THE NEW BUFFALO HARBOR BREAKWATER.

There has recently been completed at Buffalo a new stone breakwater, which forms the most important section of a long line of breakwaters that extend for 4½ miles to form the artificial harbor of Buffalo. The work just completed has been carried out under the charge of, and according to the designs of, Major T. W. Symons, whose long experience in similar classes of work in connection with river and harbor improvement has been used to excellent effect in the, in many respects, novel and unprecedented work just completed at Buffalo.

At the time that the present work was undertaken there existed the north breakwater, which is built of concrete and extends for 2,200 feet, with a light at its southerly end. Opposite this light and to the westward of it is the northerly end of what is known as the old breakwater, a timber and concrete structure which extends for 7,608 feet. There is a light at the northerly end of the old breakwater, with a harbor entrance between it and the southerly light of the north breakwater. To the south of the old breakwater is the new structure of which we are treating. It consists of a stone breakwater 7,261 feet in length, which connects with a timber and concrete structure that extends southerly for another 2,739 feet, with a light at its southerly extremity. Parallel with the previous structure, and slightly to the westward of it, is a timber crib breakwater 2,803 feet long, which runs northerly from Stony Point. It has a light on its northern extremity, and the opening between this and the last-named breakwater forms the south harbor entrance, the opening between the stone breakwater and the old breakwater being known as the middle harbor entrance. The 7,261-foot stretch of the new breakwater is of the rubble mound type, stone-topped, while the southerly end of it, 2,739 feet, is built of timber crib construction, to enable vessels to moor alongside of it inside of the harbor. The work was done by Messrs. Hughes Brothers & Bangs, of Syracuse.

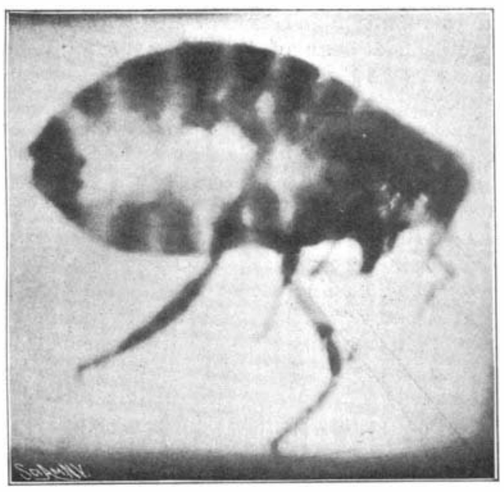

Fig. 2.—PHOTOGRAPH OF A FLEA MADE WITH THE CRYSTALLINE LENS OF A BULLOCK'S EYE

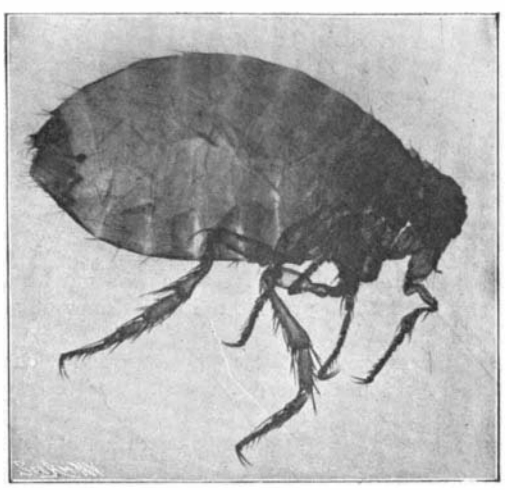

Fig. 3.—PHOTOGRAPH OF A FLEA MADE WITH THE USUAL LENS.

