

THE IVES SYSTEM OF COLOR PHOTOGRAPHY.

THE KROMSKOP AND THE KROMSKOP CAMERA.

The development of trichromatic color photography appears to have superseded experiment along the older lines, by which it was sought to obtain photographs in natural colors in the camera direct, and this fact is due largely to the work and writings of Mr. Frederic E. Ives, who must also be credited with the attainment of the most perfect results by means of his Kromskop system, in which a "color record" is first made in a special camera, and then viewed in an optical instrument which is used like an ordinary stereoscope.

In view of the fact that the Kromskop system has now been reduced to a remarkably simple and practical basis, and that it yields reproductions which are astonishingly beautiful and realistic, we feel sure that our readers will be interested in a somewhat detailed explanation and description of the method and the special apparatus devised for carrying it out.

As long ago as in 1881, Mr. Ives made trichromatic color prints from half-tone process blocks in the printing press, but it was not until 1888 that he announced the new principle which is the basis of his perfected methods, and by the application of which he then first demonstrated the possibility of accurate color reproduction by an automatic process. This principle, very briefly stated, is that of making the three images of the color record by the action of mixtures of spectrum rays in accordance with Maxwell's color curves, and then optically combining the three images with pure spectrum colors, red, green, and blue, or by superposed prints in the complimentary colors, cyan blue, crimson, and canary yellow. The optical synthesis has always been Mr. Ives' favorite method, and the application of his new principle to this method involved an important difference in the character of the color screens employed in making the photographs and in viewing them, whereas, all other experimenters had employed the same color screens for both purposes—a fatal defect, according to this inventor.

The first demonstration of the method was by means of triple lantern projection; but, with a view to obtain the results by the simplest and most reliable means, and to render them readily available to everybody, he has succeeded in designing an automatic camera that is an exposure camera for making the negatives, and a viewing device to show the perfect reproduction as readily as stereograms are seen in the stereoscope. Many years before, Louis Ducos Du Hauron, in France, had endeavored to do the same thing, but he failed to recognize the distinction which must be made between the taking and viewing color screens, and his viewing device was so crude and imperfect that there is no record of its ever having been exhibited in operation. Undoubtedly the first successful viewing device was Mr. Ives' "Helio-chromoscope," which attracted considerable attention when it was first shown at the Royal Society and at the Royal Institution, in London, in 1892. This device, however, proved too complicated and delicate in its adjustments to meet commercial requirements, and the evolution toward greater simplicity and practicability which has since gone on is a most interesting one. The present viewing device is called the "Kromskop," and the abbreviation of mechanical and optical complications is even

larger, or in any way more perfect. Another simpler form of instrument has been recently devised, but only by further optical complication, and by curtailing the apparent area of the image, both of which seem to be inseparable from any departure from the "step-Kromskop" design.

Mr. Ives has also devised the only cameras for making three images of the color record, identical in

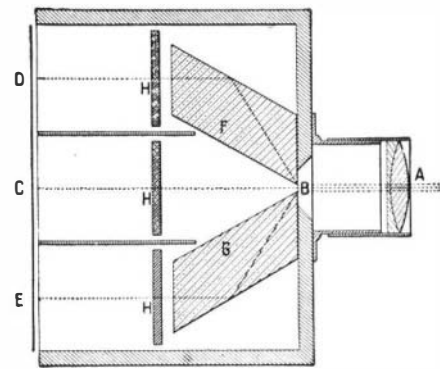
the greater refractive index of the glass as compared with air, extends the focal point, so that the images are equal, except for differences of light and shade introduced by the selective color screens, *H, H, H*. It seems perfectly safe to say that no simpler optical device could possibly secure three images identical in size and perspective on one plate, from one point of view, at one exposure.

The time of exposure is dependent upon the time required to impress the red and green images on the sensitive plate; for this reason the largest section or central portion of the lens transmits the image direct through the red screen, while the blue violet and green pass through the side prisms. Referring to the view camera engraving there is located between the inner end of the prisms and the back of the lens pivoted diaphragm shutters which, when moved, one way or the other, by the extended levers over a gage observed on each side of the prisms, regulate the amount of light that is to pass through the prism. In this way the actinic value of the light on the plate is adjusted and proportioned so that the blue and the green rays will impress the plate in a given time equally with the red rays, the latter requiring the longest time. The plate holder, made of special length to fit the camera, will be seen on the left of the picture. Special chromatic plates are used.

