able condition, which is not in use, and is willing to part with it for work of national importance at a reasonable price, I should be glad to hear from him the particulars as to type, condition, and price desired. When the war is over machines will return to their normal price—indeed, will probably be at reduced prices, for the war has taught many persons their value, and the market will be wider than it has hitherto been, so that foreign monopolies are certain to be broken down. KARL PEARSON.

Department of Applied Statistics, University College, University of London, July 5.

The Hippocampus in Ancient Art.

REPRODUCTIONS of early figures of the common Mediterranean species of Hippocampus have been published by Prof. Raymond Osburn in the *Zoological Bulletin* for March, 1915, and also by the present writer in the annual report of the Smithsonian Institution for the same year.

It is remarked in the latter of these articles that no mention is found in Aristotle of this striking form of fish-life, and the term "Hippocampus" was used by the poets of classical antiquity as the name of a sea monster, half-horse and half-fish, on which sea divinities rode. Nevertheless, the design of the seahorse occurs not infrequently in the plastic arts of Hellenistic civilisation, both in Greece and in Italy. The seahorse is figured occasionally also among the island gems, as stated by Fürtwangler, who figures one of them (*Antike Gemmen,* vol. i., pl. v.).

Figures of animals, including fishes, represented in ancient Grecian vase paintings have been made the subject of special study by a young French artist, Morin-Jean,[1] and a compatriot of his, P. H. Boussac, has written interesting articles on fish designs inscribed in ancient Egyptian monuments.[2]

FIG. 1.—Hippocampus, from an Egyptian mummy-case, *c.* 500 B.C.

Only one instance is known where the Hippocampus is depicted in ancient works of art from the Nile valley. The design referred to forms part of a decorative painting in the interior of a mummy-case dating from the Twenty-sixth Dynasty (700–500 B.C.), now preserved in the City Museum of Gloucester. A brief description of it is given in vol. ii. of the "Historical Studies" published by the British School of Archæology in Egypt, and this is accompanied by a photograph of the original, which we have copied in the annexed figure.

Certain of the details are thus indicated in the description just referred to:—"The greater part of the Hippocampus is outlined in black on the white ground of the coffin; the ears, the eyes, the nostril, and the mane [*i.e.* conventionalised dorsal fin] are indicated in black; round the jaw is a wide black band edged with yellow; the muzzle is yellow with black dots; the wide horizontal stripes on the neck are alternately blue and red edged with black. . . . The date of the coffin accords well with the period of the archaic Athenian pediments." C. R. EASTMAN.

American Museum of Natural History, New York.

[1] "Le dessin des animaux en Grèce, d'après les vases peints." Pp. 262, illustrated. (Paris, 1911.)

[2] "Les poissons sur les monuments pharaoniques," *Le Naturaliste*, vols. xxxi. and xxxii. (1909–10).

THE HUNDRED-INCH REFLECTOR OF THE MOUNT WILSON OBSERVATORY.

BY the courtesy of Prof. Hale we are able to reproduce the accompanying interesting photographs relating to the giant reflector of the Mt. Wilson Observatory, which is now rapidly approaching completion.

The history of this great telescope dates from 1906, when Mr. John D. Hooker, of Los Angeles, presented the sum of 45,000 dollars to the Carnegie Institution for the purchase of a glass disc and to meet other expenses incident to the construction of a 100-in. mirror for a reflecting telescope of 50 ft. focal length. In making this gift, Mr. Hooker was well aware that the construction of such an instrument was to be regarded as an experiment, but in view of the great possibilities in astrophysical research which a large reflector seemed to offer, the experiment was considered to be well worth making. No insuperable difficulty was anticipated in the casting of a suitable disc by the French Plate Glass Company, of St. Gobain, and there was every reason for confidence in Mr. Ritchey's ability to grind and figure the mirror to the highest pitch of perfection. Experience already gained with the 60-in. telescope also gave confidence that the mounting of the larger instrument could be successfully accomplished.

Although no financial provision was made for the mounting and housing of the proposed telescope, Mr. Hooker's gift was accepted, in the confident belief that in due course a donor would be forthcoming.