The new breakwater is built in the open waters of Lake Erie, parallel with the shore, 1,500 feet out from the pierhead line of the harbor, and in 30 feet of water. The first operation was to deposit two parallel ridges of small rubble on the lake bottom, one on the lake side and one on the shore side of the proposed breakwater, the intervening space being filled in with gravel. Another five feet of rubble ridges were added and again filled in with gravel, the mound thus formed being raised to within 10 feet of the surface of the water. The breakwater was then built up for the remaining 10 feet to the surface of the lake by dumping upon it large rubble stones. The slopes of the structure were covered with a revetment of large stones, which were lowered into place in close touch with each other, so as to completely cover the rubble stone, the object of these heavy quarried stones being to prevent displacement of the rubble by the action of the water. Then came the important work of covering the mound with large capping stones, which were quarried to prescribed dimensions, many of the stones measuring as much as 6 feet in thickness. These stones were carried out by five large floating derricks, each with a lifting power of 20 tons. The capping stones were laid snugly together, the finished top and side of the breakwater presenting a fairly even and true appearance. The photograph shows very clearly the way in which the top of the breakwater is finished, the heavy top angle stones serving by their weight and friction to prevent the heavy seas from taking hold of the rubble mound, loosening it and washing it away. A cross section of the breakwater as thus constructed shows it to be normally about 140 feet wide at the bottom and 14 feet wide at the top.

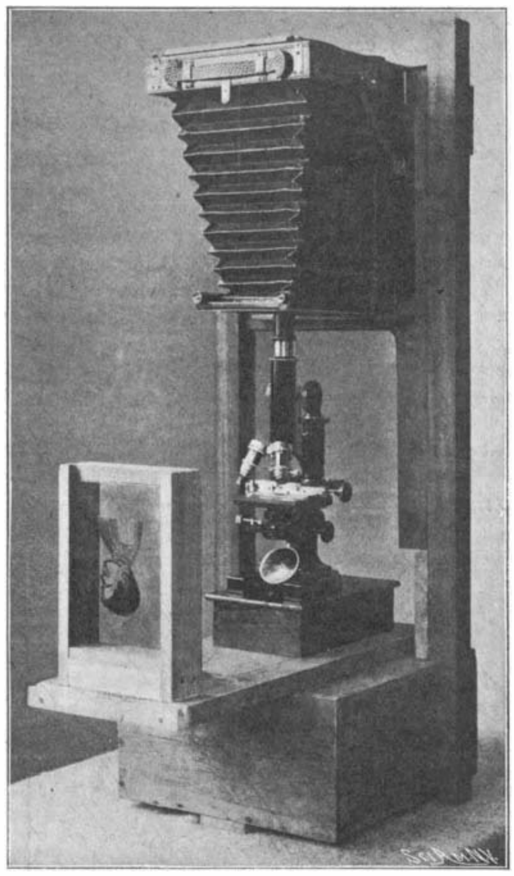

Fig. 1.—APPARATUS FOR MULTIPLE IMAGE PHOTOGRAPHY WITH THE LENS OF A BEETLE'S EYE.

While the masonry breakwater was being constructed, the work of building the timber-crib structure was also going on apace. As compared with the rubble mound type, the timber and concrete form has the advantage of being cheaper in construction. In building it the first step was to prepare a foundation and for this purpose a powerful clam-shell dredge built especially for the work was used to dredge a trench along the line of the breakwater in the bottom of the lake 95 feet in width, and 50 feet in depth through the clay. Then through the center of this trench another excavation was dredged out which was 50 feet in width and extended everywhere to solid rock. The next task was to fill in the trench thus formed with gravel which was brought to the spot in scows and dumped in, a bed of gravel, 30 to 40 feet in depth being formed in this way. Upon this was placed an embankment of rubble stone, 8 feet in height, which formed a foundation for the timber cribs. These cribs were built of sawn timber and were 36 feet in width, 22 feet in height and from 60 to 180 feet in length. They were towed to position over the foundation and sunk by loading with stone. The superstructure was built in three benches, the first 6 feet, the second 10 feet, and the third 12 feet above the mean water level of the lake. Each bench was 12 feet in width.

As shown in our illustrations, a certain portion of the crib breakwater, as finished, is of this construction; but the larger portion of it has been capped with concrete. This was done to strengthen the structure, the heavy gales of September 12 and November 21, 1900, in the latter of which the wind reached a velocity of 80 miles an hour, having loosened up and broken the above-water timber coping and finish. In repairing the ravages of the storm, the damaged superstructure was removed and the cribs were cut down to an elevation of 2 feet below the mean lake level. Upon this, concrete blocks, forming longitudinal and cross walls, were placed, and the pockets thus formed filled in with rubble stone, and roofed in with heavy concrete work, which was carried up to the level of the original breakwater. In place of the three benches of the crib superstructure, the reconstructed portion shows a parapet and a banquette. The parapet which is exposed to the lake side covers a width of 27 feet and its crest is 12 feet above mean lake level. The banquette is 8 feet in width and is uniformly 4 feet above the lake level. The new breakwaters have taken some six or seven years to construct, and the cost has been $2,200,000.