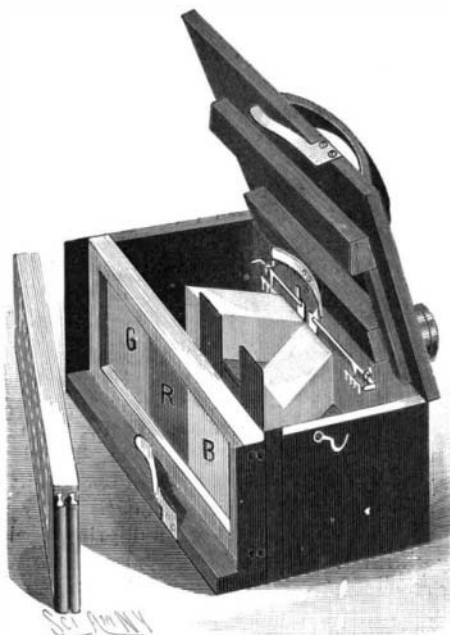
With this camera, the exposures on a landscape may be reduced to five or ten seconds, under the most favorable conditions. Advantage is taken of the same property of a body of glass to extend the focal point, in a somewhat more complicated camera, which, with a single point of view transmits enough light for portraiture in the studio.

From each triple negative made in these cameras, any number of positive color records, "Kromograms" can be produced by contact printing, as in making lantern slides, and when mounted on an ingenious folding cardboard frame, they are ready for viewing in the Kromskop, as easily as a stereogram is seen in the stereoscope; and the principal Kromskop, which is also a stereoscope, shows not only the colors but the effect of solidity as well, so that the very object itself appears to stand before the eyes.

Referring to the larger illustration, the general appearance and construction of the Kromskop, or viewing step instrument, will be noted. It is tilted at a suitable angle to allow the light to fall equally on all the duplicate images. When viewed without any color record transparencies in place, the screen of the combined colors has a bluish-white appearance. If one of the screens is shaded red, blue or green will appear. The red screen is located just above the viewing lens, on the next step to the right is the blue-violet screen and vertically below that is the green glass screen. Just in front of this is a green colored reflector which illuminates the green screen. In the interior, held in place by spiral springs, are two green glass reflectors located under the blue and red screens, which possess the quality of reflecting the colored images above, without the secondary reflection which occurs when a clear glass reflector is employed, and at the same time transmit the green lower image through them to the viewing lens. The green image in its passage upward through the green reflectors blends, first with blue reflected image, and lastly with the red reflected image as the white dotted lines in the picture show. The three stereoscopic transparencies secured together by flexible cloth joints (partly opened in the engraving) are very readily placed on top of several steps and quickly adjusted to the proper position. At the ex-



SECTIONAL PLAN OF TRI-COLOR CAMERA.



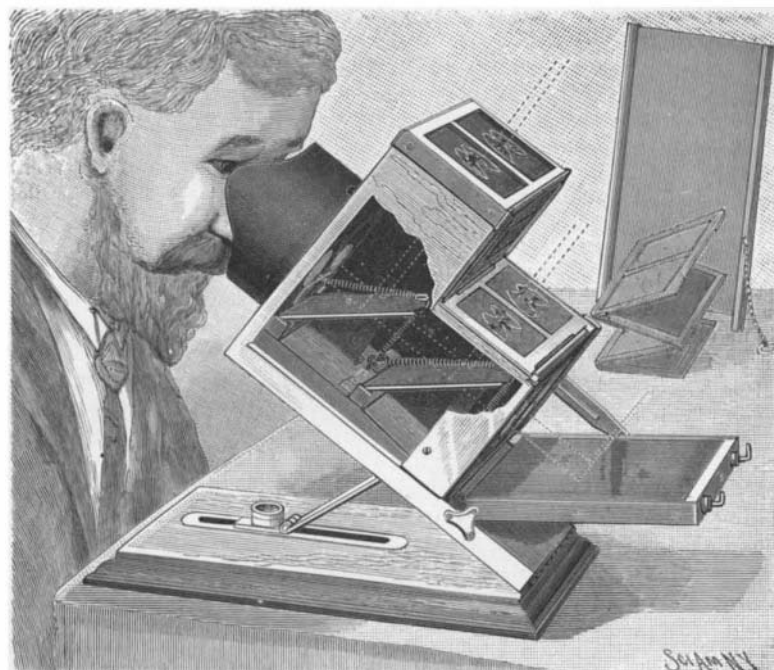
THE KROMSKOP TRI-COLOR VIEW CAMERA.

