The exhibits were housed in the Civic Auditorium in Columbus, Convention Headquarters of the A.A.A.S., and were open from December 27 to 30, 1939. The writer wishes to express his sincere appreciation of the assistance accorded him by Professors Paul Herget, J. J. Nassau, and H. D. Curtis in planning and arranging the displays. He is also greatly indebted to the directors of the various observatories whose coöperation made possible the exhibition.

Perkins Observatory, Delaware, Ohio.

The New Goethe Link Observatory

By VICTOR E. MAIER

The State of Indiana has needed more facilities for modern work in astronomy. In order to meet this need this institution was established in its entirety by Dr. Goethe Link, an Indianapolis surgeon. The observatory stands on a high bluff near Brooklyn, a small village about twenty-five miles southwest of Indianapolis.

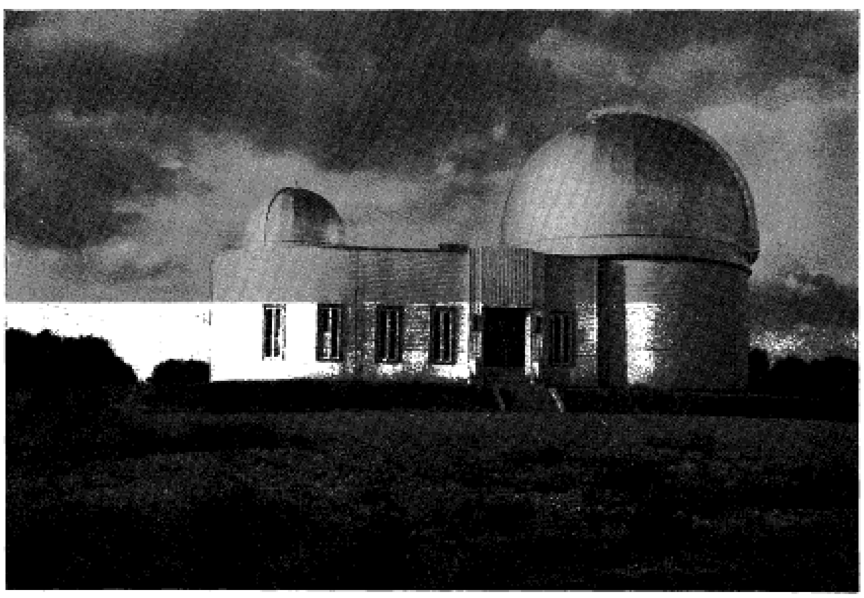

Figure 1
Goethe Link Observatory, Brooklyn, Indiana

The location is an admirable place for an observatory. From it the landscape is visible for many miles in all directions. It is approached by an auto road that includes a steep hill nearly a mile long. This is a rarity in Indiana which has mostly flat country. On clear nights the transparency of the atmosphere is excellent for astronomical work. The location is far enough from Indianapolis to escape the lights and smoke, but close enough to make efficient city connections. Further, it is situated near the geographical median of a number of colleges and universities in the state.

