New Telescopes for New Universes

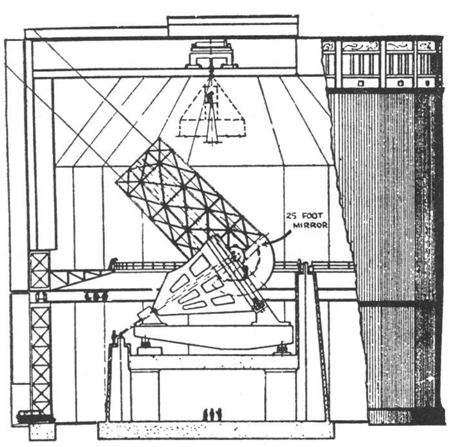
Astronomy

By James Stokley

Huge new telescopes, already planned, will reveal thousands of "universes" of stars now beyond our reach. Probably it will not be long—a year or so, perhaps—before the construction of one of these great instruments is actually begun. Already such large instruments as the 100-inch reflector at Mt. Wilson, now the world's greatest, can reach out and record on the astronomer's sensitive photographic plates objects so distant that their light started on its way millions of years ago when the earth was in the making.

But these big telescopes will not only be useful for revealing heavenly objects now beyond the reach of astronomers. They will be just as useful in revealing the closer objects with a now unobtainable wealth of detail. Mars will be brought so close that the mystery of its canals should be definitely settled when the telescope is first turned on that neighboring planet. Through the projected telescopes Jupiter will appear greatly enhanced in size. As compared with its appearance through present large instruments, the improvement will be as striking as was Galileo's first telescope sight of it in 1610 contrasted with the best naked-eye view of previous days!

About ten years ago there was built, for the Dominion Astrophysical Observatory, at Victoria, B. C., a modern reflecting telescope with a six-foot mirror. This was of American construction, for the mounting was made in Cleveland and the mirror in Pittsburgh. The Victoria telescope was thus the largest in the world at the time of its completion in 1918.



PRELIMINARY PLANS prepared by Francis C. Pease for a telescope with a twenty-five foot mirror, using a mounting originally devised by Russell W. Porter, of Springfield, Vt.

It did not hold this position long. The following year the 100-inch reflector of the Mt. Wilson Observatory in California was completed and placed in operation, and since then it has held the record.

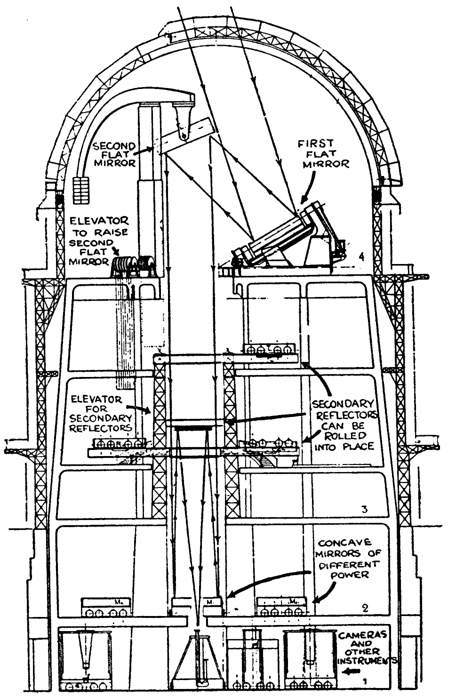
In the years since its completion, the two men most concerned with the design and construction of the 100-inch have both been working on methods of making still larger instruments. One is Prof. George W. Ritchey, who built the 60-inch telescope at Mt. Wilson and who made the optical parts of the 100-inch; and the other is Francis G. Pease, who designed the mechanical parts of the latter instrument.

A year or two after the 100-inch was completed, Prof. Ritchey left Mt. Wilson and went to France. There plans were being formulated for a great telescope, larger than any in the world, that was to be built on Mt. Salève in the French Alps. Prof. Ritchey was given space for a laboratory at the Paris Observatory, and a large staff of assistants, with whom he began to work out new ways of making great mirrors, as well as new designs for such an instrument.

Unfortunately, the funds for this great observatory were not forthcoming, and so the plans have been dropped—at least so far as the Mt. Salève institution is concerned. But in the years that he has spent in Paris Prof. Ritchey has had the opportunity of working out the best designs for large observatories, as well as actually constructing and testing a mirror made on entirely new principles. One improvement involves making the mirror with a structure something like a honeycomb. Another is in the curve that the glass is given.

