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Alaskan Eclipse Expedition

The National Bureau of Standards participated in an expedition to Attu Island, Alaska, to observe the total eclipse of the sun by the moon on September 11, 1950. The expedition was organized by Dr. John P. Hagen, of the Naval Research Laboratory, primarily to apply the methods of radio astronomy to the study of the eclipse at various radio frequencies. Included in the party of 10 scientists were Grote Reber and E. A. Beck of the Bureau's Central Radio Propagation Laboratory.

In addition to infrared, visible, and ultraviolet radiation, the sun is continually giving off energy at radio frequencies. In recent years, the techniques of radio astronomy have been developed for receiving and analyzing these longer wavelengths. This has made it possible to obtain information about the positions of stellar bodies and the matter in interstellar space that could never have been seen with an optical telescope. As the radio waves given off by the sun are received without difficulty through rain or fog, the methods of radio astronomy proved particularly valuable for observations in the cool, damp climate of Attu Island, where the eclipse was accompanied by a severe rainstorm.

The path of the total eclipse began in the Arctic Ocean and proceeded south-eastward across Siberia, the Bering Sea, and Attu, finally ending in the Pacific Ocean northwest of Hawaii. This path crossed United States territory only on Attu, a small piece of land, the last and most westerly of the Aleutian chain. Although the climate of Attu is most undesirable for making visual observations with an optical telescope, it seemed likely that significant results could be obtained there with radio apparatus.

The party spent approximately a month on Attu installing equipment and making preparations. The center of the path of the eclipse crossed the eastern end of the island. However, this location is very inaccessible both by land and by sea. The apparatus was therefore mounted upon an old airplane runway on Alexai Peninsula, one of the few open flat places on the island. At the place of observation, which was about 2 miles from the center of the path of totality, the eclipse lasted 73 seconds.

The high-frequency energy from the sun was collected by a mirror 10 feet in diameter having a focal length of 3 feet. An altiazimuth mounting made it possible to sight the mirror on the sun. The mirror served to focus the incoming radiation on an antenna placed at its focal point and connected to a high-frequency receiver. Signals thus received were amplified and applied to an automatic recorder, providing charts of intensity versus time for various frequencies.

Measurements of solar radio intensity were made at wavelengths of 3, 10, and 65 centimeters. The receiving equipment for use at the 65-centimeter wavelength, which was supplied and operated by the National Bureau of Standards, was a superheterodyne receiver having a 30-megacycle intermediate frequency and two stages of radio-frequency amplification. The

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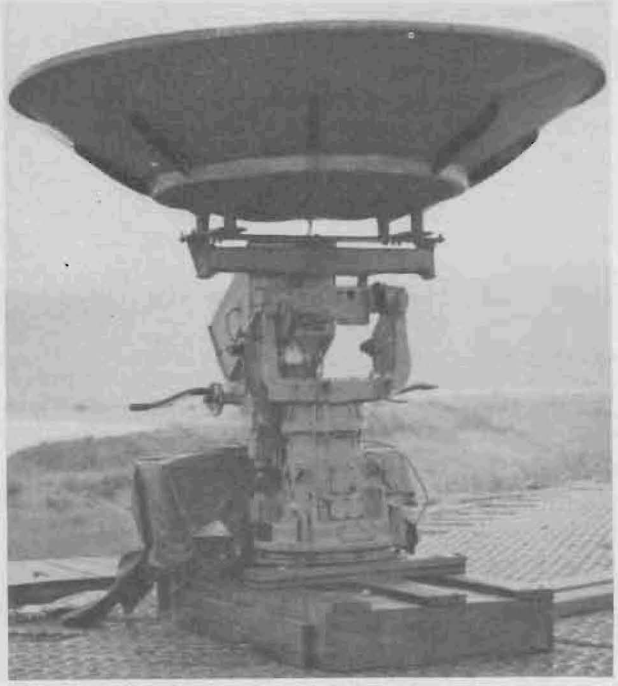
measurements were made from two to four times a minute beginning about 2 hours before the eclipse. The sky at an azimuth of about 90 degrees from the sun was used as zero reference. The sun was found to be quiescent and reasonably free from the transients that are often present during periods of solar activity.

Because of the radio waves sent out by the sun's ionized atmosphere, the apparent diameter of the sun at radio frequencies is always appreciably greater than at visual wavelengths. Consequently, all solar eclipses "viewed" with radio apparatus must appear to be annular rather than total. Preliminary results obtained from analysis of the data indicate that the apparent diameter of the sun exceeds that of the moon by 3, 7, and 11 percent, respectively, at wavelengths of 3, 10, and 65 centimeters.

Besides the ionized atmosphere of the sun, a variety of other solar phenomena are effective in generating radiation at radio frequencies. For example, the magnetic field associated with sun spots causes additional radiation at centimeter wavelengths to originate in the neighborhood of the spots. Thus, as the edge of the moon first covered and later uncovered a spot group near the center of the solar disk, the observed intensity at radio frequencies dropped sharply and then rose again.

An eclipse of the sun by the moon, when viewed in an optical telescope, passes through four significant positions known as first, second, third, and fourth contact. First contact occurs when the edge of the moon appears just to touch the edge of the sun. When the moon covers the sun completely, second contact is said to occur. Third contact takes place when the sun again becomes visible, and fourth contact marks the instant at which the edge of the moon finally leaves the edge of the sun.