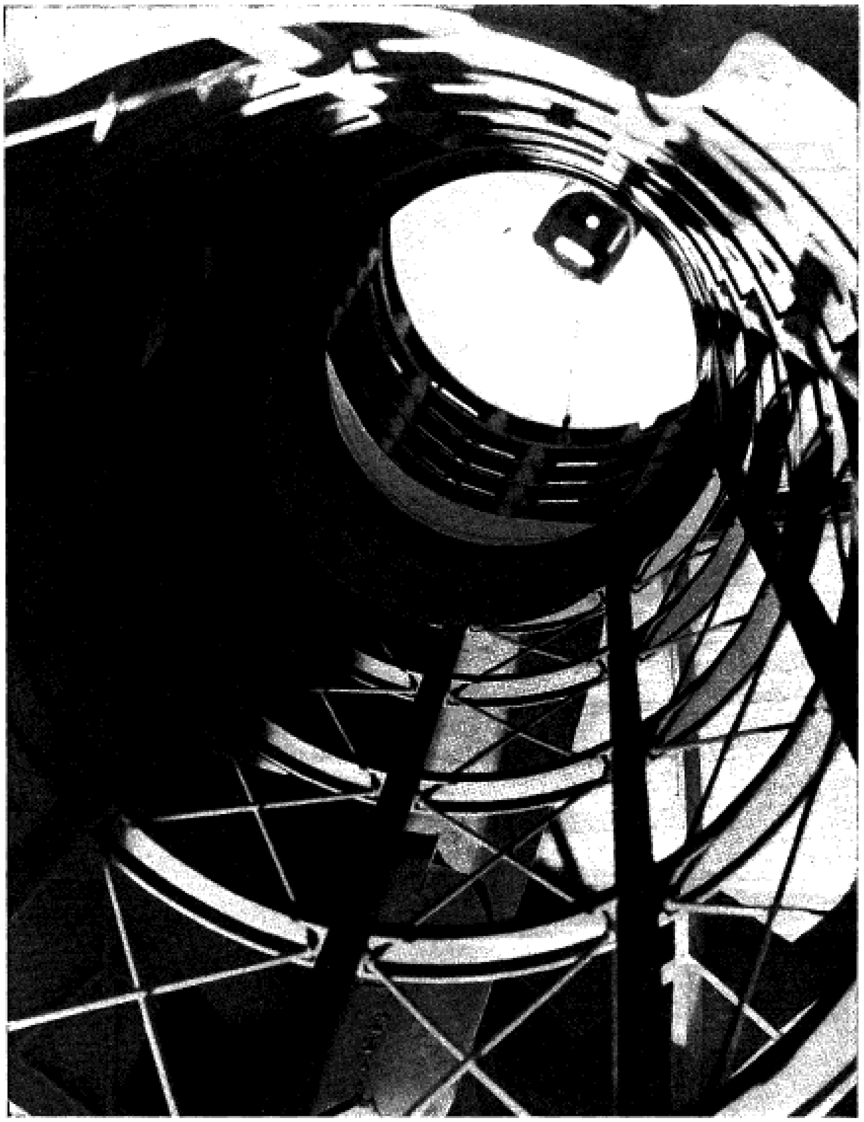

FIGURE 2

VIEW DOWN THE OPTICAL TUBE OF THE GOETHE LINK REFLECTOR. This shows the method of covering the mirror: with a stainless steel sheet that bends to the curve of the inside of the tube when open and flattens when it is closed. The photograph also shows the method of "tuning" the aluminum optical tube.

The observatory and its equipment were made by men in the Indianapolis area under the supervision of the writer. Work on the project was started when it was learned that the Corning Glass Works had a 36-inch mirror blank on hand, after they had shipped the 200-inch blank and its auxiliaries to California. The glass, similar in pattern and material to the 200-inch giant, was purchased through Mr. Carl Turner, an Indianapolis telescope builder. Everything else was designed to fit in with the 36-inch reflector, the principal instrument at the observatory. In both its design and construction its builders have tried to include the best features of other observatories along with many innovations.

The construction work arranged itself into four branches, all of which were started early in 1937. A grinding machine for large optical surfaces was designed and built by Mr. Turner. Mr. Charles Herman, a local mirror-maker, was given the task of finishing the parabolic surface. Mr. Turner and his associate, Mr. Klaisler, then turned their attention to the work of building the telescope mounting. Designs for the observatory building were done by Messrs. Tislow and Pittman, and the construction work by Mr. C. F. Bowers. Two and a half years were required to complete the work.

The telescope has a focal length of five times the diameter of the mirror. The mounting is the "German" counterbalanced type, selected as giving the greatest number of advantages. In appearance the telescope is similar to others of its size, but in its construction two basic departures from past practice were undertaken which have been found to be very satisfactory. Heretofore, nearly all telescope mountings have been made of cast iron parts, each part especially molded to fit its particular use. But in this instrument the new techniques developed in electric welding and oxy-acetylene cutting were used as much as possible. With this method, parts of any shape and description can be quickly made up from steel pieces purchased at any warehouse. Braces can be interposed where they are most needed. Great strength without great weight is therefore gained.