Our thanks are due to Major T. W. Symons for the illustrations and particulars in the above description of this important work.

PHOTOGRAPHIC EXPERIMENT WITH NATURE'S LENSES.

BY PROF. W. F. WATSON.

The eyes of animals possess various devices for the refraction of light and the formation of images upon the retina. The crystalline lens and the cornea appear to be the most important of these devices. When first removed from a large eye, as that of a bullock, the crystalline lens is a beautiful, clear, double-convex lens, about three-quarters of an inch in diameter. But it is quite soft and delicate, and must be handled with great care to prevent its being injured. Fig. 8 shows a crystalline lens which has just been removed from an eye and transferred to a round opening at the center of a square of pasteboard. It is covered with a bell-jar to protect from dust. Figs. 2 and 4 show the results of experiments which were made in attempting to produce photographs by using this natural lens in the camera in place of the ordinary camera lens. The method of making the photograph of the flea shown in Fig. 2 may be described as follows:

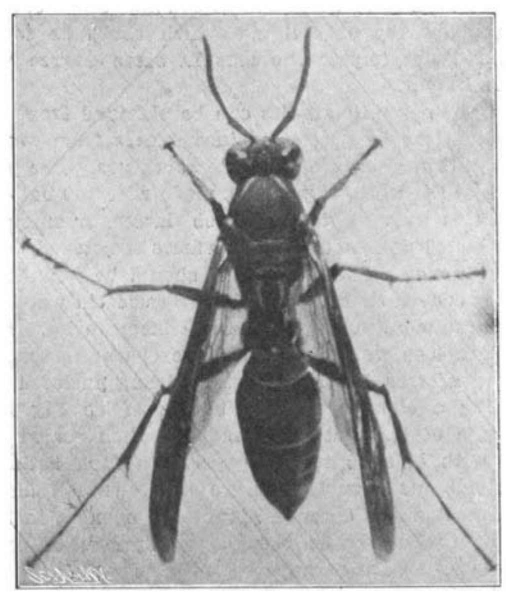

Fig. 4.—PHOTOGRAPH OF A WASP MADE WITH THE CRYSTALLINE LENS OF A BULLOCK'S EYE.

In the center of a pasteboard square a round hole is cut for the reception of the lens. This square is supported in a horizontal position by a wire frame. Its central opening must be less than three-quarters of an inch in diameter, so that the lens will be supported in it but will not drop through. The hole may be cut evenly in the pasteboard either on a microscopist's turntable or with a cork-borer of suitable size. Considerable skill is required in dissecting the eye without injury to the delicate lens, and also in transferring the lens, which must be done with a camel's-hair brush which has been dipped in aqueous humor. The lens is next

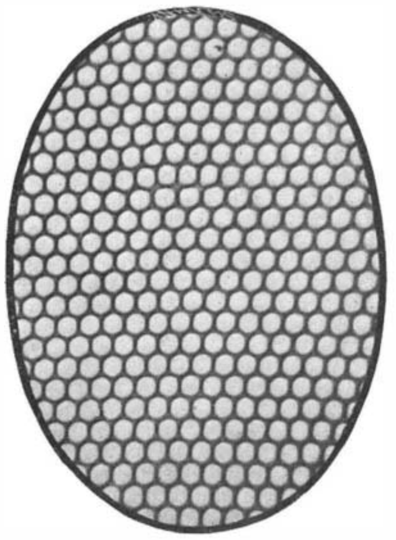

Fig. 5.—PORTION OF THE EYE LENSES OF A BEETLE, USED IN MAKING THE MULTIPLE-IMAGE PICTURE SHOWN IN Fig. 6.

