A PHOTOGRAPHIC METHOD OF PRODUCING BAS-RELIEFS.

BY DR. ALFRED GRADENWITZ.

Hitherto photography has been used both in competition with and as an aid to the artist in reproducing life on a flat surface, but a recent development indicates that it will soon invade the field of plastic art. Endeavors to extend the scope of photography to a third dimension date from the earliest days of photography. In fact, as far back as in 1861 M. Willème, a Parisian sculptor, designed a half mechanical, half photographic process for reproducing the plastic form of a model. This process consisted in photographing the model from all sides with a number of cameras, and then using the photographic records to reconstruct the model, probably with the aid of some mechanical drawing apparatus or pantograph. This process soon fell into oblivion because it depended too much upon the skill of the sculptor, and hence hardly deserves the name "photo-sculpture" chosen by its inventor.

Toward the end of last century Selke inaugurated an improvement by substituting for the ordinary photographic camera a biographic apparatus. A shadow gradually progressing in the direction of the latter was projected on the model and the apparatus thus recorded quite a number of silhouettes corresponding to as many parallel cross-sections of the model. These negative records (about 500 in number) were next magnified separately on bromide paper and each of the magnified prints was pasted on cardboard and cut out with scissors, in order by a clever combination of silhouettes to reproduce the relief of the original model. The difficulties inherent to this process, which likewise depended on the operator's art far more than on photography, are too apparent to need being dwelt upon.

Among authorities in the art of photography it has long been held that to reproduce the plastic form of a model by photographic means alone is indeed a hopeless task. And yet the chief element which enters into the present solution of the problem was found many decades ago, in the discovery that a certain gelatine made sensitive to light by the addition of bichromate when immersed in water will lose its capacity of swelling in a measure corresponding to the intensity of its illumination. This phenomenon at first sight would seem immediately to afford a solution of the problem, as the substance in question produces of its own accord a relief, whose depth depends exclusively on light intensity. In fact, a negative plate allows all grades of light intensity to be produced, so that a relief of any desired depth can be obtained. However, such a plate, in order to achieve this result, should be more or less transparent, according as the corresponding portions of the model are more or less in relief, and ordinary photographic negatives do not comply with this condition. There are, in fact, two disturbing factors; for one thing color is bound to exert some influence on the photographic record, so that surfaces in the same plane will come out with different intensities according to their tint. On the other hand, the light effects of an ordinary photograph depend chiefly on the angle of incidence upon the different parts of the model. The same beam of light which, when striking a surface at right angles illuminates an area of say 1 square inch, obviously lights up a far greater surface when arriving at an angle, and as the same amount of light is used for illuminating surfaces of different size, the intensity of the illumination must vary as the size (and hence the inclination) of the surface.

These difficulties, which seemed insurmountable, have been overcome by an Italian engineer, Signor Carlo

Portrait Produced in Bas-Relief by the Photo-sculpture Process.

About to Make an Exposure Through One of the Revolving Disks.

Portrait Produced in Bas-Relief by the Photo-sculpture Process.

Baese. If in a stereopticon a colored glass prism or wedge of small angle be inserted, the thicker portions will absorb a greater amount of light, and the thinner portions will allow more light to pass. This graduated illumination is made to strike the model to be reproduced in the shape of a plastic photograph. If

Revolving Disks Used to Intercept the Light.

the model be photographed with this illumination, owing to the two disturbing factors just mentioned (that is the color and inclination of the surfaces) the gradations produced by the wedge will be practically lost. If, however, another negative be taken after inverting the glass prism and accordingly the direction

of this gradation, those portions which formerly had been struck by the strongest light will now be in a half-shadow, while the remaining portions will be more intensely illuminated. However, this second negative will for the same two reasons fail to show gradation of the prism. Now it will be noticed, that the two negatives, while comprising the given light gradation in opposed directions, are affected by the two disturbing factors in accurately the same sense. Again, as is well known, a photographic print will be

darker, as the corresponding points of the negative plate are brighter or more transparent.

These facts are utilized by Baese in making from one of the two negatives a positive glass print, which obviously is the reverse of the original negative, both as regards light gradations due to the glass

wedge and the disturbing factors which are above referred to. Whereas the two negatives had reversed light gradations and identical defects, the positive plate shows the same light gradations and reverse defects. The two plates can obviously be placed one above the other so as to accurately register. When inspecting this combined picture as a transparency its capacities will be seen to be added, while the defects due to the two disturbing factors are accurately compensated. The combined picture (which for all practical purposes can be regarded as a single picture) now complies with the requirements that its transparency vary directly with the relief of the model and independently of the color and inclination of its surfaces. It can accordingly be utilized for obtaining photographic bas-reliefs on a bichromate gelatine plate.

