ASTRONOMY

More Power to Telescopes

Devices using some of the principles of television soon promise to make the 200-inch telescope the equal of a 2,000-inch instrument.

By ANN EWING

➤ A REVOLUTION in astronomy second only to the invention of the telescope itself is foreseen in electronic devices now being tested to make every telescope the equal of one ten times its size.

These devices, which use some of the principles of television, are under intensive development in the United States, as well as in Russia, England and France.

Known as image converters, they promise to make the 200-inch Hale telescope on Mt. Palomar the equal of a 2,000-inch instrument. They will also boost by an equivalent amount the light-gathering use of all other telescopes to which they are attached. Such electronic devices, when perfected for telescopic use, could make a 20-inch the equivalent of a 200-inch.

Considering the discoveries already made in the last 50 years with such large telescopes as the 40-inch, 60-inch and the 100-inch, routine use of image converters may bring discoveries requiring mankind to reconsider the universe, as Einstein's theory, showing that time and space were not separate, once did.

To Test Model This Year

The chances are very high that scientists in the United States will actually test a pilot model of the most promising type of image converter during 1957. If so, they would be using a test model that, with further development, could easily be attached by any astronomer anywhere in the world to almost any telescope. Goal of those working on perfecting an image converter is to take a successful photograph using such a tube.

News that this has been done will be greeted with loud cheers by astronomers and by television experts, although some time may pass before realization of the revolution to follow will be understood generally, just as it took several years for Einstein to become a household word.

Taking this photograph, however, will not mark the first time that stars or planets have been photographed after their light was amplified by electronic means. Although two devices have already been used to do this, neither of them yet meet the standards of easy use and reliability which astronomers believe are required.

What an image converter does is to change light to electrons, greatly multiply the number of electrons, then turn these tiny negative particles back again into light that, much intensified, then falls on a photographic plate.

Since bigger and bigger telescopes have been built for the last 100 years, some might ask why not build an instrument ten times the size of the 200-inch and thus accomplish the job. Besides prohibitive cost, there are other practical reasons why astronomers want to make better use of the already available light gathered by telescopes now built rather than set up larger mirrors. These reasons are "seeing," night sky glow, and the "full exposure" effect.

Reasons Explained

"Seeing" is the astronomers' term for the same effect that causes stars to "twinkle"—the dancing of the earth's atmosphere resulting in the blurring of stellar images on a photographic plate. This air turbulence is greatly magnified by a telescope, and the larger its field is, the more this effect is magnified.

Night sky glow is a very faint luminescence covering the entire sky due to chemical processes in the earth's upper atmosphere. Stars fainter than 24th magnitude, which is just above the limit of the 200-inch, are completely drowned in this glow.

The "full exposure" effect is the overlapping of darkened photographic grains after a certain exposure time. The larger the aperture of a telescope, the more important this effect becomes. Doubling the exposure time at the main focus of a large telescope with fast film allows photographing stars only half as bright as previously but only up to a certain point. Beyond that, further exposure is more likely to result in loss than in gain.

For instance, after about 30 minutes, a photograph taken with the 200-inch will show about as much as it is going to, and further exposure is likely to blur the information already recorded about distant galaxies.

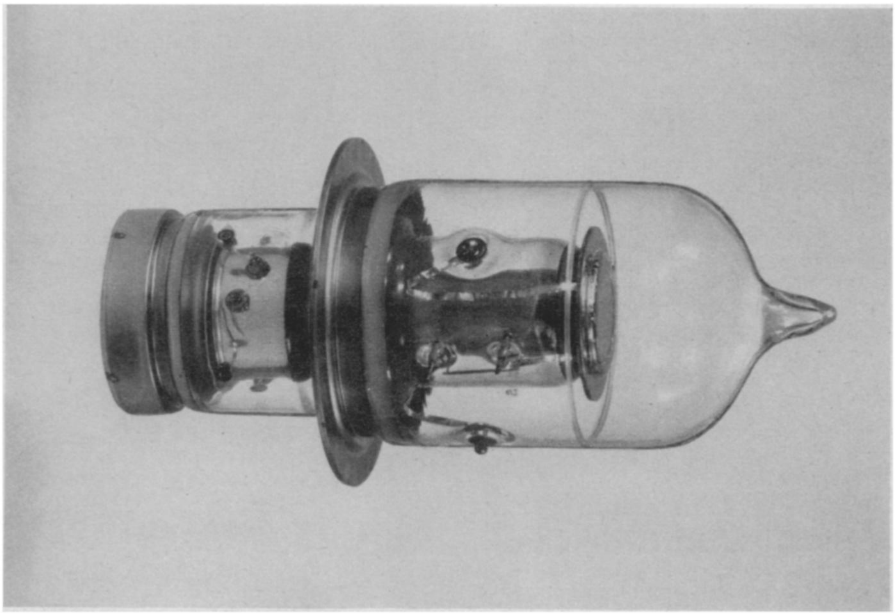
The answer to reaching objects fainter than those about two billion light years away, believed to be the present limit of the 200-inch, is to magnify the star's image either by making the photographic grains smaller to reduce the "full exposure" effect or by subtracting away some of the background light, thus eliminating the effects of turbulence and night sky glow.

Need Electronic Means

Both methods require electronic means, since so far astronomers have not been able to use photographic means for increasing the light from faint heavenly objects caught by their telescopes.

In normal photography with fast film, with a Brownie camera as well as the 200-inch telescope, every 1,000 photons, or light packets, hitting the film blackens only one grain of emulsion. This is an efficiency of only one tenth of one percent.