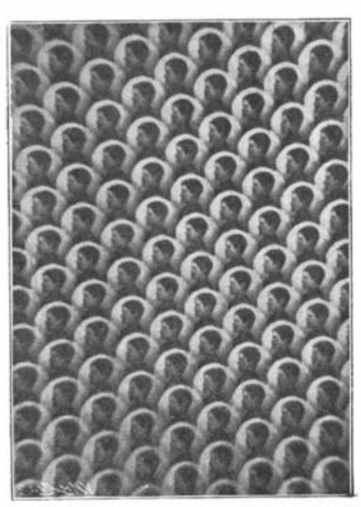

Fig. 6.—PART OF A MULTIPLE-IMAGE PICTURE MADE WITH THE LENS OF A BEETLE'S EYE.

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incased as shown in the upper sectional drawing of Fig. 7. To accomplish this, a small pasteboard pill-box (such as used in drug stores) is quite convenient. With a cork-borer one hole is made in the bottom and another in the top piece. The hole in the shallower piece, which is to go below the lens, should be about double the diameter of the other. These holes will serve as diaphragms. The pill-box parts are cemented to the pasteboard square, inclosing the lens, the shallower part below and the deeper part above, as shown in the lower sectional drawing of Fig. 7. The lower and shallower part should be cemented on the pasteboard square before the lens is placed in position. The camera must be supported pointing directly downward with its lens removed. While in this position the pasteboard bearing the natural lens is carefully inserted in the instrument and the surrounding parts made light tight. All of these manipulations must be accomplished without inverting the natural lens or turning it upon edge, on account of its liability to injury. The object is focused in the usual way and the picture taken by transmitted light. This method was used in producing the imperfect picture shown in Fig. 2. The negative and photograph have not been retouched or changed in any way, as the intention is to show exactly what the natural lens will do under these conditions. Beside it, in Fig. 3, is shown for comparison a photomicrograph of the same object made in the usual way by combining the microscope and camera. The imperfections in the picture produced in Fig. 2 are caused by minute irregularities in the surface of the natural lens. When first removed from the eye, the surface of the lens is very perfect. But upon exposure to air it immediately begins to dry, and thus minute irregularities develop upon its surface. If the surfaces of this lens could be kept moistened, as the cornea of the living eye is kept moistened by the eyelid, very perfect photographs could be made with it. It seems not only possible, but even probable, that if sufficient experimentation could be made on this lens, a method could be found for hardening it, without destroying its original shape and transparency. Experiments so far made, having this object in view, have not been successful. The liquids which were used as hardeners all made the lens either opaque or opalescent. In fact, this lens is very sensitive to the action of liquids in general. In making these experiments, about the only liquid which could be found which did not impair the lens in some degree was aqueous humor.

Good photographic results can be obtained from the crystalline lens by protecting its surfaces from evaporation by thin glasses of suitable curvature. The photograph of the wasp, Fig. 4, was made with the natural lens in this way. Two thin watch-glasses, or crystals, were selected and their inner surfaces moistened with aqueous humor. The crystals, it should be remarked, are more convex than those ordinarily used in watches, and are commonly used in chemical laboratories. The crystalline lens was taken from the eye and immediately transferred to these glasses, being inclosed by them like a clam within its shells. (See Fig. 7.) The edges of the watch-glasses were then sealed together with black, gummed paper. In fact, both of the outside glass surfaces were covered with black paper except a small, round diaphragm opening in the paper at the center of the convex surface of each watch-glass. A lens prepared in this way can be conveniently mounted in a camera in lieu of the ordinary camera lens. It is especially useful for photographing objects which are too small for the common camera lens and yet too large for ordinary photomicrography. The watch-glasses used with the natural lens should be accurate in curvature and free from flaws. Fig. 4 was made, like ordinary photographs, by reflected light. As this lens is of short focus, and must be brought very close to the object, the taste and skill of the experimenter are severely tested in the matter of securing proper illumination of the object for this kind of work.

The corneal lenses of an insect's eye, being very minute, are about as difficult to use in photography as the lenses just described. Possibly the images which they produce are just as perfect as those formed by any lenses, for it is known that the most minute natural objects frequently show the most marvelous perfection. But the difficulties encountered in magnifying and photographing the tiny images produced by these lenses are considerable. The eyes of a single beetle (in some species) have as many as 25,000 lenses, and each lens produces a separate image of the object. There will therefore be as many separate images as there are lenses. Though a large number of images can be photographed with these lenses at one exposure, this number is small in comparison with the number of images produced by the lenses.

