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The navy "Big Dish" radio telescope at Sugar Grove, W. Va., as it will appear upon completion, scheduled for 1962. Called the world's largest steerable radio-telescope, this 20,000 ton monster has a saucer shaped reflector 600 feet in diameter and more than seven acres in area, behind its transmitting and receiving elements. Towering higher than a 60 story building, the telescope will tilt as the semicircular rockers move on an oil film a few thousandths of an inch thick, and will rotate on a circular railroad to face in any direction. Automobiles in the picture are drawn to scale for comparison. While in use, the instrument could not tolerate electrical equipment so close. —Drawing by Einar V. Quist, a Journal Artist

Radio Telescopes Hear S

Spectacular New Insights Into Cosmic Structure and Events Probable With Giant 'Ears' Being Built in United States and Abroad; Tracking Missiles and Space Ships Are Routine Uses

By HARRY S. PEASE, of The Journal Staff

LIKE giant steel mushrooms with inverted heads, radio telescopes are blooming on the American landscape in one of the most prodigous growths of equipment in the history of science.

Nourished by military dollars, a whole new branch of astronomy has burgeoned in this decade. Listening to static from the stars was only a stunt until the end of World War II. It has proved to be a thoroughly practical activity in the dawning age of space.

The radio telescope's relation to killing large numbers of people still appears remote, but some of its uses could be important to military offense and defense. In a world which shudders to rocket blasts and nuclear explosions instead of the tramp of jackboots, a world whose future battles may be fought for the moon and Mars instead of mere earth continents, accurate information about the vastnesses beyond our atmosphere may prove precious indeed.

Hear Stomach Noise of Man 4 Miles Away

One reason the radio telescope has progressed so fast may be the familiarity of the ideas on which it is based. It demands sophisticated electronics and ingenious structural engineering, but it represents only a couple of generations' evolution beyond the sets on which you listen to Braves games or your children watch the Three Stooges.

In its simplest form, the one used in astronomical studies, a radio telescope is only a sensitive receiver. For most military projects it demands a transmitter, too, be-

scope receiver has a 700 tube amplifying system. It can detect a man four miles away by the radio noise from his stomach.

Possibly the most spectacular such instrument thus far is the 600 foot, 79 million dollar "Big Dish" being built for the navy at Sugar Grove, W. Va.

Milwaukeean's Design

One of its principal designers is Max O. Urbahn, a New York architect who was valedictorian of the 1930 class at Boys' Tech here. His mother, Mrs. Hedwig Urbahn, lives at 3851 N. 37th st., and a sister, Mrs. Elly Reinhart, lives at 15225 W. Burleigh rd., Brookfield.

Urbahn, now 46, came to this country with other members of his family in 1925 from what is now West Germany. His father, who died in 1956, was a maintenance engineer for the A. O. Smith Corp.

The architect attended the University of Wisconsin—Milwaukee and studied further at the University of Illinois and Yale university before setting up his Manhattan offices.

Some purposes of the "Big Dish" are secret, but many can be guessed.

Most prosaic of its jobs but one of unquestioned importance will be the tracking of artificial satellites and space off the moon. A series of artificial satellites about 25,000 miles high might permit unbroken communications to any point on earth.

A Look at Venus

This partial list of things close to home raises questions enough to keep the instrument busy for years, but some of its most exciting projects depend on its capabilities at far longer range.

No man has ever seen the surface of the planet Venus, for it is perennially shrouded in clouds. Used as a radar, the "Big Dish" could conceivably see through the clouds and determine at least how fast the planet rotates. It might even develop a crude map of the surface.

The machine can almost certainly supply us with accurate distances to the near-by planets. To astronomers, interested principally in the forces and principles that govern the universe, an error of 100,000 miles in the 483 million that separate us from Jupiter would not amount to much. The error would be crucial to astronauts who may attempt to fly there before the end of the century.

The "Big Dish" may answer such fundamental questions of cosmology as the origin of the universe, whether the universe has any limit and miles, begin with 228 million. Multiply by a million. Multiply by a million again. Then multiply by a thousand.

Not only will it pick up things at that distance; it will "see" them as they were 38 billion years ago. All the inferences that can be drawn from classical astronomy seem to indicate that the universe began about five billion years ago, so the "Big Dish" may carry us across the horizon of time.