An order for the disc was accordingly placed in the autumn of 1906, and the building in which the grinding, figuring, and testing of the mirror were to be carried on was erected during the following winter. In 1908 Prof. Hale reported that a disc had been successfully cast, but in the following year it was stated that on its arrival in California the disc exhibited many defects, and had been immediately rejected. The makers generously expressed their willingness to bear the loss and to make a further attempt. A large furnace and melting-pot capable of holding twenty tons of material were constructed, and improved methods of annealing were introduced. Early in 1910 another large disc was successfully cast, but owing to defects in the mould, strains were set up during annealing, and the disc was broken.

In view of this disappointment it was resolved to make a trial of the disc which had previously been laid aside, and grinding was commenced in the autumn of 1910. Meanwhile, further attempts to cast a disc free from flaws and bubbles were made, but again, owing to difficulties of annealing, a second disc was fractured in the oven. In the course of these trials, however, a flawless disc of the necessary diameter was produced, but its thickness was only 8 in., and this was not considered adequate to prevent deformation, unless a very perfect system of supports could be devised.

Mr. Hooker, unfortunately, did not live to witness any progress beyond this stage, having died on May 24, 1911.

In his report for the year 1912 Prof. Hale had the pleasure of announcing a great additional gift to the Carnegie Institution by Mr. Carnegie, accompanied by the hope that adequate provision would be made for the completion of the 100-in. telescope. Plans for the mounting and for the observatory were accordingly prepared in elaborate detail, and work on the mirror was energetically continued. In addition, a 60-in. plane mirror, to be used in testing the 100-in. at its principal focus, was put in hand. Pending the trials of the mirror, however, actual construction work was not commenced until 1913. The smaller parts of the mounting, including the driving clock, were undertaken in the workshops of the observatory, and the larger by the Fore River Shipyards at Quincy, Mass. The dome, 100 ft. in diameter, was undertaken by the Morava Construction Works in Chicago.

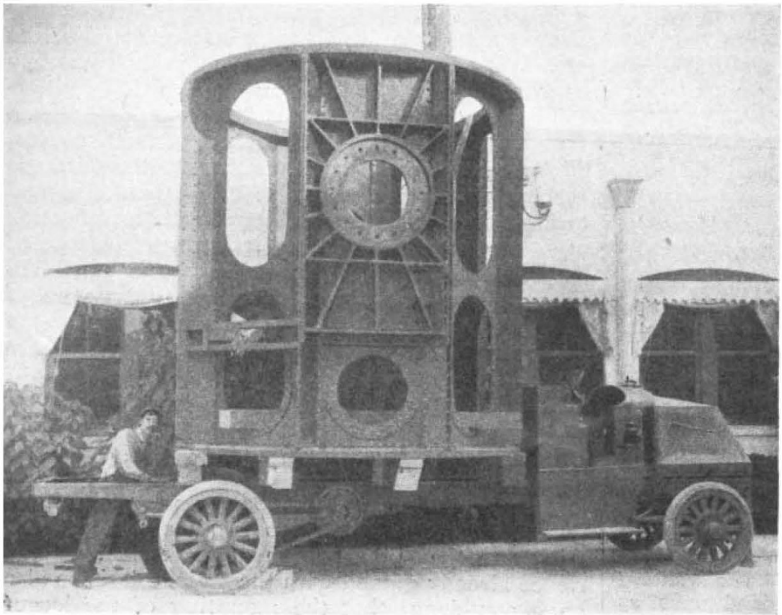

Fig. 1.—Lowest section of 100-in. telescope tube, ready for transportation to Mt. Wilson.

Not the least of the difficulties to be faced was that of transporting materials and heavy instrumental parts to the summit of the mountain, which is about 6000 ft. above sea-level. For about half the distance of nine miles from Pasadena it became necessary to widen the bed of the mountain road from 3 ft. to 8 ft., and special motor trucks, with excess water capacity to guard against overheating the engines on the steep mountain grades, had to be provided. As an instance of the extensive demands on the transportation service, more than 650 tons of steel for the dome, some of the pieces being 24 ft. long, with a maximum weight of 4½ tons, were conveyed to the summit during the spring and summer of 1915. At a later stage, parts of the telescope weighing more than nine tons were safely transported. Fig. 1 shows a section of the telescope tube in course of transit.

