The Proposed New 200-Inch Telescope.

IT is now common knowledge that plans for the construction of a 200-inch reflecting telescope are being worked out at Mount Wilson observatory. This enterprise has been rendered possible by the generosity of the International Education Board, which in May 1928 authorised its executive committee to provide for the construction of an astrophysical observatory equipped with a 200-inch reflecting telescope and auxiliary instruments. The proposed new observatory is to be conducted in close co-operation with Mount Wilson and the increased light-collecting power of the 200-inch telescope should permit further studies of the size and structure of the galactic system, of the spectra of the brighter stars under very high dispersion, and of many other important problems. A short account of the plans for the 200-inch in so far as they have matured will interest many readers of NATURE. More complete details are given by Prof. Hale in an article in the November number of *Harper's Magazine*, the source from which the substance of the present article has been drawn.

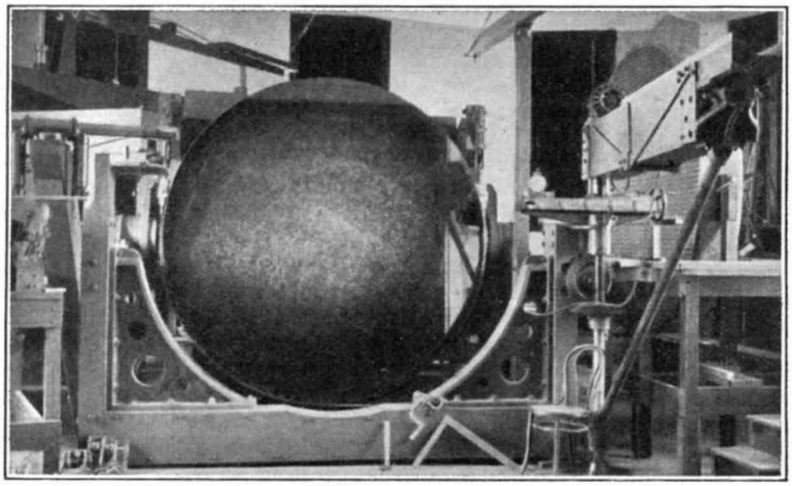

FIG. 1.—The 101-in. mirror in the vertical position for optical testing.

In the construction of the new instrument the experience gained in constructing the present 100-inch instrument at Mount Wilson will naturally be of great assistance, and it will be helpful to recall some of the difficulties met with in the construction of the smaller instrument. The greatest troubles were in the construction of the mirror itself. It is obviously desirable to secure a disc of glass which is free from internal flaws, but in the case of the 100-inch the disc which was finally used was one which was delivered in 1908 and was rejected at the time. It was only after further attempts to produce a suitable disc had failed that the present mirror was figured from this rather unsatisfactory disc. The disc in question was full of bubbles, as can be seen from Fig. 1, which is reproduced from a recent memoir by G. W. Ritchey.[1]

[1] "The Development of Astro-Photography and the great Telescopes of the Future." Publié sous les Auspices de la Société Astronomique de France. 1929.

The chief difficulty in the construction of very large discs of glass arises from the fact that they suffer devitrification during the weeks or months required for the slow cooling known as annealing. This leads to loss of rigidity—a serious defect. Furthermore, glass is a poor conductor of heat and consequently the outer parts of a large silver-on-glass mirror change in temperature more rapidly than the inner. The curvature of the surface is thus affected, and this means that the stellar image, instead of being nearly a point, may often be expanded into a much less brilliant disc. This defect can in the case of existing mirrors be partially removed by the provision of constant temperature water jackets and a similar plan might conceivably be adopted in the case of the 200-inch, but the difficulties clearly increase with size. It seems probable that a limit has already been reached in the construction of large mirrors of solid glass.

Prof. G. W. Ritchey has recently advocated the construction of cellular mirrors, constructed by

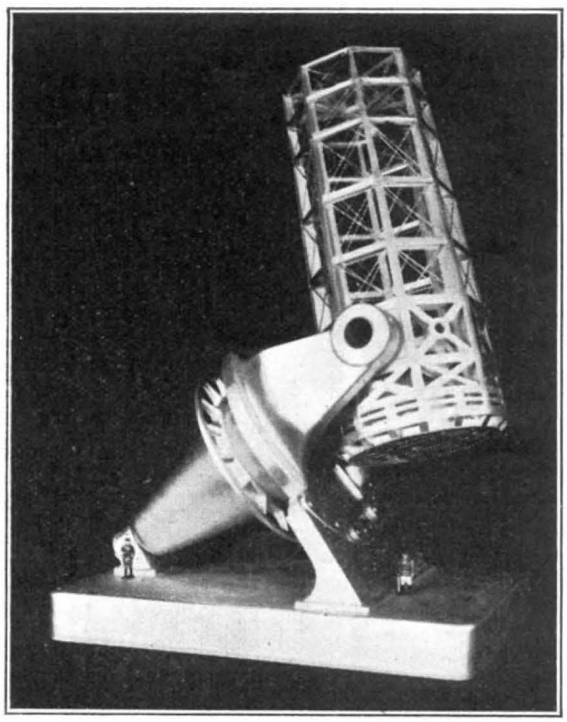

FIG. 2.—Tentative model of 200-inch telescope for the California Institute of Technology. Made by the Warner and Swasey Company after preliminary designs by E. P. Burrell and Francis G. Pease.

building up a kind of honeycomb from thin glass plates, and this plan has been considered at Mount

Wilson by Prof. Hale and his collaborators. Its adoption, however, has not been favoured, on account of the difficulty of figuring with optical perfection the thin glass faces and the edges of the honeycomb structure. In addition, doubts have been entertained as to the optical permanence of a heavy cemented structure subjected to wide ranges of temperature.

