

ACTION AT A DISTANCE.

PHOTOGRAPHIC EFFECTS OF DRYING OILS.

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THE discovery of radioactive substances naturally caused many to turn to the examination of all kinds of materials, with a view to investigating whether they by any chance exerted an action at a distance resembling radioactivity. At the present day there is ample material to show that radium does not stand alone with its emanations, but that many other metals also, and various substances, produce effects at a distance and have a more or less pronounced action upon a photographic plate.

In such cases, however, we are not by any means necessarily dealing with radioactive processes. For the term radioactivity implies something more than the mere property of sending out invisible rays which affect the photographic plate. Radioactivity is characterized by certain other typical effects. Thus a charged electroscope is discharged if a radioactive body is brought near to it; the rays proceeding from radium can be deflected by a magnet; colorless salts and gems acquire a more or less marked and permanent coloration by exposure to radium, and so forth. All these typical effects are produced exclusively by the elements of the radium group, such as thorium, actinium, polonium, uranium, etc.

However, quite a large number of other substances, which do not display these characteristic radioactive effects, nevertheless do possess the faculty (which first attracted attention in the case of radium) of affecting the photographic plate, in other words, of producing an action at a distance, as if by invisible radiation. Among these substances is the class of so-called "drying oils," i. e., oils which in contact with air undergo oxidation, and harden to a solid mass. The best known example of this kind is linseed-oil varnish.

The occasion for the investigation of the phenomena here concerned arose out of certain observations made in the paper industry. It had been noticed that mucilage (gum arabic), as used in the manufacture of letter-envelopes, under certain conditions passes into an insoluble state. On moistening the gummed edge of such envelopes, in which the change in question has taken place, it is observed that the gum absorbs the water like a sponge. The surface looks lumpy and rough, and has an appearance like starch flour. The adhesive power is completely lost, and from its original colorless state the gum has turned brownish yellow.

Now it was a remarkable fact, that the gum had deteriorated only on envelopes whose inside or outside was covered with a printed or lithographed pattern, such as is frequently used in order to render them opaque. This peculiar influence of the printed surface showed even where there was no visible connection between the gum and the print.

Since the same effect was observed without exception, no matter what coloring matter had been used in the printing process, the cause of the change could reside only in the binding agent common to all printing inks. This binding agent is in all cases linseed-oil varnish.

The alteration of gum proceeds only very slowly, and it was therefore desirable, for the purpose of the investigation of the phenomena involved, to work with more sensitive material, namely, photographic plates. Dry plates were covered with different samples of printed papers or with glass plates coated with linseed-oil varnish and allowed to dry. Various objects such as paper, glass, small pieces of metal, coins, etc., were interposed between the photographic plate and the varnish, in order to obtain, if possible, "shadow" effects, which would give a clue as to the character of the forces emanating from the print. At the same time this would show whether some bodies were transparent to the "radiation."

After eight to ten days exposure the plates upon development showed very clear shadow photographs. Metal, glass and mica showed up with sharp edges. However, coarse wrapping paper one-fifth of a millimeter thick gave a rather less marked shadow, and fine (so-called grease-proof) cellulose paper one-fifteenth of a millimeter in thickness was clearly traversed by the radiation. Direct copies are also obtained of words printed with ordinary coloring matter upon the paper, and this action takes place through the paper, for if the latter is placed with the unprinted side against the plate, a copy is nevertheless produced.

In order to investigate further the mode of propagation of this effect, experiments were made with the following arrangement: At the bottom of a small cardboard box was laid a photographic plate, and upon it a narrow vulcanite frame about two millimeters

thick. This latter served to support a brass plate provided at the center with a hole one millimeter in diameter. Over this, and separated therefrom by a second vulcanite frame, was placed a glass plate coated with linseed-oil varnish (see Fig. 1). This box with its contents was allowed to stand for three weeks at room temperature. The plate was then developed, and showed the image of a ring, as seen in Fig. 2. Another brass diaphragm, with a slit one millimeter broad and two centimeters long, gave, under similar conditions,



FIG. 1.

an elliptical ring (Fig. 3). This ring formation caused considerable surprise, until the matter was elucidated by further experiments. Advantage was taken of the observation which had been made, that the radiation from the varnish increased with rise of temperature. Eight photographic plates were therefore exposed in the manner described above, but at a temperature of 40 to 45 deg. C. (104 to 113 deg. F.). Every two hours one plate was taken out, and thus the process of formation of the ring could be followed step by step. It was found that there first formed on the plate a dark spot, which gradually spread and became larger. Finally this spot acquired a bright nucleus, so that a ring was formed. If the action was allowed to continue for a sufficient length of time, the image ultimately was completely reversed, so that the plate showed, instead of a black shadow, a bright image on dark background.

Thus the action of the varnish is exactly similar to

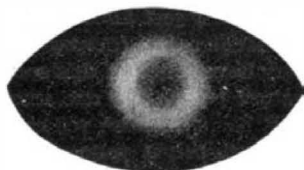


FIG. 2.

that of light, which, as is well known, will produce a reversed (positive) image on sufficiently prolonged exposure. This phenomenon is known in photography as solarization, and it is interesting to note that this solarization is produced also by the action of varnish.