The multiple-image picture, Fig. 6, was made by using the corneal lenses of the eye of a beetle. The photograph of a portion of the eye itself is shown in Fig. 5.

The apparatus for making multiple-image photographs is shown in Fig. 1, and the method of procedure may be described as follows:

Prepare a negative of the person whose picture is to be made. This negative is made in the usual way except that it should show very strong contrasts. From this negative prepare a positive by contact in a printing frame, in the manner of making a lantern slide. Support the positive (inverted) squarely in front of the sub-stage mirror of the microscope. Remove the Abbe condenser and adjust the mirror at an angle of 45 degrees. Place upon the microscope stage such an insect eye cornea as will best show multiple images, having previously mounted it as flat as possible with the cover-glass pressed down close to the slip. At first, focus the instrument upon the small lenses, then rack the objective backward from the object. If adjustments are right, the multiple images will now come into view. Open the iris diaphragm a little larger than it is intended to show in the picture, and adjust the sub-stage mirror so as to center the small image in each facet of the cornea. Connect with the camera bellows and place the apparatus in front of a south-view window, where no tree branches throw shadows into the room. Stand the apparatus facing the sun exactly, as any slight inclination to the right or left affects the lighting of the picture unfavorably. The strong sunlight falling upon the positive is modified by placing a plate of ground glass just in front of it. The groove shown in the base just in front of the frame holding the positive plate, in Fig. 1, is for the reception of the ground-glass plate. All extraneous light, not needed for making the picture, should be excluded as far as possible. The multiple images may now be focused upon the ground-glass of the camera. This must be done with great accuracy if good results are obtained. In using the high power lenses it should not be forgotten that the focus of the actinic rays does not exactly coincide with the focus of the light rays. Hence after obtaining the best possible focus on the ground glass with the fine adjustment, the screw should be turned slightly so as to move the objective an infinitesimal distance forward, toward the object. The exposure is made in the usual manner for photomicrographs. The time of exposure depends mainly upon the strength of the light and the degree of magnification of the lenses used. The time of exposure is about one minute and a half.

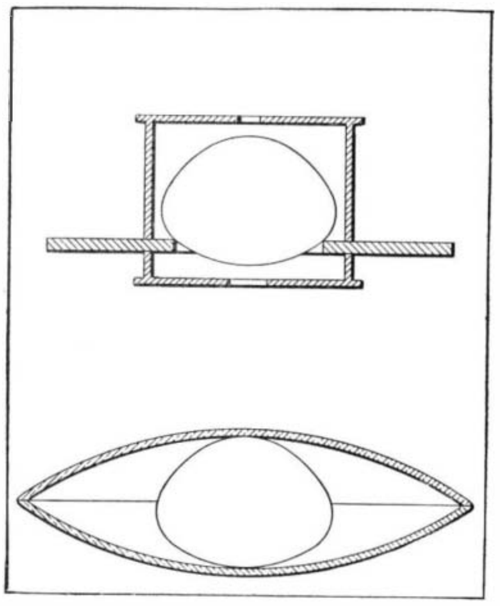

Fig. 7.—HOW THE LENS OF A BULLOCK'S EYE IS MOUNTED FOR PHOTOGRAPHING.

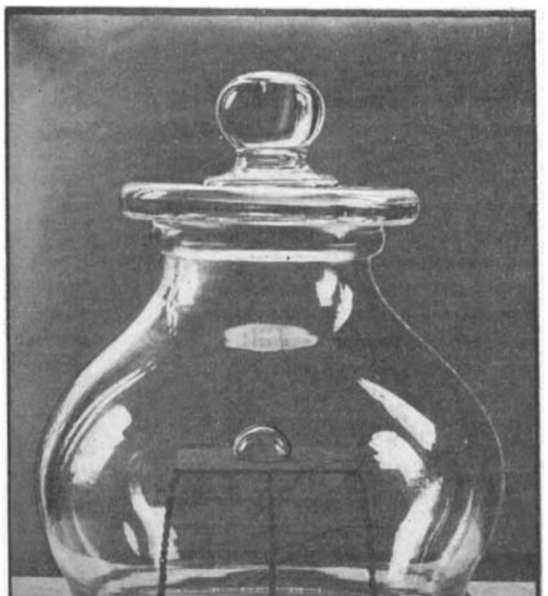

Fig. 8.—CRYSTALLINE LENS OF A BULLOCK'S EYE UNDER A BELL-JAR.