In the past a mirror has always been made of solid glass. The disc from which the 100-inch mirror was made was, for instance, 101 inches in diameter, 13 inches thick, and weighed nearly five tons. Though it was not a perfect piece of glass, it was used because the makers, at Saint Gobain, France, were unable to cast a perfect disc of the required thickness.

The huge piece of glass is poured while molten and very hot in a mold to give it the necessary disc shape. Since glass transmits heat very slowly, it must be cooled very slowly. Otherwise, the outer layers would cool rapidly, then the inside, with the result that the disc would break into small pieces. In cooling such a disc it is annealed, by lowering the temperature very gradually. It may take as much as a year for it to cool. Usually during this time the disc is buried in sand.



PLAN OF TOWER REFLECTING TELESCOPE designed by Prof. George W. Ritchey, formerly of the Mt. Wilson Observatory, and intended to use mirrors twenty-five feet or more in diameter

Several attempts were made to cast a disc for the 100-inch. The huge pots of glass were prepared, then poured into the molds, and the cooling begun, only to find months later, when the disc was uncovered, that it had cracked in the annealing. Finally, a disc was safely brought through this critical stage. It was the required thickness, but in casting it, three separate pots of glass had been used. One after the other had been poured into the mold. In this process layers of air bubbles had been carried to the mold, so when the disc cooled it was like a three-story layer cake, with air bubbles for the filling.

Even though it was defective, the disc seemed to be the best that could be obtained, so it was sent from France to Pasadena, where the observatory shops are located. The authorities saw the bubbles and rejected it, sending word (*Turn to next page*)

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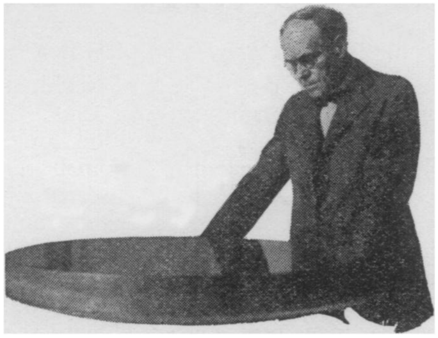
to Saint Gobain to try again. Try again they did, and finally did cast a perfect disc seven inches thick, but failed to make one of 13 inches. The seven-inch-thick disc was considered too thin, so the observatory authorities looked at the one with the bubbles. After tests, they found that in making it of the necessary dish-shape, they would not reach one of the bubble layers, and so they would not interfere. In 1910, under Prof. Ritchey's direction, the work of grinding began, to be completed six years later. Within a few years more the mounting had been completed.

With so much difficulty involved in making the glass for the 100-inch, it became apparent that still larger ones would be nearly impossible. Since that time there have been great improvements in glass making. At the United States Bureau of Standards, in Washington, a large disc has been successfully cast for a reflecting telescope in Ohio. Mr. Pease thinks that a disc as large as twenty-five feet in diameter could be cast now. Probably, he thinks, it could be done with Pyrex glass, which has in recent years been widely used for cooking utensils and glassware used in laboratories. This glass has the advantage of standing sudden and large changes in temperature remarkably well.

However, it cannot be denied that the casting of a disc so large would be attended with considerable difficulties, even though they could doubtless be overcome. Prof. Ritchey has therefore worked out another method of making large mirrors. The trouble in making the large discs is to get them of large diameter, and at the same time sufficiently thick. A piece of glass only an inch or so thick could easily be made as large as desired, but a disc so thin could not be used for a mirror. Glass is slightly flexible and it would bend enough to throw the image out of focus when in use.

Prof. Ritchey's method is to provide a support for such a thin mirror. He takes a thin, flat piece of glass of the required diameter. On top of this he cements vertical partitions of thin glass in the same form as the cardboard partitions in an ordinary egg box. The tops of the glass partitions are lower in the center, so as to correspond to the eventual concavity of the mirror. On the top he then cements a thin, round, dish-shaped piece of glass of the same diameter as the lower one. The entire



PROF. GEORGE W. RITCHEY, examining glass blank for telescope mirror

structure is baked to harden the cement, which is an invention of Prof. Ritchey's, and then the top surface is ground to the proper concavity.