1,000 Foot Ear Planned

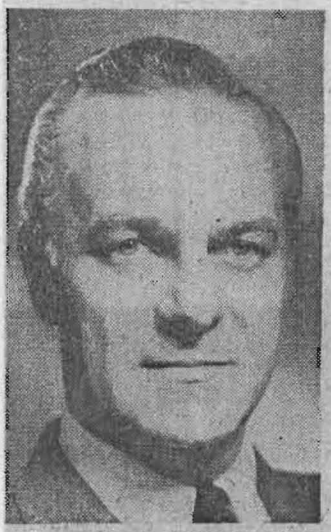
The growing family of radio telescopes constitutes one of the greatest mass assaults on the unknown in the history of science.

The United States alone has 33 major instruments

emits a high frequency shout and listens for the echo.

WTMJ broadcasts with 5,000 watts of power. WTMJ-TV sends its sound signal with 50,000 watts and its picture with 100,000. By contrast, the strongest signal of any use to a radio telescope reaches the earth with a power of a hundredth of a billionth of a watt.

A rather simple radio tele-



—Fabian Bachrach

Max Otto Urbahn, former Milwaukeean and a designer of the navy "Big Dish."

rockets. After its completion in 1962 it will undoubtedly be called upon to follow orbiting and interplanetary vehicles' progress fifty million miles from the earth and to record the information they transmit with no more power than a hearing aid.

Many of its duties will be linked to earthly communication.

Bounced Signals Off the Moon

Our globe is girdled by an electrified layer of upper air—more properly, a group of such layers — called the ionosphere. The ionosphere has weather just as the lower air does. Its changes affect radio communications. They may be critically important, for example, in detecting and intercepting incoming rocket weapons.

The northern lights are caused by showers of charged particles falling on the earth from space, most of them from the sun. Such showers cause communications disruptions which are still imperfectly understood.

With much smaller radio telescopes which are working now, scientists in England and in the United States have exchanged messages experimentally by bouncing them

whether the universe is running down or will continue forever as it is with only minor changes in deatil.

