000 accuse une différence de coloration et une différence d'intensité notables après 18 mois de contact.

Enfin, soumis à l'influence des très hautes activités (20000 - 50000) le Sulfure de Zinc peut perdre toute phosphorescence en moins d'un mois d'excitation

Janvier 1903

L. Boulau

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ALL CORRESPONDENCE
SHOULD BE ADDRESSED
TO THE SECRETARY

SMITHSONIAN INSTITUTION.

Washington, U.S.A.

UNITED STATES NATIONAL MUSEUM
INTERNATIONAL EXCHANGES
BUREAU OF AMERICAN ETHNOLOGY
NATIONAL ZOOLOGICAL PARK
ASTROPHYSICAL OBSERVATORY

October , 1907.

Dear Sir:

Your communication of September 10, relative to the interesting subject of phosphorescence, was laid before the Secretary upon his return from the field, and he authorizes me to send you herewith a brief list of articles relating to the subject, which may be of service to you. A complete bibliography would require a considerable investigation on the part of several members of the staff of the National Museum, which is rendered impossible by the large amount of current work.

The only mounted specimens which could be supplied to you are those of Pyrophorus and of ordinary fire flies, which I judge would not be of any use to you in your research work. It is not felt that the Institution can properly be at the expense of securing living specimens of the large tropical fire flies, as a previous experience indicated that this is both troublesome and costly.

By reference to previous correspondence, I find that a copy of Mr. Langley's paper on "The Cheapest Form of Light" has been sent to you, as well as all other available publications of the Institution on the subjects of radio-activity and phosphorescence, and I do not think that anything has been published since by the Institution on the subject. If, however, you require additional copies of any of the Institution's papers, they will be supplied if available, and there is going with this a copy of the latest list of Smithsonian publications, from which you may select such as will be of service to you.

Very respectfully yours,

Cyrus Adler

Assistant Secretary.

Mr. William J. Hammer,

1408 Havemeyer Building, 26 Cortlandt Street,

New York City.