All difficulties, however, appear to have been successively overcome, and with the aid of Prof. Hale's annual reports a general description of the instrument can now be given. First, with regard to the great mirror itself. The work of changing the spherical surface into a paraboloid occupied about a year, and for many months tests were made daily, both at the centre of curvature and at the principal focus. In general, the tests at the centre of curvature were found to be most useful in determining the total amount of parabolisation, and under the best conditions of air in the testing room it was possible to determine the radius of curvature of a zone within one-thousandth of an inch. The tests made at the focus, with the aid of the 60-in. flat, were invaluable for detecting and correcting slight zonal errors of surface, and by a combination of the two tests a higher degree of accuracy of surface was secured than would have been possible with either test alone. The parabolising was almost entirely performed by mechanical means, the final figuring by hand tools occupying less than twenty hours.

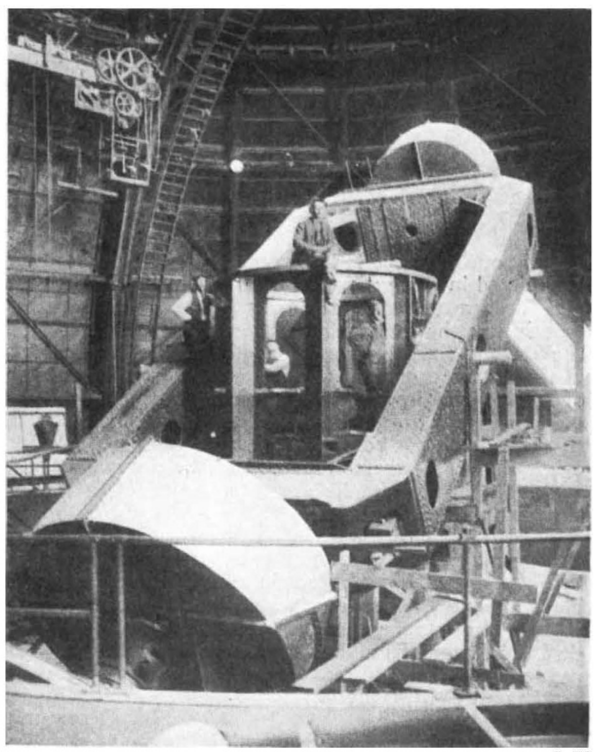

Fig. 2.—Partially erected mounting of 100-in. telescope, December, 1916. (The cutting of the teeth of the large worm gear has since been completed.)

After the final figuring, the Hartmann test was applied photographically, in order to check the visual observations, and to provide a permanent record of the surface. The largest deviation of the observed from the theoretical focal length for any of the zones, except a small useless portion at the centre, was 0·14 mm., or about one part in 92,000.

The clear aperture of the mirror is nearly 101 in., and its focal length 42 ft. $3\frac{1}{2}$ in.; the thickness at the edge is $12\frac{3}{4}$ in. The depth of the curve is about $1\frac{1}{4}$ in., and to some it may come as a surprise to learn that at the centre, where the difference is greatest, the depth of the finished paraboloid differs from that of the nearest spherical surface, which was that first given to the mirror, by only one-thousandth of an inch. The weight of the finished glass is a little more than four tons.

Although the area of the surface to be silvered was 8012 sq. in., this operation was accomplished without difficulty. About 150 gal. of distilled water and 32 oz. of silver nitrate were used in the entire process; 35 gal. of distilled water were required to fill the concavity, and to this 9 gal. of dilute silver solution and 9 gal. of dilute reducing solution were added. Deposition was complete in fifteen minutes.

Two convex mirrors have been prepared for use with the large mirror. One is $28\frac{3}{4}$ in. in diameter and more than $6\frac{1}{2}$ in. thick; it has a radius of curvature of 28 ft. $10\frac{3}{4}$ in., and in Cassegrain combination will give an equivalent focal length of about 150 ft. The second convex mirror, to be used alternatively, is 25 in. in diameter, with a radius of curvature of about 22 ft. 11 in., giving an equivalent focal length of 251 ft. when in combination with the large mirror. We believe that arrangements have also been made for observations at the principal focus.