size and perspective on one plate, at one exposure, from one point of view.* His earlier cameras for this purpose, although efficient, were too delicate in adjustment for regular use. The perfected system is a "one-plate-one-exposure" process, as simple in actual operation as the ordinary black and white photography, and is carried out entirely with apparatus which appears to have realized the utmost possible degree of optical simplicity.

The Kromskop view camera, as shown in our engraving, contains, in addition to the essential parts of an ordinary camera, nothing more than two prisms and three color screens in one frame, blue, red, and green, designated *G, R, and B*. In making this construction Mr. Ives has very ingeniously taken advantage of the property of a body of glass to extend the focal point of the rays, which form the images on those parts of the plate furthest removed from the view point. The camera is provided with a hinged cover having a handle on the upper side and a flat spring underneath for clamping the prisms. Referring to the diagram, *A* is a simple achromatic lens, focused by means of a slip tube or rack and pinion, with a diaphragm at *B*; the lens normally focuses an image at *C*, which is perfectly defined to the edges of the small image required, but in order to divide the light and form other images at *D* and *E*, the prisms, *F* and *G*, are so placed that their inner front edges partly cover the diaphragm aperture, which then appears like three juxtaposed slits, giving three practically, though not absolutely, identical points of view. The light passing into the prisms is twice

reflected, producing unreversed images at *D* and *E*, which, owing to the greater distance from *B* to *D* and *E* than from *B* to *C*, would be of larger size than the middle image and much out of focus, but for the fact that

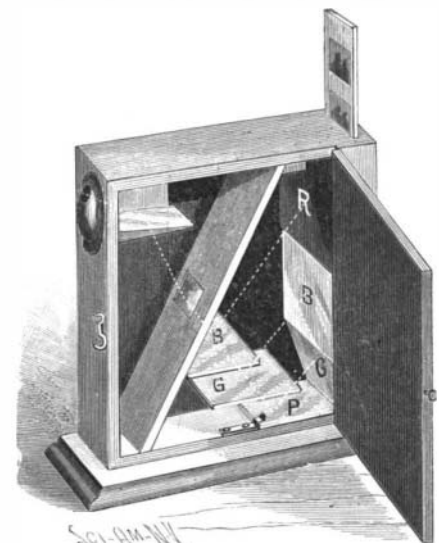
*The Du Hauron camera, recently described in our columns has (optically) three points of view, one behind another, thereby introducing differences of perspective, size, and focus of the three images if the objects are within a few feet of the camera.



THE KROMSKOP, AN INSTRUMENT FOR VIEWING PHOTOGRAPHS IN THE COLORS OF NATURE.

more striking than the abbreviation of the name from six to two syllables.

The Kromskop, although sufficiently elaborate mechanically to make it an instrument of precision, consists essentially of nothing more than a case and four pieces of colored glass. Nevertheless, it seems impossible that any reasonably simple construction could permit of showing an image which should appear



THE MINIATURE KROMSKOP.

trime right corner of the picture is a ground glass screen for equalizing the light falling on the reflector when a clear sky cannot be had. The eye lenses not only magnify but cause the eyes to blend the two sets of images which constitute the complete stereoscopic pair, as in the ordinary stereoscope. The result is a single image in solid relief, and in the natural colors. The color record transparencies simply shade

or cut out certain portions of color, causing red or blue to predominate as the case may be, and thereby in their various gradations cause a harmonious and pleasing intermingling of colors, photographically recorded, which reproduces an image in the natural colors of nature.