Many metals in a vacuum, however, re-



POWERFUL TELESCOPE AID—To increase ten-fold the faint stars in space photographed by any telescope, scientists are developing electronic devices called image converters, such as this pilot model made by Farnsworth Electronics Company.

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act much more efficiently. When struck by light photons, one electron may be ejected for every ten photons hitting the metallic plate, or photocathode. If each one of these electrons can then be made to blacken one photographic grain, the process is 100 times more efficient than using light alone. Pioneering experiments along this line were first carried out by Prof. Andre Lallemand at the Paris Observatory in France.

To avoid the difficulties caused by gases from the photographic plate contaminating the light-sensitive cathode, which Dr. Lallemand and others have found is a problem for all but very short exposures, scientists have placed the two in separate chambers.

Passage of Electronics

The problem then is to find a way for the electrons to pass from one chamber to the other but not the gases. A thin film no more than a few millionths of an inch thick, is believed to be the best answer. This solution, however, gives another problem, preventing the thin film from rupturing during operation. Several attacks are being made on this.

One group now working to develop a practical design for image converters so they can be usd by any astronomer is sponsored by the Carnegie Institution of Washington. It is headed by Dr. M. A. Tuve, director of the Institution's Department of Terrestrial Magnetism, and includes Drs. John Hall of the U. S. Naval Observatory, L. L. Marton of the National Bureau of Standards, and William A. Baum of Mt. Wilson and Palomar Observatories.

Develop Image Converter

Two companies, the Radio Corporation of America and Farnsworth Electronics Company, are cooperating with this committee in developing an image converter that can be produced in commercial quantities and made available to astronomers around the world.

One model tube is about five inches long and has a three-quarter-inch field. When put into operation, the tube is installed in a vacuum plate-changing device, a breakaway cap protecting the thin film is cracked off after a protective vacuum has been set up around it, and exposures are made by placing photographic plates close to the thin film.

In recent tests at the Naval Observatory, Drs. Hall and Baum managed to record stellar images, but were troubled by various sources of background glow.

The first astronomers to experiment with the thin film system were Drs. W. A. Hiltner and J. Burns of Yerkes Observatory, Williams Bay, Wis. They have succeeded in keeping the photocathode in good condition for several weeks. Although at present they are limited to using extremely short exposures, they have reported a 50-fold increase in photographic speed.

Both these groups use systems that require high vacuum. In Russia, the astronomer Krassovsky and his collaborators have reported results using a glass window with a fluorescent covering in place of the thin film, putting the photographic film directly against this window.

Another approach is to provide internal intensification between the photocathode and the fluorescent screen. Drs. E. J. Sternglass and M. M. Wachtel at the Westinghouse Electric Corporation are experimenting with a tube containing a series of parallel thin films that multiply the number of electrons in the image as it progresses through the tube.

Scientists are also attacking the other method of making much-improved use of light gathered by present telescopes—subtracting some of the unwanted background light. They adapt features now used in commercial television to operate at a very considerably lower light level.

Basis of these schemes is to store all the light hitting a photocathode temporarily as electric charges on an insulated surface, then increase the contrast between image and background by electronic beams. The picture is read off by a scanning beam and then transmitted to a screen as in television.

Those working on this method include Dr. G. A. Morton and his associates at Radio Corporation of America Laboratories in Princeton and Dr. J. D. McGee at the Imperial College of Science and Technology, London.

Drs. R. E. Sturm of Bendix Aviation Corporation and Russell H. Morgan of Johns Hopkins Medical School have modified a television camera and receiver, so that the brightness of the original image is multiplied as much as 50,000 times.

Although originally designed to intensify fluoroscopic X-ray images for diagnostic purposes, it was used experimentally to photograph Mars at Lowell Observatory. Dr. Sturm believes that planned improvements should make it possible to get even shorter exposures than so far possible, perhaps short enough to catch Mars and the other relatively close planets when the atmosphere is momentarily not dancing.

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Do You Know?

The *soybean* is now the leading American food fat source, having overtaken lard, cottonseed, and butter.

The world's oldest *corn* experiment field, in continuous use at the University of Illinois since 1876, is showing how to renew worn-out soils.

The area now planted to *grain sorghum* in Mexico is estimated at more than 100,000 acres, in contrast to a few hundred acres in 1945.

It was recently discovered that the *toadfish* contains a chemical now in the process of investigation toward the treatment of diabetes.

Questions

AERONAUTICS—What is the missile which should prove very important in the conquest of space? p. 131.

□ □ □

ASTRONOMY—What do the image converters, which promise a revolution in astronomy, do? p. 138.

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BIOLOGY—Where did chimney swifts roost before the erection of chimneys? p. 144.

□ □ □

GENERAL SCIENCE—What is the second hole in the Iron Curtain? p. 137.

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MEDICINE—What is the function of the "Cardiac Monitor"? p. 136.

□ □ □

PHYSIOLOGY—At what time of the year do blood donors show low hemoglobin? p. 137.

□ □ □

ZOOLOGY—In what areas does evolution proceed the fastest? p. 132.

□ □ □

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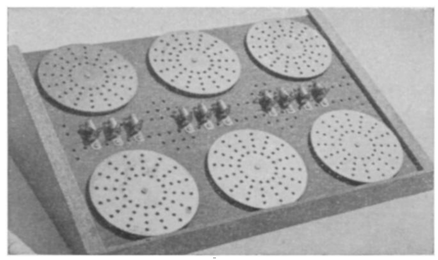
Can you think faster than this Machine?



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