Few details of the mounting have been given in Prof. Hale's reports, but from the photograph reproduced in Fig. 2 it would seem that the "English equatorial" construction has been adopted. In this arrangement, the polar axis takes the form of a long rectangle, turning on an axis parallel to the longer sides, and the telescope tube is pivoted so as to turn on an axis parallel to the shorter sides. These two movements correspond respectively with motions of the telescope in Right Ascension and declination. The illustration shows the polar axis, with one of the sections of the tube in position. The tube is in four such sections, and has a diameter of 11 ft. The greater part of the pressure on the bearings, due to the immense weight of the moving parts, will be relieved by the flotation method first introduced by Dr. Common, and afterwards adopted for the 60-in. reflector at Mt. Wilson. Large circular floats, concentric with the polar axis, are provided for this purpose, one at the top and another at the bottom of the polar axis. As will be seen in Fig. 2, in the case of the lower float, each of these revolves in a nearly semicircular trough, and the intervening space will be filled with mercury. The driving clock is described as a highly perfected piece of mechanism. It required more than half a ton of bronze castings, and nearly $1\frac{1}{2}$ tons of iron castings. It is provided with a driving weight of two tons.

The pier which supports the telescope measures 20 ft. by 45 ft. at the ground level, and is 33 ft. in height. The top consists of a circular concrete floor 11 in. thick and 54 ft. in diameter, being supported on the east and west sides by massive reinforced-concrete brackets extending outwards from the pier. A metal wall about 8 ft. high reaches from the edge of this floor to the level of the main steel floor of the building, and the joint between the two may be made air-tight by means of a water seal if found desirable. The pier itself is a remarkable structure. It is hollow in construction, with three heavily reinforced floors at different elevations. The first, at a distance of 16 ft. from the ground, is intended for a large water tank, to form a reservoir for a water circulation system enveloping the 100-in. mirror for the maintenance of constant

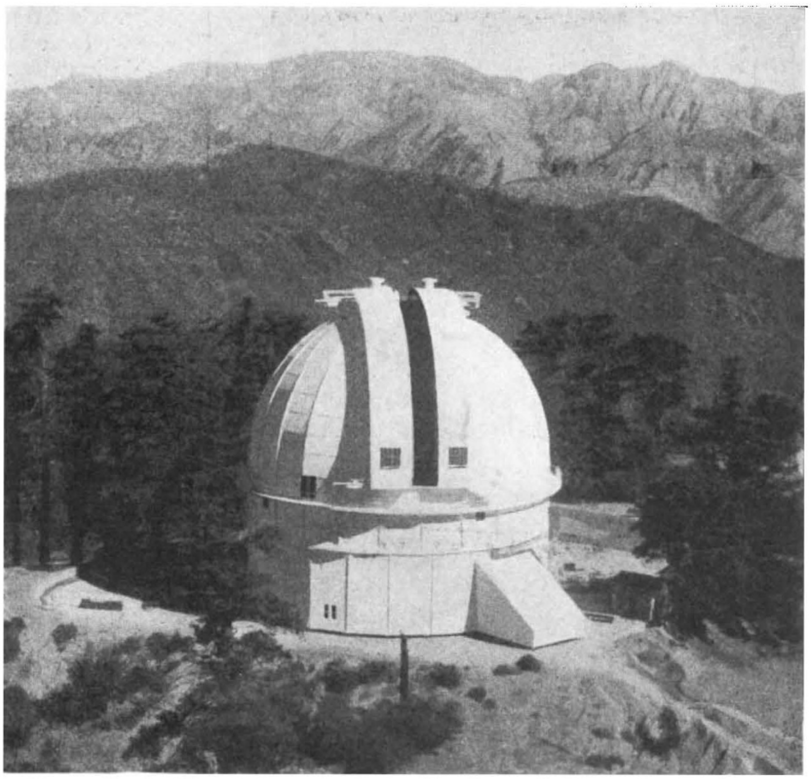

FIG. 3.—Completed dome for the 100-in. telescope, from the summit of the 150-ft. tower telescope.

temperature. At a height of 25 ft. is the floor which supports the driving clock and other parts of the mechanism, and on this floor also is a room designed for silvering the large mirror. Near the centre of the pier there is an opening, 14 ft. in diameter, which accommodates an electric elevator for handling the mirror.

On the south side of the pier is an extension, with a slope equal to the latitude, designed to carry large spectrographs when the instrument is used in *coudé* form. It is large enough to permit the use of a concave grating of 21 ft. radius, or a plane-grating spectrograph of 30 ft. focal length, the light being received through an aperture in the lower portion of the polar axis.