The plan which at the present moment appears most promising to the astronomers concerned is to make the mirror of fused quartz, a substance which possesses a very small temperature coefficient. The process consists of fusing a mass of nearly pure silica in a circular electric furnace which constitutes the mould. The disc thus obtained contains a large number of small bubbles, but it can be ground to the approximate curvature of the mirror desired and then coated to a sufficient thickness with perfectly transparent quartz free from bubbles. The final figuring is then carried out on the surface of this clear layer. The quartz composing the clear layer is sprayed on to the hot disc by means of multiple oxy-hydrogen burners. A 22-inch disc has already been constructed in this way, and it is now proposed to make a 60-inch mirror before finally embarking on the construction of the 200-inch mirror itself.

With regard to the figure of the mirror, it has been decided to construct it with a focal length of 55 feet, that is, with a focal ratio of *f* 3·3. The use of such a small focal ratio will give an immense concentration of light, but in common with all short focus mirrors the field of good definition will be small. It is proposed to remedy this defect by the use of a correcting lens, designed by Dr. F. E. Ross, which will be placed immediately in front of the photographic plate at the principal focus of the 200-inch mirror. Dr. Ross has in addition to this computed a correcting lens which will, it is hoped, reduce the equivalent focal ratio to *f* 2·2. Provision will also be made for a Cassegrain arrangement with an equivalent focal ratio of *f* 10. The convex mirror in this arrangement will be 60 inches in diameter.

The telescope will be mounted equatorially. The problem of the mounting will be an engineering enterprise of no mean dimension, and the lessons learnt and the difficulties met with and overcome in the mounting of the existing 100-inch telescope will doubtless be invaluable in this connexion.

Considerable attention is being paid to the selection of a suitable site. It is highly important that the efficiency of the 200-inch should not be impaired by poor seeing arising from atmospheric tremors. The experience gained with the 100-inch has shown that at Mount Wilson itself a 200-inch telescope could be depended upon to show a gain in keeping with its increased size. It is, however, probable that a still better site can be found in California, and the possibilities are being explored by observations at various sites with portable telescopes.

One of the proposed models for the 200-inch telescope, which is now on exhibition in the building of the National Academy of Sciences, Washington, D.C., is shown in Fig. 2. It should be mentioned that the plans include the provision of an adequate laboratory and workshop. W. M. H. G.

The Locust Problem.

By Dr. A. D. IMMS, F.R.S.

THE theory of the phases of locusts, advanced by B. P. Uvarov in 1921, is now well known to entomologists and has proved a fertile stimulus to further investigation of this important problem. It recognised the existence among these insects of two definite or extreme forms—one gregarious and the other solitary — which are connected by a continuous series of less defined transitional forms. Messrs. B. P. Uvarov and B. N. Zolotarevsky[1] have recently discussed certain aspects of the problem, in the light of new observations made by S. A. Predtechensky in Russia, and by the junior author in Madagascar. Although their remarks apply more especially to the well-known species *Locusta migratoria*, these authors believe that a standard phase nomenclature, applicable to all species, would be both possible and advantageous. According to their interpretation a locust can exist in three unstable biological phases, namely, a solitary one, *phasis solitaria*: a gregarious one, *phasis gregaria*, and a transitional phase between these two which they term *phasis transiens*. These phases differ from each other in morphological and colour characteristics, on one hand, and in biological features (mainly behaviour) on the other. Whether it will prove possible to distinguish such phases solely by the convenient method of examining their morphological characters, can only be determined by studying the whole series of phases of a given locust in a specific locality.

The solitary phase consists of isolated individuals and is represented where no swarms exist, or have existed, within at least one preceding generation. The transient phase is not represented by any definite form, but by a continuous series of transitional forms between the solitary and gregarious phases. Such a series may be observed either (*a*) when the transformation is from the solitary phase towards the gregarious phase, when it may be termed *phasis congregans*; or (*b*) the tendency is in the opposite direction, when it is termed *phasis dissocians*. These two phases are, therefore, essentially of a biological nature, but it appears that it may be posssible to distinguish them also by minor details of structure and colour. The gregarious phase is that assumed when individuals form dense and extensive emigrating swarms (Fig. 1). Recent studies of *Locusta migratoria* have shown that, although this species is a very

[1] Phases of Locusts and their Interrelations. *Bull. Entomological Research*, **20**, pp. 261-265, Oct. 1929.