The other basic difference between this mounting and others is embodied in the concrete pier. The pier has the conventional curved yoke at its top in which the polar axis turns, but the bearing trunnions are bedded directly in the concrete. This has the effect of making the pier an integral part of the telescope mounting, and requires that the concrete be very accurately set on the earth's surface. Accordingly, excavation was made to bed rock, and the pier started there. The altitude of the pole and the direction of the meridian were accurately determined by observations made on stars with a transit instrument. Readings were made on the concrete every hour while it was hardening. It has since been found that the pier was set within one millimeter of the correct position even though it weighs 200 tons and its top extends thirty feet above the ground level. Its base measures 9x17 feet. It is hollow, and provides an excellent fireproof "strong-box" on the first floor of the observatory.

After the pier was finished, the building was erected around it, care

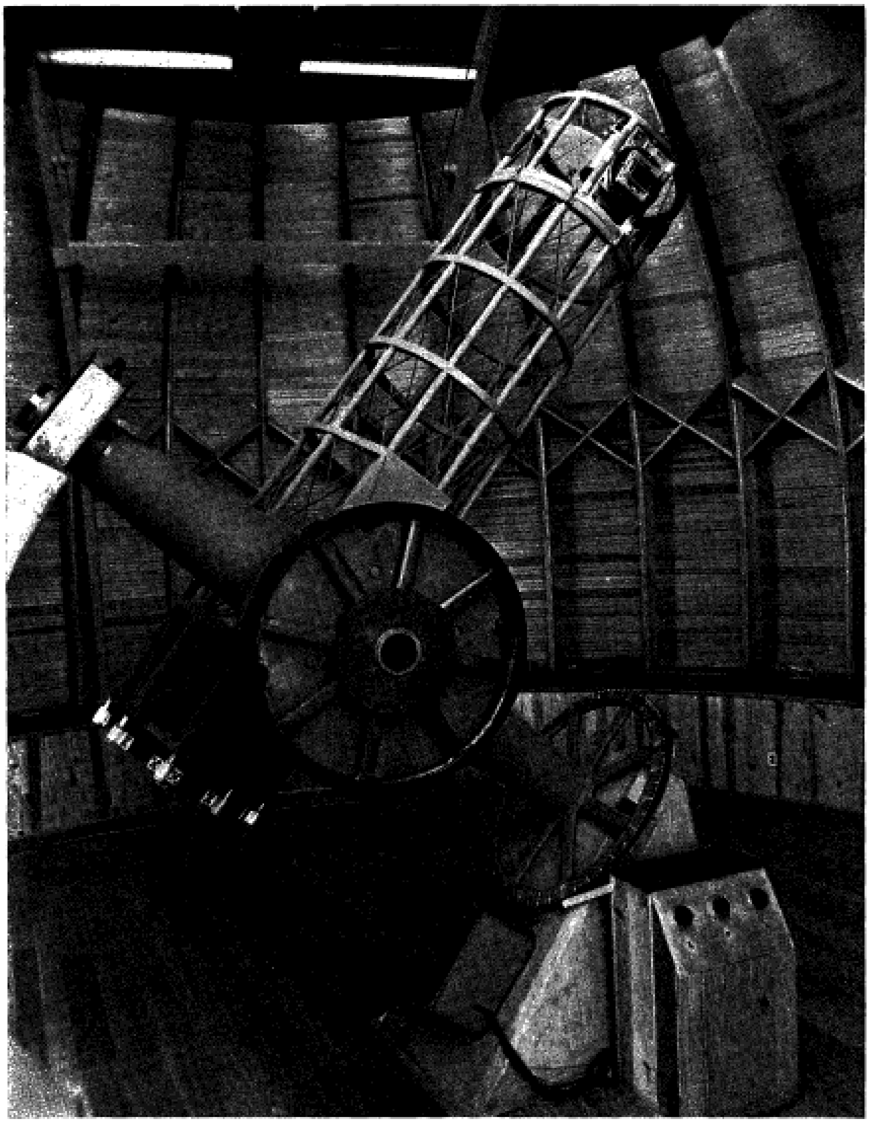

FIGURE 3

INSIDE THE LARGE DOME SHOWING THE REFLECTOR WITH NEWTONIAN FOCUSSING ARRANGEMENT AND DOUBLE-SLIDE PLATEHOLDER.