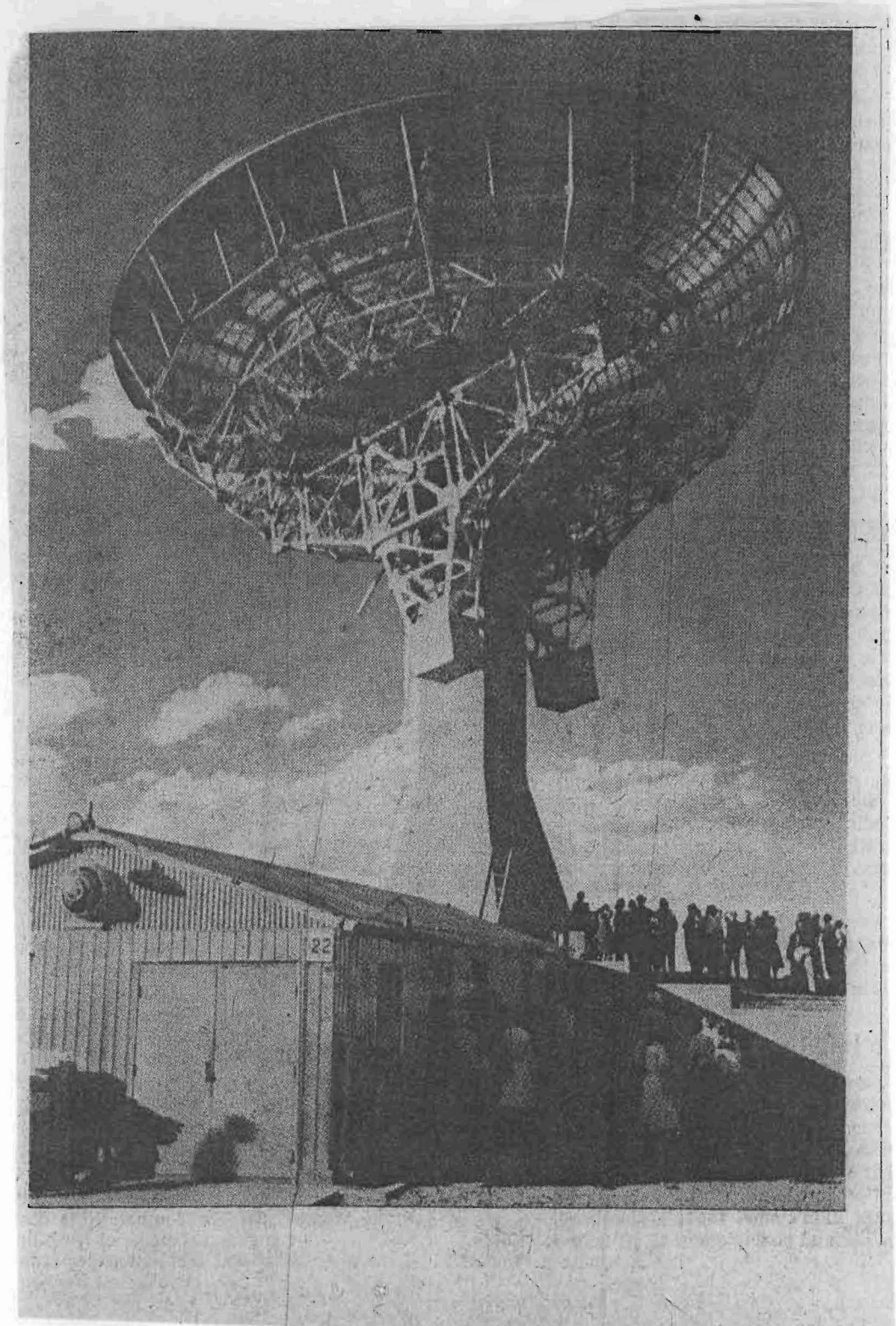
'See' Happenings 38 Billion Years Ago

The instrument's theoretical range is 38 billion light years, nearly 20 times that of the "Big Eye" on Mount Palomar. If you want to know the range of the radio telescope in

A small radio telescope now in use is this 60 foot instrument on Table Mesa outside Boulder, Col. The national bureau of standards operates it and a twin instrument a few miles away. The bureau is charged by congress with determining conditions which affect radio waves and setting standards for them. The visitors in the picture are an exception to the rule; normally only the operators are allowed to approach so close, to minimize radio interference. The sheet metal building houses banks of vacuum tubes and circuitry for the transmitter and receiver.

—Journal Staff

ecrets of Space



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- planned, under construction or in use.

The greatest giant's ear yet to be announced will be built by the air force in a natural bowl of coral limestone in Puerto Rico. Its antenna, 1,000 feet in diameter, will be too big to move, but its beam will be warped electronically to look anywhere within 20 degrees of straight up. Construction is to begin in about two months.

Because it is immovable, this machine will be relatively cheap. Its cost: $4,500,000.

Thirty miles from the "Big Dish," at Green Bank, W. Va., the National Science Foundation is erecting the 142 foot reflector of the National Radio Astronomy observatory. It is to operate next summer.

The air force is erecting a similar instrument for Stanford university and another to be installed in Scotland. The University of Michigan recently dedicated an 85 foot, navy financed dish at Ann Arbor. Another 85 footer is being paid for by the navy for operation by the University

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Here are the candidates for governor, besides the two in the top picture. The three at left are considered real contenders, as are Davis and Rainach.

who are predominantly Moslem.

Radio Telescopes: 'A Mass Assault on the Unknown'

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of California in Hat Creek, a remote area of the Lassen national forest. The national bureau of standards and the Carnegie institute of Washington, D. C., operate some smaller sets with 60 foot reflectors.

The birth of radio astronomy occurred in 1931, and the man in attendance was Karl Jansky of Madison, Wis.

Jansky, 23, was newly graduated from the University of Wisconsin when the Bell Laboratories hired him and assigned him to find out what was interfering with the transatlantic radiotelephone calls. Some sort of interference was occurring.

The young engineer built a 100 foot long directional antenna of brass pipe and wooden scaffolding, put four scrapped wheels from a model T Ford under it so it could rotate, and set it up in a New Jersey potato field near Sandy Hook bay.

He heard various local disturbances, but underneath it all he heard a steady hiss. Sometimes the hiss was strong, sometimes weak. He considered a lot of possibilities, and it was more than a year before he hit on the right one.

Stars Send Waves

The noise rose in the east and set in the west. Every day it rose four minutes earlier than it had before. It was coming from somewhere in space, beyond the solar system, and it came from the direction that astronomers said was the center of our galaxy. Jansky was listening to the heart of the Milky Way.

He was, after all, a communications engineer and not an astronomer. Having identified the interference, he virtually abandoned his investigations.