When the gelatine is exposed below the combined plate, the relief forms very rapidly. As soon as a sufficient relief is obtained, the process is discontinued, when the model can be used for manifolding by any of the well known mechanical or electro-chemical processes. Instead of exposing the whole model at the same time it may be illuminated in sections, reproducing each to a given depth of relief, viz., about one-half inch. A convenient combination of the reliefs corresponding to the various portions of a model obviously allows greatly increased effects to be obtained, the aggregate depth of relief being as many times one-half inch as there are sections separately formed.

While the above description embodies the principle of Baese's invention, the system represented in the accompanying figures is a decided improvement on the original experimental arrangement. Instead of using a colored glass prism, the light gradation is obtained more efficiently by the aid of a rotating disk, out of which there is cut an aperture bordered by a peculiar curve for intercepting the light required for the desired gradation, the opposite gradation being secured with a similar disk showing an inverted curve.

Then, instead of directly striking the model, the light generated by a single electric arc lamp is reflected on the latter by a system of mirrors arranged in a circle, the model, situated in the center of this circle, being lighted with an intensity about thirteen times that of a single lamp. As this intensity always remains the same, and as the plates have always the same sensitiveness, a standard exposure of about 5 seconds can be made, thus eliminating any chances of failure as in ordinary photographic work.

As regards the possible applications of this method of "photo-sculpture," as it is rightly called, it should be understood that it is by no means intended to become a competitor but rather a valuable aid to the real artist, like ordinary photography, which has become so indispensable to both the painter and sculptor. It may further be used for reproducing the original work of the artist in an economical manner, with a practically perfect

A Circle of Mirrors Focuses a Strong Light Upon the Subject Which is to be Reproduced.

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truthfulness and to any desired scale. On the other hand, photo-sculpture will allow plastic portraits to be obtained with all their details. The accompanying illustrations of portraits produced by the photo-sculpture process will give an idea of the possibilities of Baese's method.

Many art industries, such as those producing medals, cameos, brooches, and any other plastic objects from leather, paper, porcelain, terra cotta, etc., will likewise derive great benefit from this ingenious and inexpensive process.

The Beck Isostigmat—A New Photographic Lens.

Some years ago the development of photographic lenses reached a point as near perfection as could be attained with the glass at that time available. Then, as the result of a very thorough series of experiments in glass making, a number of new kinds of glass of different refractive powers were produced at Jena, and enabled opticians to extend widely the capabilities of their lenses. The modern "anastigmat," which gives a sharply-defined undistorted image at or near the margins of the field which it covers, became possible, and was developed by many firms. The wide variety of new glasses available made it feasible to correct the faults of the older types of lenses by various methods; and many anastigmatic lenses were designed and patented by different firms, all attaining to similar results, though not necessarily by the same combinations of glasses or lenses.

The addition of another to the long list of anastigmats is not in itself a matter for comment. The "Isostigmat" invented by Beck is, however, unusual, in that it has been evolved by departing from some of the accepted laws of lens making, and that it gives new power to the photographer in a direction where he has long needed it.

It has long been recognized by lens makers that in order to produce a lens which will give a flat field, free from astigmatism, what is known as the "Petzval condition" must be observed. Perhaps the simplest statement of this condition is that the sum of the focal powers of the individual surfaces, when divided by the product of the refractive indices on either side of the surface, should be zero. To obtain absolutely perfect correction over a small field, this condition must be satisfied. The makers of this new lens have not taken the Petzval condition into consideration, but proceeding along lines of trial and correction, have gradually produced a lens which, while violating theory, has proved a practical advance. The advantage of the "Isostigmat" is that it gives a flat field over a very wide angle, although, according to Petzval's condition, it should show a large error. In a lens covering an angle of 70 deg., theory says that on the margins of a plate the image given by the "Isostigmat" should be half an inch in front of the plate, whereas in fact it is barely one-fiftieth of an inch away, or for practical purposes in sharp focus. With this flatness of field it would seem to be unnecessary to stop down the lens for wide-angle work, as is at present done. Whereas at present many lenses covering an angle of 90 deg. work at $f/16$ or $f/22$, or occasionally as wide open as $f/12$, this new lens may be used without stopping down. A wide-angle lens which will give a crisp negative of architectural subjects when working at $f/6.3$ will prove a most useful addition to the powers of the photographer.

Interest in Safety Devices.