The electric driving unit is shown in its shatterproof glass case in mesh with the RA worm gear. Corners are blurred because of the extreme wide angle necessary to include the instrument. Floor controls are in right foreground.

being taken to keep them separated. The frame of the building is made of massive oak posts and beams that were cut from the forest a few miles from the observatory. The interior is finished with hardwood floors, panelled knotty-pine walls, and beamed panelled ceilings. It presents a pleasing, beautifully finished, rustic appearance. A hardwood spiral stairway leads to the upper floor and the large instrument. Another stairs opens on the roof, and allows access to the small dome.

Nearly half of the first floor is taken up by an auditorium with a seating capacity of 150 persons. The remainder contains a darkroom, astronomical laboratory and workshop, and living quarters for the staff. The building is not heated, but the living quarters and workrooms are kept comfortable in cold weather with electric unit heaters. These rooms are well insulated and the temperature in them can be raised from subzero to 75° Fahrenheit in a few minutes. Air currents that disturb the seeing are kept at a minimum with this method of heating. Electric power is purchased from the local utility, but the observatory has its own water system and fire protection. The large dome is always at the same temperature as the outside air.

The dome is 34 feet in diameter, and is provided with an opening eight feet wide, nearly three times as wide as the mirror. The length of the opening extends four feet past the zenith. Work near the zenith is convenient in any position of the dome. Two long shutters, weighing one ton each, cover the opening. They open and close at the push of a button. The dome is clad with steel terneplate and aluminum paint. Although its moving weight is 34 tons, the dome is rotated easily with a one-half horsepower electric motor activated by toggle reversing switches. The shutters and the dome are from Mr. R. W. Porter's design. He generously sent one of his famous "thumbnail" sketches from Mount Palomar.

The observing platform in the Goethe Link Observatory is a notable piece of equipment. Two long steel arches span the inside of the dome, and the floor of the platform is hung from them. The entire unit is independent of the dome, but rotates with it. The arches were made strong enough not only to hold the platform and its raising mechanism, but to contribute to the rigidity of the dome and the entire structure. The platform has a capacity of six persons and is run with electric power. Many of the ideas incorporated in this platform are those of Dr. Carpenter at Tucson, Arizona, who helped in its design.

The small, fourteen-foot dome houses a Zeiss apochromatic refractor. This instrument has a full complement of accessories, and is used for visual work. It affords beautiful views of all the familiar celestial objects. Its dome is a descendant of the well-known Burnham dome. It opens halfway, permitting the observer a view of half the sky at one time. Unlike the Burnham dome, this one is made entirely of steel, electrically welded into but two pieces. In order to reduce the heat of the summer sun, the inside is treated with a special insulator that was sprayed on with a hose. The Zeiss refractor has an aperture of 130 millimeters, and is one of the very few fully corrected instruments in America.

While all these things were being assembled, the mirror and the mounting for the large reflector were being finished. Grinding and polishing were accomplished in the conventional manner in about ten months. The difficulties of figuring were eliminated one by one until the final, necessary perfection was reached. Many tests, both visual and photographic, were made to determine the accuracy of the finished surface. The Hartmann test yielded a "Hartmann criterion" of .066. (This figure is derived from Professor Hartmann's equation used in the test. It is essentially the diameter of the star image in seconds of arc, as produced by the mirror's surface.) The visual tests showed the surface to be even better. The result ranks the glass as one of the most accurately figured mirrors ever made. It was aluminized in Chicago by Mr. Clausing. The 12-inch Newtonian diagonal, recently completed, is flat to within one-tenth wave-length of red light.

The large reflector mounting contains many new ideas, only a few of the most outstanding of which can be mentioned here. The welded steel axes are fitted with Timken precision bearings eight inches in diameter. Two large gears, that were made off the same pattern, control the motion in right ascension and declination. The right-ascension gear has a bronze ring shrunk on its perimeter into which 400 worm teeth are cut. The declination gear has a ring of internal teeth fastened to its side. The gear and setting circle are incorporated in the same piece. The saddle, to which the optical tube is fastened, is made up of a number of small steel pieces welded together. It is very strong and rigid.