Professionals pretty much ignored the hint he had provided, but an amateur radio operator whose profession was radio set design took up the study. His name was Grote Reber, and he lived in Wheaton, Ill., a Chicago suburb.

Reber read some of Jansky's reports in 1937. He set to work on a galvanized iron dish 31 feet 5 inches across, and installed it in his back yard. After 15 months and $2,000 of expense, he heard the stars. He identified a number of sources of radio noise in the sky, and two of his reports were printed in the Astronomical Journal, but still nobody took up the challenge.

Two technical developments ripened radio astronomy. One was the radar experiments of World War II. The other was the optical astronomers' brilliant inferences about the atomic processes in the stars. Together, they pointed to the possibilities of the new scientific tool.

In their tremendous nuclear explosions, in hurling electrified particles through their gigantic magnetic fields and possibly in other processes, the stars do not emit light alone.

They send widely varied waves of electromagnetic energy at a constant speed of 186,000 miles a second. In length the waves run from fractions of millionths of inches to multiples of miles. Visible light is only a trifling portion of the whole range.

Found Galaxies Unknown Before

By opening the radio window into space, the astronomers found things that optical astronomy had been unable to detect or had overlooked. One intense radio source turned out to be two galaxies the size of our own—great pinwheels of 100 million stars each, spread out over 100,000 light years of space—colliding like a pair of cymbals. The optical men had overlooked them on photographic plates, but the radio men recognized them as a transmitter with a power of a million million million million million watts. That figure is 1 followed by 36 zeroes, if you want to write it out.

Most of the 3,000 radio sources discovered up to now have no visible counterparts in the sky, and are objects of enticing mystery to scientists.

An exception that proved quickly identifiable was the Crab nebula in our own galaxy, the remains of a star that blew up in 1054 A.D.

Map Own Galaxy

No cataclysm known in nature matches that of a supernova, or exploding star, and we are fortunate that this one happened 3,300 light years away. The violence of the burst was roughly equivalent to the total which could have been put out by seven million H-bombs exploded every second since the earth was formed. Debris is still spreading at the rate of 70 million miles a day after 900 years of slowing down.

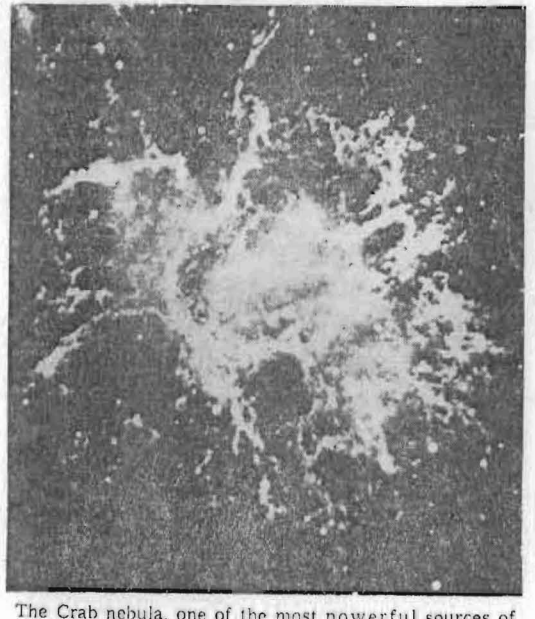
One of radio astronomy's more momentous achievements is the mapping of our own galaxy. The optical men were hopelessly blocked from studying its details. Great clouds of dust cut off all the light from the center of our pinwheel.

But just as radar can see things behind the clouds, radio astronomy can penetrate the interstellar dust.

Careful listening was required. Individual atoms of neutral hydrogen out in space were the telltales, and the average atom there gives off a burst of radio energy once in 233 years. There are so many atoms that their sound comes in as a steady hiss, but its power is only a billionth of a billionth of a watt.

In radio astronomy we stand where optical astronomy stood when Galileo first saw the moons of Jupiter through his crude spyglass 300 years ago.

The new information the giant dishes may trace out with their pens on moving strips of graph paper, or present on dials or televsion tubes, will probably add as much to our knowledge of the grand scheme of the universe as did the telescope made of glass.



The Crab nebula, one of the most powerful sources of radio noises from outer space, is in our own galaxy, a mere 3,300 light years away. It is the remains of a star that blew up in 1054 A.D. with the power of about 1,000,000,000,000,000,000,000,000 (septillion) hydrogen bombs.

—Wisconsin Alumni Association

Karl G. Jansky, Wisconsin inventor of the radio telescope.