One of our engravings shows another modified form more simple, non-stereoscopic, which gives a smaller though equally as perfect a color reproduction of the step-Kromskop, and is called the miniature Kromskop.

In this case the kromogram is made up of the three color record pictures on one plate, as will be seen at the right end of the picture, where one end of the transparency projects upward.

To avoid distortion in viewing these images at an angle of 45°, Mr. Ives devised a special correcting combination, consisting of a prismatic lens and a prism, observed in the center of the diagonally placed board, and just below the view aperture. One side of the instrument forms a hinged door, so that access can be had to the interior.

R, B, G, are the three color screens respectively red, blue and green, in front of which the kromogram is placed. The light passes through the kromogram images and the color screens in the direction of the dotted lines, *R, B, G*, the green being reflected by the silvered mirror, marked *P*, and the other colors by the transparent colored glass mirrors, *G* and *B*, along one line, through the prismatic lens on diagonal board, and the prism fixed just below the eye aperture.

From a personal examination of these color record transparencies in the two viewing instruments just described, we have been more than satisfied with the remarkable natural blending of colors that were produced and were particularly interested in the quick, simple, yet scientific way in which all the adjustments and results are obtained.

Mr. Ives has constructed a color-projecting attachment for lanterns which is very effective and accurate in its adjustments. This we shall hope to describe at another time.

In the correct optical rendering of photographic pictures in the colors of nature, the Kromskop certainly can be compared in its effectiveness and importance to the phonograph as a reproducer of sound, or to the kinoscope in the reproduction of motion.

A commercial use suggested for this instrument is that colored articles such as rugs, carpeting, and china, and other kinds of merchandise, can be presented in their original coloring to the prospective purchaser, and thus save the expense of transportation and display of actual samples by the manufacturer.

We are informed that Mr. Ives is regarded as being the first to invent and protect by patents the only practical photo-chromoscopic apparatus that has been placed on public sale, and that several medals have been awarded to him by important scientific societies at home and abroad.

THE UPBUILDING OF THE AMERICAN MERCHANT MARINE.

The public has heard a great deal recently about the revival of American shipbuilding, particularly as regards that branch of it which is devoted to deep-sea navigation, and we now take pleasure in presenting illustrations of a fleet of a dozen American freight and passenger steamers which are being constructed on the Delaware and the Clyde. Eight of these vessels are upon the stocks at the yard of the William Cramp & Sons Ship and Engine Building Co., Philadelphia, while the other four are building at the shipyard of the Clydebank Engineering and Shipbuilding Co., Glasgow. By far the most important of these boats are four large steamers of 12,000 tons measurement and 17 knots speed which are being constructed for the Red Star Line service between New York and Antwerp; two of which, the "Vaterland" and "Zeeland," are being built by the Cramps, and the other pair by the Glasgow firm above mentioned. The boats will take rank among the largest afloat. They are 560 feet long, 60 feet wide, and 42 feet deep. They are, of course, fitted with twin screws, and the twin engines in the case of the "Vaterland" and "Zeeland" will be of the quadruple expansion type, and in the case of the other two boats, of the triple expansion type. The maximum indicated horse power will be 10,000. There will be accommodations for 300 first cabin, 250 second cabin and 750 steerage passengers. The cabin passengers, both of the first class and second class, will be carried in the bridge deck house amidships, and the majority of the rooms will be deck cabins. There will be a certain number of first cabin suites, each of which will include a sitting-room, a bedroom, and a bathroom. On the promenade deck, which will be of the generous proportions which are found on recent ships of this type, will be a large library and a smoking-room, while the first-class dining salon, which is situated amidships on the upper deck, will be large enough to accommodate all the passengers at one sitting.

The second cabin accommodations will be amidships, chiefly in the deck house, so that most of these rooms, also, will be deck cabins. The dining salon will have the added attraction that comes from being placed

near the center instead of, as is usually the case, at the stern of the vessel. A feature of these ships which is worthy of particular note is the successful attempt which has been made to render life in the steerage more comfortable. The accommodations consist largely of two, four and six-berth rooms, all of which are well lighted and ventilated, while ample lavatory accommodations have been provided. A distinctly modern innovation is the provision of a large social hall.