In the development of all plates for multiple-image pictures it is essential to work for a considerable contrast. Ordinary strength developers are quite unsatisfactory for these experiments, as they do not produce sufficient contrast. The best developing agent for this kind of work appears to be hydroquinone.

Discovery of the Tomb of Thothmes IV.

An American archæologist, Theodore M. Davies, has made one of the most interesting archæological discoveries of recent years in the ruins of ancient Egypt. Mr. Davies has succeeded in excavating the tomb of one of the Pharaohs of the eighteenth dynasty, Thothmes IV. In this tomb was found the chariot in which Thothmes rode at Thebes. Mr. Davies himself was not present when the actual discovery was made, that good fortune being left to Mr. Howard Carter, an Egyptian government officer.

Like the other royal tombs in the same valley, Thothmes' tomb consists of a gallery cut in the heart of the mountain.

After sloping downward for a considerable distance it is interrupted by a deep square well, on one of the walls of which is a band of paintings. On the further side of the well the passage turns back, and finally opens into a large chamber, at the extreme end of which is a magnificent sarcophagus of granite covered with texts from "The Book of the Dead."

On either side are smaller chambers, the floor of one of which was found by Mr. Carter to be covered with mummified loins of beef, legs of mutton, and trussed ducks and geese, offerings made to the dead king. Clay seals with the name of the Pharaoh had been attached to the doors of the chambers, and, it is stated, these seals contain proof that the Egyptians of between 3,000 and 4,000 years ago had to some extent anticipated the invention of printing, the raised portions of the seals having been smeared with blue ink before being pressed on the clay.

As Egyptologists know, there could be little hope of finding a mummy in the tomb, since the mummy of Thothmes IV. is already in the Cairo Museum, having been found in the tomb of Amen-hotep II., to which place it had been carried by the priests for the purpose of concealment, probably at some time in the twenty-first dynasty. A great many of the objects in the tomb of Thothmes were found to be broken, and this was explained by a hieroglyphic inscription on one of the paintings which adorn the walls of the vestibule to the chamber in which the sarcophagus was found. This inscription states that the tomb was plundered by robbers, but that it had been restored as far as possible to its original condition by Hor-em-heb, the reigning Pharaoh.

The floor was literally covered with vases, dishes, symbols of life, and other objects of blue faience. Unfortunately, nearly all of them had been wantonly broken, though in some cases the breakage had been repaired in the time of Hor-em-heb. Equally interesting is a piece of textile fabric into which hieroglyphic characters of different colors have been woven with such wonderful skill as to present the appearance of painting on linen.

It is, however, of course the Pharaoh's chariot which is regarded as the great find. The body of it alone is preserved, but in a perfect condition. The wooden frame was first covered with papier mache made from papyrus, and this again with stucco, which had been carved, both inside and out, into scenes from the battles fought by the Pharaoh in Syria. The art is of a very high order, every detail being exquisitely finished and the faces of the Syrians being clearly portraits taken from captives at Thebes. The chariot is, in fact, one of the finest specimens of art that have come down to us from antiquity. Along with the chariot was found the leather gauntlet with which the king protected his hand and wrist when using the bow or reins.

Next Week's Special Automobile and Yachting Number.

With the "fitting out" season for yachtsmen at hand, and with the country roads drying up after the winter's snow, ready for the automobile tourist, next week's large special number of the Scientific American, devoted to automobiles and yachts, comes most opportunely. The number contains just the kind of information wanted by the yachtsman, the automobilist and the public. In its pages will be found a full description of the "Reliance," together with her sheer plan, midship section, and details of her construction; an explanation of the new rating rules of the New York Yacht Club; and an illustrated account of the New York Yacht Club and its magnificent clubhouse. In the automobile section of the number, motor vehicles of all types for all uses are described. An article on automobiles in warfare tells much that is interesting of South African experiences; a full description and many pictures of the gasoline locomobile, the gasoline Columbia, the Cadillac, and other American and French machines will be found of value. Industrial vehicles are represented by motor trucks and an automobile log-conveying sled.

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