Great interest was awakened in the American Museum of Safety Devices at a dinner given in New York, January 15, in honor of the conferring of decorations by the French government. The fortunate members of the museum's board to be so highly honored were Mr. Charles Kirchoff, editor of the *Iron Age* and Chairman of the Committee of Direction; Mr. T. Commerford Martin, editor of the *Electrical World* and Vice-Chairman of the same committee; and the Rev. Percy Stickney Grant, rector of the Church of the Ascension. These gentlemen are of the highest professional standing, so that it is of interest to know that this honor was conferred for their labors for humanity rather than for their intellectual attainments. The presiding officer was the Hon. Elbert H. Gary, chairman of the United States Steel Corporation, and the other speakers were the Rt. Rev. Henry C. Potter, Mr. John La Farge, Mr. W. D. Dickson, Dr. W. H. Tolman, and Dr. Josiah Strong. There were about 250 gathered to greet the three guests of honor, who were presented by their sponsors, and who replied with appropriate remarks concerning the brave war which they and their associates are waging against industrial accident and disease. Some of the figures mentioned were really appalling. Over fifty per cent more lives are lost in America by accident, each year, than were lost in the Russo-Japanese war. Dr. Strong stated that in the years 1900 to 1904, 80,000 more lives were lost in this country through accidents than in the whole course of the civil war, including the casualties on both sides. Mr. Martin called attention to the fact that the museum was now being rapidly put into shape, and that a part of it had been set aside as an in-

ventor's laboratory, where penniless inventors might work out their safety devices under the protection of the museum. Gilded bronze replicas of the SCIENTIFIC AMERICAN medal were passed around for inspection. The field of this "grand prix" has been limited to that of transportation the first year, and the medal will be awarded for the best device that has appeared or will appear between January 1, 1906, and December 31, 1908. The jury of award is composed of men of international reputation and includes Messrs. Stuyvesant Fish, George Gilmour, John Hays Hammond, Frederic R. Hutton, Samuel Sheldon, Herman H. Westinghouse, and Cornelius Vanderbilt. That the work of these gentlemen will be most painstaking and their findings most just is of course assured. It is pleasant to know that this great humanitarian movement is being backed by men of the highest attainments and in control of some of the largest industries in the world. Surely the wage earner is fortunate in having such powerful allies. From a small beginning the museum is destined to be a power against the often preventable accident, which is an economic calamity.

Aeronautical Notes.

The SCIENTIFIC AMERICAN Trophy for heavier-than-air flying machines will be shortly placed on exhibition in the show window of Messrs. Reed & Barton, Fifth Avenue corner Thirty-second Street.

When the bids for the proposed new army dirigible were opened by Gen. Allen, the chief signal officer, at Washington on the 15th instant, the proposals, which were six in number, were found to be as follows: Carl E. Myers, Frankfort, N. Y., \$9,996; 120 days for delivery. Charles J. Strobel, Toledo, Ohio, \$8,000; 120 days. William Reiferscheid, Streator, Ill., \$5,000; 150 days. Harry B. Schiller, Philadelphia, Pa., \$25,000; 120 days. A. W. Cracy, Washington, D. C., \$12,500; 90 days. John Kairies, Mt. Vernon, N. Y., \$10,000 to \$15,000; no time specified. For an airship capable of making 40 miles an hour, Mr. Kairies bid \$25,000 to \$30,000. Mr. H. H. Curtis, Hammondsport, N. Y., also submitted a bid, but it arrived a day late. But three of these seven bidders furnished the certified check for 15 per cent of the price asked, as required by the War Department, while but two of the three, Messrs. Myers and Strobel, are men who have had much practical experience in the construction of airships.

M. Henri Deutsch's airship "Ville de Paris" was placed at the disposal of the French government immediately after the loss of "La Patrie," and recently, on January 15, it flew from Paris to Verdun, a distance of about 140 miles, in 9 hours time, or at an average speed of 17 to 18 miles an hour, if an hour is deducted for a stop made to effect repairs to the machinery. The first attempt to fly to Verdun was made the day before Christmas, but on account of a strong wind, which was dead against the airship, a speed of only 10 miles an hour was obtained, and the new military dirigible was obliged to return to its shed.

It is likely that the "Lebaudy," the original airship built by Engineer Julliot, and now located at the Chalais-Meudon Aerostatic Establishment, will be put in service in order to replace the "Patrie," and it will be able to render the same services as the latter. The construction of new airships of the "Lebaudy" series is now being actively taken up. Georges Juchmes, who has already commenced work at the Moisson establishment upon the new airship "République," which is of the same type as the "Patrie" and built after the designs of M. Julliot, stated to our correspondent that the "République" does not differ from the former airship except in some improvements in detail, such as some changes in the form of the balloon body and in the arrangement of the plane surfaces. The new airship will have a capacity of 3,600 cubic meters (127,121 cubic feet) and will be equipped with a 70-horse-power motor. The speed and the net load carried on the new model will be greater than in the former case. It is expected to have it finished before next May and even as early as next February.

Natural Ice Making in the Tropics—The Peculiar "Ice Farms" of East Bengal.

BY L. JORDAN.