From the above description it will be seen that these fine ships hold a position midway between the modern ocean greyhound and the modern cargo and passenger ship of 14 and 15 knots speed. They will make the trip from New York to Antwerp in eight days, steaming about 17 knots an hour. The International Navigation Company, or the American Line, as it is more popularly known, for whom these ships have been built, is also having two steamers of similar design and speed, but of 10,000-ton measurement, constructed at Glasgow for the Philadelphia-Liverpool service.

The New York and Cuba Mail Steamship Company has under construction at the Cramp's yard three freight and passenger steamships which are to carry cattle, fruit and merchandise between New York and Cuba. They will be ranked as second-class vessels under the Subsidy Act of March, 1891. The vessels, whose general appearance is shown in the drawing on the front page of this issue, will contain three decks, in addition to hurricane and shelter decks. They will be built of steel with the usual cellular bottom and watertight compartments, and will be provided with bilge keels to give steadiness in a sea-way. It will be noticed from the illustration, they will have a high freeboard, a feature which will conduce greatly to good sea-going qualities and general comfort. One of these vessels, the "Morro Castle," will be of 6,000 tons measurements, 400 feet in length, 50 feet in width and 36½ feet in depth. On a draught of 20 feet she will have a deadweight capacity of 3,400 tons of freight and 800 tons of bunker coal. She will be driven by two four-cylinder triple-expansion surface-condensing engines with a combined horse power of 8,000. With this maximum indication the engines will run at 100 revolutions per minute, when the boiler pressure is 170 pounds to the square inch. The sea speed will be about 18 knots per hour. Two others are being built which will be of 4,500 tons gross measurement. They will be 341 feet long, 47½ feet wide, with a depth of hold of 36 feet. The draught will be 30 feet on a deadweight carrying capacity of 3,000 tons of freight, and 360 tons of bunker coal. The twin three-cylinder triple-expansion engines will indicate 5,000 horse power at 97 revolutions per minute, when the boiler pressure is 160 pounds to the square inch. The largest of these three ships will accommodate 150 first, 85 second and 100 steerage passengers, while the two sister ships of 4,000 tons measurement will accommodate 125 first, 85 second and 100 steerage passengers. The speed of these three vessels will be about 17 knots per hour, as against a speed of 18 knots per hour for the "Morro Castle."

The Oceanic Steamship Company, which, for many years has maintained a service between San Francisco and Sydney, N.S.W., calling at Honolulu, at our newly acquired island of Tutuola and at Auckland, New Zealand, is having three handsome vessels constructed at the Cramp's yard, and these, like those above mentioned, are steel vessels, of first-class construction with double bottom, bilge keels and extensive subdivision by watertight bulkheads. The new boats are 400 feet in length, 50 feet in width and on a draught of 23 feet have a gross measurement of 6,000 tons. The twin-screw, triple-expansion engine will indicate 7,500 horse power and drive the vessels at an average sea speed of 17 knots an hour. The ships are specially designed for the requirements of the long trip across the Pacific Ocean, the larger part of which lies within the tropics. They are distinguished by the large port-holes and abundant means of ventilation which have earned for the old "Alameda" and "Mariposa," of this company, a well-deserved reputation. Because of the great distance between coaling stations on this run, the ships are to be provided with the liberal bunker capacity of 2,000 tons.

Although the American merchant marine has a long road to travel before it reaches the proud position which it once held, the fine fleet of vessels depicted in our front-page engraving is cause for justifiable pride, and without indulging in over-sanguine expectations we may look upon it as an earnest of a great revival of deep-sea shipbuilding in this country.

The Latest Work of the Palestine Exploration Fund.