The next step in the investigation was to examine the penetrating power of the "radiation." Pieces of foil of various materials were inserted into the exposure box under the perforated brass plate. Substances thus examined were glass, mica, gold leaf, celluloid ($\frac{1}{4}$ millimeter thick), paper (0.05 millimeter thick), gutta percha ($\frac{1}{5}$ millimeter thick), and gelatine ($\frac{1}{4}$ millimeter thick). The result was rather surprising. Glass and mica, as might have been expected, were quite opaque, but all the other materials tried were pervious to the radiation, and some of them, as celluloid, gelatine, and paper, in very high degree.

This peculiar action at a distance produced by the varnish can also be shown on polished metal plates.

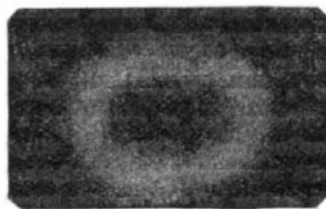


FIG. 3.

These usually become blackened in the neighborhood of printed surfaces. Thus if a fairly recently printed paper is packed up together with a bright zinc plate, and exposed for several days or weeks to a moderate heat, an image of the printed characters or drawing is found to have formed as a dark stain of oxides upon the bright background.

The explanation of these phenomena is probably to be sought in the property which the varnish possesses, of giving rise to ozone or other peroxide bodies in the course of its "setting," i. e., oxidation. These products form traces of hydrogen peroxide in the presence of moisture, and it is probably the hydrogen peroxide so formed which causes all the observed effects. This substance exerts an oxidizing and bleaching action upon organic matter in its neighborhood. Thus for

instance the cork stopper of a bottle containing varnish in a short time becomes bleached. The penetration of colloidal bodies by this action is quite what might be expected, for they are mostly capable of taking up hydrogen peroxide, and allowing it to evaporate off on the opposite side.

In this way the action of the varnish upon the photographic plate can be quite satisfactorily explained. At the same time these observations give the clue to the behavior of gum arabic in the presence of linseed-oil varnish.

When this influence upon gum arabic was investigated it was found that the purity of the solutions used for preparing the gummed surface was an important factor. Certain metallic impurities in the water used, or in the gum itself, may materially influence the process which goes on. But the alteration of the gum arabic could be demonstrated in all cases, if only it was left for a sufficient length of time in the neighborhood of printed paper or a varnished surface.

Here again there was a remarkable parallelism in the action of the varnish and that of light. It was found that exposure to sunlight caused the same change in the gum arabic, and that the time required for the alteration was almost identical in the two cases. Thus if a surface coated with gum containing iron salts as an impurity is laid in the sun, it loses its adhesive power in a few days, even though the impurities present amount to less than one in one thousand; the same is the case if the gum has been exposed to the action of a varnished surface. If on the other hand gummed paper is stored by itself in the dark, the gum seems to keep indefinitely. Some of the experimental results obtained are tabulated below.

Substances Added to a 2% B.C. Solution of Gum Arabic.	The Coat of Gum Became Insoluble		Remained Unchanged in the Dark on Storing in Absence of Varnish.
	By Exposure to Light.	By Action of Varnish in the Dark.	
Pure gum solution without addition.	In about 90 days.	In about 90 days.	After 365 days.
Ferrous sulphate, 1:1000.	In about 20 days.	In about 15 days.	After 365 days.
Iron dissolved by galvanic action, 1:2:1000.	In about 25 days.	In about 25 days.	After 365 days.
Potassium bichromate, 1:2:1000.	Very quickly.	In about 5 days.	After 365 days.

From the experiments it was therefore evident that gum arabic behaves more or less closely like a dry plate according to its composition and the degree of its purity, and that the proximity of drying varnish has an action upon gum similar to that of light.

Radioactive substances are not capable of causing this alteration in the gum, and in other respects also the action of varnishes differs entirely from radioactivity. On the other hand, the experiments described above show that in the neighborhood of drying oils an action occurs which outwardly resembles certain kinds of radiation, in affecting the photographic plate, and producing this effect even through interposed shields of colloidal substances, such as paper, gutta percha, gelatine, celluloid, etc.—Abstracted from Zeit. fuer physik. Chemie.

In their latest published patent Messrs. Orville and Wilbur Wright disclose a method of automatically controlling and maintaining the balance of the machine longitudinally, laterally, and vertically. The method consists in employing a movable horizontally mounted plane adapted to be actuated by air currents. This plane is mounted on parallel levers just in front of the main planes and between the main planes and the elevator plane. The automatically operating plane is rigidly connected to a link pivotally jointed to the front ends of the projecting levers. The rear end of one of the levers is provided with a weight to balance the movable plane. Air currents met with that tend to upset the balance of the machine automatically deflect this plane. By means of the plane a valve is operated between a differential cylinder containing a differential piston and a reservoir in which air is stored under pressure. The movement of the differential piston in its cylinder by means of the air pressure is employed to control the elevator plane, the warping planes, and the rudder, so as to counteract any tendency of the wind to disturb the balance of the machine as soon as it occurs. Means are provided to enable the pilot to control and vary the automatically operating mechanism during flight.