In order to gain lightness and ease of control, the optical tube and all its accessories, are made of an aluminum alloy called Lynite. The tube itself contains over 500 pieces all of which are drawn together by an ingenious arrangement of tension struts. The arrangement allows the tube to undergo temperature changes without twisting, and reduces flexure to a negligible amount. The upper section of the tube rotates and allows the plateholder to be set in any desirable position. By using aluminum for the optical tube, welded steel for the rest of the mounting, and ribbed Pyrex for the mirror, over 5000 pounds have been spared from the moving weight of the assembly. As it is, its moving weight is 5200 pounds. The heaviest single piece is the 2000 pound counterweight, which is attached directly to the polar axis.

The telescope is controlled entirely by electric motors. Dual controls are mounted on the floor of the observatory and the observation platform. The high-speed motors which set the instrument have universal windings and are controlled by rheostats. This enables the operator to move the telescope quickly over large angles or to give it a very small movement, slowly. The sidereal rate is accomplished through a synchronous motor and a special set of worm gears corrected for atmospheric refraction. There is also an electric differential for varying the rate. During the setting operation the telescope is automatically thrown out of engagement with the sidereal motor with an ingenious magnetic clutch. Although a double-slide plateholder has also been provided for guiding, the electric rate is so closely fixed that exposures of an hour or more have been made without touching the controls.

The observatory and its equipment have been inspected by many astronomers from all over the United States. All have been very kind in complimenting its excellence. Its builders are indebted to the many

FIGURE 4

DR. GOETHE LINK, *Founder* — VICTOR E. MAIER, *Director*

members of the profession for their generous help in making this institution practical, and placing it among the best. The most recent piece of equipment, a zero-coma-corrector using 4x5 plates is being finished in Indianapolis. It will be used in the prime focus, and was recommended by Dr. Harlow Shapley.

The institution was founded to aid in the advancement of astronomy in the state of Indiana. The equipment has been made available to the astronomy departments of the colleges and universities in the vicinity who can use it to advantage in their research problems. The program of the observatory consists of the individual researches conducted by these universities. Dr. James Cuffey has already published his work on star clusters done with this instrument. Dr. Cuffey has the research fellowship from Indiana University and works full time at the observatory. Student lectures and visitors' nights are also a part of the program.

The administration of the observatory is vested in a non-profit corporation called " The Goethe and Helen Link Foundation for Scientific Research." The foundation has been endowed with a permanent income, and no charges are made for the use of the observatory's equipment. The directors of the corporation determine the policies of the observatory, and employ its workers. The writer has been installed in the capacity of director.

BROOKLYN, INDIANA, MARCH 1, 1940.

An Approach to the History of Astronomy

By EARLE G. LINSLEY

During the second semester of the academic year 1939-40 there was an opportunity at Mills College to organize and present a semester course of three hours in the History of Astronomy in what the instructor considers an original, interesting, and profitable way. There were twenty-five young women in the class, all of whom had had the elementary course; none of these expected to major in the science or to become astronomers, few had had any mathematics but all were interested in the development of astronomy. They also wished to have the history of the science presented in such form that at the end of the course they might feel acquainted with the astronomers and the observatories, together with the methods of work and the results achieved.

The choice of topics in the outline was limited somewhat by the materials easily available for reference. It was supplemented by an excellent set of lantern slides from the large collection at Chabot Observatory, including portraits of astronomers, pictures of observatories and equipment, and slides from the observatories themselves illustrating the work accomplished in their programs.

To each student was assigned one from each of the groups of topics (II, III, IV) which follow, and she prepared a paper and presented it before the class. When materials were available the paper was illustrated by lantern slides. The other members of the class were invited to ask questions on the topic, and were expected to take notes. The paper was then read privately by the instructor, factual errors were corrected, and it was then placed in typed form with some source materials, in a loose leaf binder for all members of the class to read.

The final examination consisted of general questions to be answered in brief essay form and one hundred true and false statements covering the