treatment, thereby overcoming the disadvantages charged to the coke made in the by-product ovens.

This process has recently been patented by C. S. Price, General Manager, and James J. Fronheiser, Superintendent of Laboratories of the Cambria Iron Company.

THE HELIOCHROMOSCOPE.

BY F. E. IVES.

[*Read at the stated meeting of the Institute, held Wednesday, Oct. 19, 1892.*]

Mr. JOS. M. WILSON, President, in the chair.

MR. IVES:—It was in 1888 that I first described and demonstrated, at the Franklin Institute, a method of reproducing the natural colors by photography, which differed in certain vitally important particulars from somewhat similar processes which had already been carried out by Cros and Du Hauron in Paris, Albert in Munich, Bierstadt in New York, and others. I succeeded in reproducing the natural colors in landscapes and various objects with a degree of accuracy which I have good reasons to believe had never before been approached by any method without the intervention of the artist's brush. The procedure was, however, too complicated and difficult for profitable commercial application, and comparatively few specimens were made.

I now present to your notice devices which so greatly simplify the operation of the process as to make it quite possible to place it in the hands of even the "press-the-button" class of amateur photographers, and yet yield results that are no more defective in color-rendering than the ordinary photograph is in the rendering of monochrome light and shade.

The first of these devices is a camera attachment, by means of which the three pictures representing the effect upon the three fundamental color sensations are made by a single exposure on a single sensitive plate, and from a single point of view. The device as now perfected is surprisingly simple, being comprised in a small box, which

may be attached to the front board of an ordinary camera. The division of the light ray is effected by transparent mirrors, as in some of my earlier cameras, but in such manner as to dispose the images symmetrically on a single plane, without altering the position of the camera in relation to the object.

FIG. 1.—The Heliochromoscope.

The second device, which I call a heliochromoscope, contains the same arrangement of mirrors, turned about so as to serve to re-combine the three photographs in such manner that the photographic color record is translated into color again as readily as the sound record in the phonogram is translated into sound in the phonograph.

The most important advantage of this device is that it may be used at any time, at a minute's notice, like the stereoscope; and, as almost everybody may possess one, it is competent to make the realization of color photography a household affair. It also more completely fulfils the theoretical conditions of success than either the production of color prints or lantern projections, and produces an illusion of nature more correctly than would be possible with even an absolutely perfect color print on paper, because the picture is seen without surface reflections or distracting surroundings.

I claim for this system of color photography that it is perfectly rational and scientific, and a true solution of the problem of reproducing the natural colors in a photographic picture. This claim meets with a good deal of opposition in the minds of some people, whose mental attitude is a source of wonder to me, because the same sort of objections that are made to the triple photograph would apply to the stereogram and the phonogram. One is an automatic record of color, another of binocular vision, and another of sound; each must be placed in a special device in order to reproduce that which it has recorded—the triple photograph or chromogram into the heliochromoscope, the stereogram into the stereoscope, and the phonogram into the phonograph. I do not remember ever to have heard the stereogram denounced because it is not a single print with embossed relief, or the phonogram because it has no vocal cords.

Some even go so far as to deny that this can properly be termed color photography at all, although the same individuals are in the habit of calling pictures that cannot be made to show colors "orthochromatic" or correct-color photographs. But the most extreme illustration of this peculiar attitude of mind that I have seen is the assertion of one who, if I am not mistaken, has aspired to be the historian of photography, that this is merely "looking at ordinary photographs through bits of colored glass!" To be consistent, this writer should describe the stereogram as "two ordinary photographs, mounted on the same

card," and the phonogram as a "wax cylinder having a roughened surface like an ordinary file." I believe he did recently write a history of photography, with "an introduction to its latest developments," without once mentioning color-sensitive plates.