When a glass is made in the form of a disc, it must first be rough-ground to a shape that is part of a sphere. Then comes the figuring, which makes it into a paraboloid, like the reflector of an automobile headlight, only much flatter. The Ritchey mirror is already in the spherical shape when it comes out of the furnace in which the cement is baked hard, so that only the figuring is required. Another advantage of such a mirror is its lightness. Also, as he puts holes in the partitions and air can circulate freely through the inside of the mirror, it can soon be brought to the same temperature as its surroundings. With a large solid mirror, especially in warm weather, it is likely to become hot during the day. Then at night, when the astronomers want to use it, it becomes cooler, and until it has cooled to the same temperature as the air around it, it cannot be satisfactorily used.

Prof Ritchey's first mirror of this kind, a small one, was made while he was in the United States. In Paris he made one of a fairly good size—about forty inches—and one of the same size out of solid glass. Thus he could compare their performance. These he made several years ago, and immediately made on them an exhaustive series of delicate tests, which showed that the built-up mirror gave just as good an image as the solid one. But there seemed the possibility that the composite affair might change with time, that it would not hold together satisfactorily. If such a change would occur, it should now be evident. He had just completed a second series of comparative tests of the two mirrors, and these show that the composite one is still entirely satisfactory.

But a reflecting telescope is more than a mirror. There must be a mounting for it, so that it can be pointed at the stars and bring the light rays to the photographic plate. In a large telescope such a mounting is a formidable affair. The moving parts of the 100-inch telescope weigh something like 200 tons. A larger telescope might be made out of some light and strong alloy, like duralumin, which has been employed in our large dirigibles. Even so, the mounting for a mirror of twenty-five feet or more diameter would be rather a considerable engineering problem.

The telescope that Mr. Pease has designed and which, he announces, can be started just as soon as the funds—about $12,000,000—are in hand, follows the usual principle of moving the entire instrument to point to the star. The mounting he has designed is one that is particularly adapted to large instruments. It was originally proposed some years ago by Russell W. Porter, an amateur telescope maker of Springfield, Vermont.

But there is another way of using a large mirror, and one which Prof. Ritchey thinks to be the ideal method. He has worked out a design for a large telescope which also follows the orthodox method. By the use of new curves that are neither paraboloids or spheres, he has found a way of making the instrument much shorter, and hence lighter, than in a telescope such as the 100-inch. His ideal, however, is a form of what astronomers call the coelostat telescope. In this a pair of flat mirrors at the top of a tower pick up the light from the heavenly body and reflect it into a fixed and vertical telescope. Two such telescopes, but using lenses, and not mirrors, are already in use at Mt. Wilson for studying the sun. Another one, also using a lens, is used for both sun and stars at Potsdam, Germany.

Prof. Ritchey has designed such a telescope for use with great mirrors. The first mirrors at the top are much easier to turn than a huge telescope, and so it is much more convenient to use. But one of the principle advantages, in his estimation, comes from the fact that a whole battery of mirrors can be used. Instead of one, as in all present instruments, a half-dozen or so, each with a different focus and magnifying a different amount, can be kept constantly at hand. Nights vary. Sometimes the atmospheric conditions are such that only a lower power may be used to advantage. Then conditions (*Turn to next page*)

New Aurora Mystery

Physics

Photographs made at the Lowell Observatory at Flagstaff, Ariz., of the spectrum of the Northern Lights at the time of the brilliant display on July 7 has opened up a new scientific mystery. For the first time, there appears, in addition to the various lines due to known elements, a very prominent line in the red region of the spectrum. As it has never before been photographed, Dr. V. M. Slipher, director of the observatory, who recorded it, is unable to state definitely what elements cause the reddish color. However, he suspects that it is due to some known gas in the atmosphere of the earth, possibly nitrogen.

On the photographs taken by Dr. Slipher there also appeared very prominently the so-called green auroral line, which was long a mystery. First photographed during visible displays of the northern lights, or aurora borealis, it was found at the Lowell Observatory in 1915 that it could be recorded by pointing a spectrographic camera at any part of the sky on any night even if cloudy. Dr. Slipher has also made such photographs of it on numerous occasions and under all sorts of sky conditions, always with success. He finds an unaccountable variation of its intensity shown even in a few minutes.