In hot India, where every day in the year the resident gets all the heat he wants, there are four or five months of the year—November to March—when the nights, although never reaching even to frostiness, can be made to produce many tons of ice in the open.

The fields in which the ice is made are low, flat, and open, and the ice is produced in large lots when the temperature of the air is 15 deg. or 20 deg. F. above the congelation point. The method practiced is an instructive example of keen observation adapted to material purposes by a nation which is to-day ignorant of the science of the thing; that is, they could not explain, if questioned, what actually causes the forming of the ice, beyond a few vague phrases like "the wind," and "keeping the earthly heat down." Yet this same ice-forming process has been utilized in Indasia since the ages that are "lost in the night of time," and all with a scientific observation and accuracy

which the Hindu has acquired by instinct handed down thorough countless generations, but which (as just observed) he is unable to elucidate to a questioning investigator.

The following method is adopted by the Ganges wallas (native coolies) for making ice in the region of the Hugli, near Kalikata, in fields composed of a black loam soil upon a stratum of sand.

The ice plot is a rectangular piece of ground, say 130 feet long by 30 broad, running in an easterly and westerly direction. The soil is removed to a depth of a couple of feet. This excavation, when made, is smoothed, and then allowed to remain exposed to the torrid rays of the sun to dry. Then rice straw in small sheaves is laid in an oblique direction in the hollow (with loose straw upon the top) to the depth of a foot and a half, leaving its surface half a foot below that of the ground.

Numerous beds of this kind are formed (the ensemble constituting the "ice farms"), with narrow sidewalks between them, in which here and there large covered earthen water jars are sunk in the ground for the convenience of having water near by to fill the shallow unglazed earthen vessels in which it is to be frozen. These dishes are 9 inches in diameter at the top, diminishing to 5 inches at the bottom, 1½ inches deep, and ¼ inch thick, and are so porous as to soon become moist throughout when water is placed in them.

During the day, the loose straw in the beds above the sheaves is occasionally turned over, in order that the lot may be maintained in a desiccated state; and the water receptacles between the beds are replenished with soft pure water from the nearby springs. When evening comes, the shallow earthenware pans are placed in rows upon the litter; and, by means of little burnt-tile pots secured to the ends of lengthy bambusa canes, each pan is half filled with water. The quantity, nevertheless, varies according to the expectation of ice; the natives can forecast that by the aspect of the heavens, and the evenness with which the air currents come from the northwest. When favorable, about half a pound of water is put into each little dish or plate; but when less ice is expected, about a quarter pound of water is the usual amount; but, in any case, more water is put into the dishes nearest the west end of the beds, as the yield there is always a trifle bigger.

There are about 5,000 plates in each of the beds, and the ice yield will average, say, ¼ pound from each dish.

In the cool season, when the temperature of the air at the ice fields is under 50 deg. F., and there are gentle breezes from the north and west directions, ice appears in a night in all of the shallow pans. Native watchers are on the lookout to note when a thin film appears on the water in the pans, when the contents of several are mixed together, and sprinkled over the other dishes. This method augments the freezing action. Stagnation has been discovered by the natives to diminish the quantity of ice produced. When the firmament is entirely clear, with zephyr currents from the northwest, the congelation begins before or about midnight, and continues to advance till morning, when the thickest ice is formed. It is often an inch thick, and sometimes the whole contents of the dish are frozen compact.

The ice dishes present a large moist external surface to the air currents, producing rapid evaporation and a lowering of the temperature. The water which percolates through the porous trays exposes so large a surface to the breeze that it is promptly frozen. In addition to the evaporative effect we also have the influence of heat insulation to fall back upon in explaining the phenomenon.

The thick layer of dry straw in the ice beds forms a large surface, which is a poor conductor of heat. The heat can penetrate but a little way into it during the day. So soon as the sun sets, this large and powerfully radiating surface is brought into action, and affects the water in the thin, porous pans, themselves strong radiators.

Some of the natural-ice "farms" of Bengal produce in a single night over ten tons of ice, employing 300 persons of all sizes and ages; and the early morning harvesting of the ice by these lithe gentry darting about, is one of the few animated scenes worth noting in the Ganges region.

The above observations were made by the writer on the spot during journeyings in the Ganges delta over a dozen years ago; and for wide extended and exhaustive data on the subject, with elaborate temperature charts, the reader may refer to the *Journal of the Asiatic Society* (Kalikata: the Institute), Vol. 2, p. 80 etc.; also to the painstaking papers of Dr. Wise, surgeon-general, British army (idem.) Up to a few years ago, this method formed the main ice-supply of Bengal; but the introduction of modern ice-producing plants has largely relegated the industry to purely local requirements. Some sections of our southwestern States, remote from ice-plants, might during a certain period of the year be found suitable for this natural-ice production.