I speak of this kind of criticism because it comes from

FIG. 2.—The Heliochromoscope.

men whose writings are in demand, and proves the existence of a deep-seated prejudice, which I have encountered in the development of other applications of photography, and which must be combated in order to overcome it. I will give an illustration: When, in 1880, I succeeded in realizing a mechanically accurate and practicable method

of half-tone block-making, I could find only one engraver who believed there was a future for processes that rendered the shading in equally spaced graduated lines and cross-lines. Engravers, printers, publishers and photographers were agreed that if a block be made up of lines, those lines must follow the contours of the object depicted, as in the conventional wood engraving. Since that could not be done, a grain, similar to the well-known lithographic grain, must be substituted for the line tint. I declared that the objection to a regularly lined tint was a prejudice, stuck to it, and already, within twelve years, plates having that same lined tint have come into such extensive use as to replace millions of dollars' worth of wood engravings. They are used in illustrating books and periodicals of the highest class, and the advantages of the mechanical-lined tint are such that it threatens even to invade the domain of photogravure. Mr. Louis E. Levy exhibited such results at the last monthly meeting of the Franklin Institute, and I myself applied for a patent on a printing plate of this character more than a year ago, having first experimentally demonstrated certain important advantages which they can be made to possess.

We did not make half-tone printing plates of the kind that engravers and printers and publishers thought they must have, but they have concluded to take what we did make, and are taking them more and more every year.

We have not made photographs in the natural colors of exactly the kind that people have been looking for, and there is good reason to doubt if such a result will ever be accomplished by a simple process; but we have actually realized, by a process almost as simple as stereoscopic photography, results better than can even be hoped for in color prints, and so perfect that they must ever represent the standard which results by any other method must be made to approach in order to be acceptable. A great many people seem to think that this is not what they want; but I have quite as much faith in the future of the heliochromoscope as I ever had in the future of half-tone block-making

in line. It has been a revelation to me, and I believe it will be to the whole world.

I met a professional artist in London, a clever painter of both portraits and landscapes, who spent what seemed to me a very long time studying a bouquet of English flowers reproduced in the heliochromoscope, and left it only to return to it again and again, as if it fascinated him. At last a friend asked him for an expression of opinion upon the merits of the device. After some hesitation, he said that he had attended one of my lectures at the Royal Institution, expecting to go away and report the failure of another attempt to reproduce the natural colors by photography. He had not been able to do so, but was forced to confess that color photography is a fact. The demonstration was conclusive to him. The heliochromoscope will have no better friends than the artists, for whom it will not only reproduce nature, but the masterpieces of art as well, in such manner that they can be studied in far-distant lands almost as well as in the galleries where they repose.

In the far West, I met the representative of a large New York firm of importers of Oriental rugs. He assured me that he was ready to pay \$100 out of his own pocket for a duplicate of the heliochromoscope that I showed him, with a set of photographs of the rugs that he carried about with him only to show their colors. It would save his firm a great deal of money that went in expensive sample rugs, and in cost of extra baggage, and it would save him a great deal of trouble. A professional house decorator spoke much to the same effect. Evidently, the heliochromoscope will have many fields of usefulness—so many, perhaps, that its function as a source of drawing-room entertainment, for which alone many have supposed it to be adapted, will prove of secondary importance. But I shall be greatly surprised if, even for the latter purpose, it does not become more popular than the stereoscope ever was, although it is necessarily a much more expensive instrument.

I have said that this system of photography is capable of giving reproductions that are no more defective in color

rendering than the ordinary photographic process is in the rendering of monochrome light and shade. Not to be misunderstood, let me say that no photographic process is capable of reproducing even monochrome light and shade with strict accuracy. The most correct negative-making process will exaggerate contrasts in the middle shades of the picture at the expense of the two ends of the scale. The same defect necessarily appears in the color process, making colors too pale in the light shades and too dull in the dark shades, with slight exaggeration of contrasts in the middle shades. This defect would not generally be noticed by most persons, and it would not be fair or reasonable to count it against this process any more than it is counted against ordinary photography.

The most serious practical difficulty encountered in the operation of the process is due to unevenness, often slight, in the coating of the sensitive plates. Unevenness that would not be noticed in ordinary negative work often seriously affects the result in this process. This difficulty can be readily overcome by the plate-makers; but it will not pay them to make the necessary changes until there is a considerable demand for plates for this work, and then they will be obliged to charge more for them than they now do for the ordinary plates. With such sensitive plates as I would ask for, and know that it is quite possible for the plate-makers to provide, the average results by this process should be better than the best that I have shown.

The subject now in the heliochromoscope is a bouquet of Yellowstone Park wild flowers, gathered by Mr. Jennings. We placed it in a pitcher borrowed from the dining-room of the Lake Hotel and photographed it in our bed-room. You will see the bouquet as it would appear by gaslight, because I am using gaslight as a source of illumination. By daylight, the colors are exactly as they appeared to us when we photographed it.