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of almost perfect "seeing" may arise for a time. With the Ritchey telescope, the highest power could be put in place in a moment, and the fullest advantage taken of the exceptional conditions. Thus the telescope would always be used at its greatest efficiency. Another advantage is that the observing chamber could be underground. All sorts of instruments, like spectroscopes and plateholders could be kept at hand like the mirrors, ready to slide into place at a moment's notice.

So far no estimate has been made of the cost of such an instrument, but it would undoubtedly run well into millions and millions of dollars. Its cost might even approach the cost of a modern battleship! And how much more useful in the development of mankind, in the extension of human knowledge, would such an instrument be than a whole fleet of dreadnaughts!

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The average height of the human race is five feet five inches.

Radiovision in Homes This Fall

Radio

Radiovision and radiomovies will be received in thousands of homes during the coming winter. Thousands of amateurs and radio enthusiasts will build their own radiovision receivers and early this fall ready-made radiovisors will come on the market. Radiovisors will be the novel and really smart Christmas gift this year. These are the predictions of those behind the scenes in radio experimentation.

Although only three radio stations are regularly broadcasting radiovision or radiomovies, at least seven more are experimenting or testing and installing radio transmitters. The fall months will see this number increased rapidly.

At present most of the radiomovies are in pantomime only but increase in "picture quality" will come with experience and perfection of transmitting methods. The recent assignment by the Federal Radio Comission of new and wide bands of short waves for radiovision will spur on the development.

At present radiovision is in a state corresponding to the crystal set days of sound radio in 1921. But the growth of radiovision will be faster than was the growth of sound radio. Thousands have learned to use tools and make their own radio sets. The vogue of home construction of radio sets has waned because it became unprofitable and uninteresting with the growth of the radio industry. Now the latent mechanical urge of the radio fan is likely to be liberated by radiovision and the construction of radiovisors is likely to become a new home occupation.

The well-organized radio set manufacturers, alert for new things to sell, are also expected to place de luxe radiovisors on the market in a remarkably short time this fall.

In the early days of radiovision only the expert amateurs and set builders are likely to obtain consistent and satisfactory results because of the fact that most of the radiovision broadcasts are now on wave lengths shorter than the usual music and speech broadcasts. Their pioneering, however, will make the day of radiovision in the ordinary parlor come sooner.

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Radiovision Programs

Radio

3XK, Washington, D. C., Jenkins Laboratories, 46.7 meters, 6420 kilocycles. 48 lines per picture. 15 pictures per second. Monday, Wednesday and Friday, 8 to 9 p. m. Eastern Standard Time. Radiomovies.

WGY, Schenectady, N. Y., General Electric Co., 380 meters, 790 kilocycles. 24 lines per picture. 20 pictures per second. Tuesday, Thursday and Friday, 1:30 to 2:00 p. m. Eastern Daylight Time. Tuesday, 11:30 p. m. to 12 midnight. Sunday, 10:15 to 10:30 p. m. Sunday and Friday transmission is simultaneously on 21.96 meters or 13660 kilocycles. Thursday and Tuesday transmission is simultaneously on 31.4 meters or 9550 kilocycles.

WRNY, New York City. Experimenter Publishing Co. 326 meters, 919 kilocycles. 36 lines per picture. 10 pictures per second. To be on regular schedule shortly.

2XAL, New York City. Short wave station of WRNY to broadcast same programs simultaneously on 30.91 meters, 9700 kilocycles.

KDKA, short wave transmitter, Pittsburgh, Pa. Westinghouse Electric and Manufacturing Co. 62.5 meters, 4798 kilocycles. 60 lines per picture. 16 pictures per second. Irregular broadcasts for experimental purposes.

1XAY, Lexington, Mass. Donald R. Laffin. 51 to 62 meters. 4700 to 4900 kilocycles. 48 lines per picture. 15 pictures per second. Nightly tests without regular schedule.

4XA, Memphis, Tenn. Wrec, Inc. 125 to 120 meters. 2400 to 2500 kilocycles. 24 lines per picture. 15 pictures per second. 5000 watts power. Irregular experimental schedule.

9XAA, short wave station of WCFL, Chicago, Ill. Chicago Federation of Labor. 6215 meters. 4800 kilocycles. 48 lines per picture. 15 pictures per second. Monday, Tuesday, Wednesday, Thursday and Friday, 10 to 11 a m. Broadcasting only frequency chart now but will broadcast movies when equipment is ready.

Science News-Letter, August 25, 1928