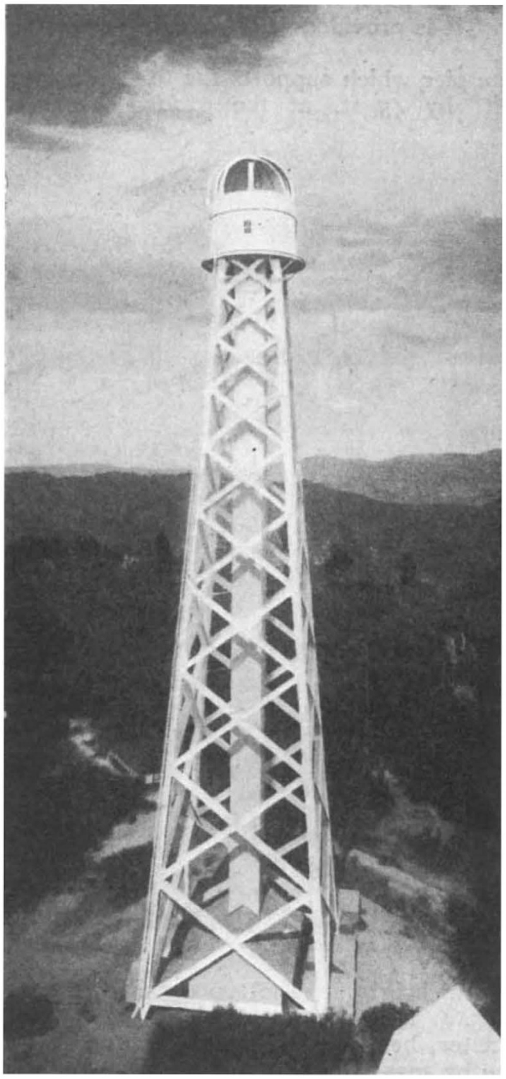

FIG. 4.—The 150-ft. tower telescope, taken from the summit of the 60-ft. tower telescope.

The foundations for the building consist of forty concrete piers, each 6 ft. square at the base and 6 ft. high, arranged in two concentric rings. The sides consist of a steel framework, with an inner covering of sheet metal. The dome (Fig. 3) is 100 ft. in diameter, and is double-sheathed for protection of the telescope against great changes of temperature. An unusual permanent feature of the dome is a ten-ton travelling crane, which has also been utilised in the work of erection. The movements of the dome and telescope involve the use of no fewer than thirty-five electric motors, and the wiring proved to be a task of very considerable difficulty.

This brief account may suffice to give some conception of the immense amount of technical skill and foresight which has been called for in the design, construction, and housing of the new telescope. That the enterprise may be rewarded by a rich harvest of new discoveries will be the earnest hope of all who are interested in the progress of science.

Fig. 4 is from a recent photograph of the 150-ft. tower telescope of the Mt. Wilson observatory. In this instrument a beam of sunlight is reflected in a vertical direction by a cœlostat situated within the dome, and an image of the sun is formed at the base of the tower by an object glass near the summit. The special advantage of this arrangement arises from the fact that the greater part of the optical path is removed from the disturbing atmospheric conditions which are usually present at the ground level. The 75-ft. spectrograph, and other appliances used with the telescope, are contained in a deep pit beneath the tower, and constant temperature is easily maintained under these conditions. An important feature of the construction of the tower is that there is an inner framework which supports the optical parts, and an outer casing designed to protect the inner tower from disturbances by wind.

MATERNAL AND CHILD WELFARE.[1]

THE two handsome volumes before us, published under the auspices of the Carnegie United Kingdom Trust, are the most recent proof of the rapidly increasing attention and importance attaching to the subject of maternity and child welfare. The need for attention to the conditions of birth and the rearing of children has impressed itself upon the public in large measure in consequence of two considerations, the steady and persistent fall in the national birth-rate and the terrible loss of the most virile part of our population in the present great world-war.

The first volume, by Dr. Hope, the well-known medical officer of health of Liverpool, gives a general outline of the subject. In fifty-six pages he sketches the chief causes of maternal and infant mortality, the facts as to its national and local incidence, and the various organisations for the care of mothers and infants. Ante-natal care is considered, and the importance of further attention to the prevention of still-births is emphasised. The care of mothers during the lying-in period and after it, and the general subject of infant

1 Report on the Physical Welfare of Mothers and Children. England and Wales. Vol. i., pp. xvi+434. By Dr. E. W. Hope. Vol. ii., pp. viii+190. By Dr. Janet M. Campbell. (The Carnegie United Kingdom Trust, 1917.)