The Turkish government has granted the Palestine Exploration Fund a firman to excavate over an area of ten square kilometers, and the region marked out for the operations is on the borders of Shephelah, or old country. It was found that three promising sites for excavation, viz.: Tell Judeideh, Tell Zakariya, and Tell-es-Safi, could be brought within the limits of the permit. On October 26, 1898, work was begun at Tell Zakariya by Dr. Bliss and Mr. Macalister. It is a hill rising abruptly 350 feet above the Vale of Elah, and is 1,050 feet long and 450 feet broad. Dr. Bliss found on

the top of the hill the walls of a fortress, to which six towers had been added at a later date. A large part of the area enclosed by the walls has been excavated down to the rock. It has been proved that the fortress has been built after a considerable amount of debris had accumulated on the mound, possibly in the Jewish period. The fortress was simply an enclosure for protecting houses within, and the datable objects range from pre-Israelite to late Jewish times, with a small proportion of later objects. It appears to be probable that the place was inhabited when Joshua conquered the land; that it was fortified in Jewish times; that it was occupied until a later Jewish period, and that during the Roman period there was a brief occupation, after which it appears to have been deserted. Interesting potsherds have been discovered. Tell-es-Safi gives great promise and it is likely that it represents the Biblical Gath.

Automobile News.

It has been suggested that automobiles be named in the same way as a yacht.

An exhibition of motor carriages under the auspices of the Austrian Automobile Club will open at Vienna on May 31 and will continue until June 10.

There seems to be an excellent opening for the sale of motor cars in Spain. In many of the provinces there is not a very extensive railroad communication and there seems to be an excellent prospect for the introduction of motor car, passenger and goods services between many places in the provinces of Spain.

In a new automobile which has been designed for doctors' use, the doctor is his own driver. He sits inside and obtains an uninterrupted view through large glass windows on all sides, the steering and manipulating devices being readily accessible from his seat. Inside the body is also a space for instrument cases and other necessary articles carried by a doctor. There is a headlight, reading light and side lights. The vehicle is an electric one.

Gottlieb Daimler, the inventor of the Daimler motor, died in Germany a short time ago. He became associated with Dr. Otto some thirty years ago, and in their little workshop at Deutz, the Otto gas engine was constructed. Herr Daimler finally started in business for himself and undertook the production of an engine using gas made from petroleum. According to The Automobile the first attempt to construct an automobile at the Daimler works was about fourteen years ago.

A series of eighteen questions has been prepared for the examination of Chicago automobile operatives. Regular examinations are required and the police are instructed to see that the ordinance is enforced. Good eyesight, sound hearing and a stable nervous system are required. The questions relate largely to the special type of vehicle which is to be used, also questions relating to the responsibility of operating a vehicle on the public streets, whether the operator has ever had any accidents or not, etc. The rules and regulations seem to be thoroughly common-sense and ought not to be objected to by anyone. Nothing will hurt the automobile industry more than a series of accidents.

At the recent German military maneuvers, four-wheeled automobiles containing an officer and driver were used, for the most part, for the speedy conveyance of the elderly staff officers, and some of them ran at a speed as great as 30 or 40 miles an hour. In the Franco-Prussian war a hard day's march of twenty-four hours for transport wagons was 50 miles. At the end of each march, the horses were useless. In the recent maneuvers motor wagons traveled at the rate of 7 miles an hour, and a day's work of ten hours was 70 miles. War authorities consider that the day is not far distant when train horses will be replaced to a considerable extent by petroleum motors. The Kaiser takes the greatest interest in this new development, and a number of officers have been set apart to study motors and impart instructions to their subordinates.

A bill was passed by the Wisconsin State Legislature on March 5, 1875, which virtually offers a prize of \$10,000 for an invention. The Motor Vehicle Review recently investigated the law, which was found on the statute books. The first section of the law enacts that the sum of \$10,000 shall be paid to any citizen of Wisconsin who shall invent and, after five years continuous trial and use, shall produce a machine propelled by steam or other motive agent which shall be a cheap and practical substitute for use in place of horses and other animals on the highway and farm. Any machine entering for the prize must perform a journey of at least 200 miles on the common roads of the State, on the continuous line north and south, propelled by its own power at an average rate of at least 5 miles per hour working time. The other sections provide that the vehicle must be of such construction and width as to conform with or run in the ordinary track of the common wagon or buggy and be able to run backward or turn out to accommodate other vehicles. It must also be able to ascend and descend a grade of 200 feet for a mile.