High-frequency radio waves from the sun were collected by this 10-foot radar mirror and focused on the antenna of a high-frequency receiver. Signals thus received were amplified and applied to an automatic recorder, providing charts of intensity versus time.

If the radio-frequency brilliance of the solar corona had been symmetrical, a minimum of observed intensity should have occurred at the time of optical totality, that is, between second and third contact. Actually, however, the minimum occurred a few minutes after

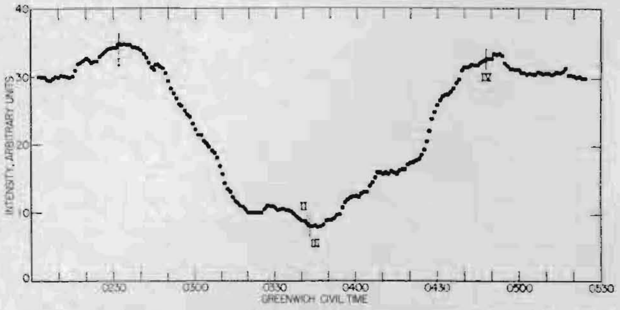


Chart of intensity versus time for 65-megacycle radiation received from the sun during its eclipse by the moon on September 11, 1950. Roman numerals indicate instants of first, second, third, and fourth contact.

totality at all three wavelengths. This was probably due to assymmetry of the corona caused by a group of spots near the east limb of the sun.

At first and fourth contact the apparent intensity rose about 10 percent above that of the unobscured sun. The explanation of this effect is not yet clear; it may be due to reflections of solar energy from the surface of the moon at grazing incidence. Diffraction around the edge of the moon could not have been the cause, as waves of kilometer rather than centimeter length would have been required. The possibility that this unexpected rise in intensity might have been caused by reflections from the landscape near the apparatus is now under investigation.

Effects of Prior Stress on the Fatigue of Aluminum Alloys

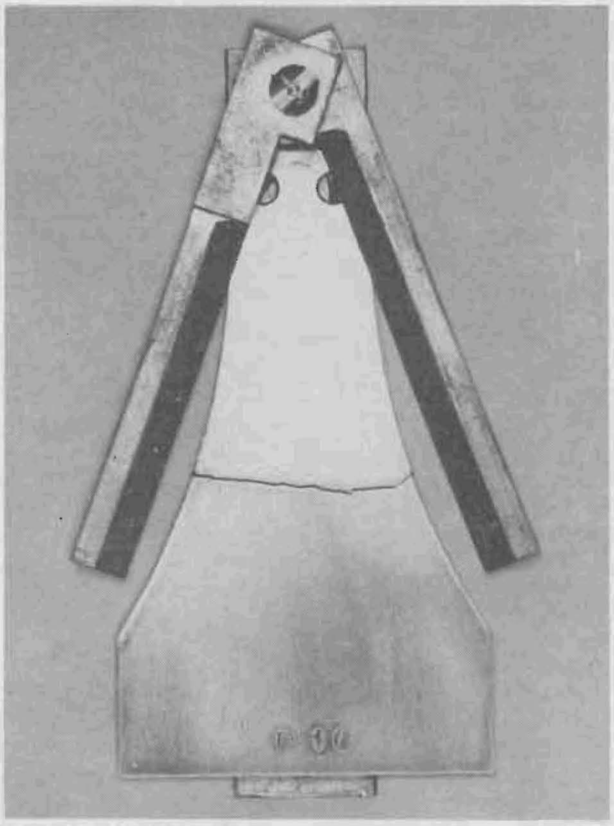
The life of aluminum alloys that are subjected to vibration and other repeated or fluctuating stresses may be materially affected by applying stress to the material before it is placed in operation. Recent investigations at the National Bureau of Standards have shown that this treatment, known as prestressing, in some instances increased the fatigue life manyfold. This was especially noticeable at lower stresses when a comparatively small number of cycles of dynamic prestress were applied. On the other hand, there were cases in which little if any improvement resulted, and at some stresses the fatigue life was shortened by the prestress. These studies were carried out by J. A. Bennett and J. L. Baker in the Bureau's mechanical metallurgy laboratory to evaluate the effects of both static and dynamic prestress on the fatigue properties of structural aluminum alloys. Similar studies have been previously made on aircraft steel.

A metal will often fracture when a pulsating load is applied for long periods of time, even though the maximum stress is much less than that which the metal can withstand if the load were steady. This phenomenon, known as fatigue, is the primary cause of failure in machine elements and other structural members to which varying loads are applied in service. Because of this, the fatigue properties of structural materials are important in the design of dynamically stressed structures. These properties are usually studied by applying a fluctuating load of constant amplitude to a specimen and counting the number of cycles that are required to fracture the specimen. In tests of aluminum alloys, it is not uncommon to find fractures occurring after as many as 500,000,000 cycles of stress, the number of cycles to fracture decreasing as the stress amplitude is increased.

One of the difficulties encountered in applying results of laboratory tests to practical construction arises from the fact that, in many structures, the stresses vary in a random manner. An airplane wing, for example, must support not only the weight of the plane, which is a steady load, but also a fluctuating load due to vertical gusts. To approximate this situation, the cumulative effect of fatigue stressing at two or more different amplitudes was evaluated, using aluminum alloy sheet specimens.

Two means of prestressing were employed. In the first, a rather high static load was applied to the specimen before the start of the fatigue test. In the second, the specimen was stressed in the fatigue-testing machine for a predetermined number of cycles at one amplitude, and then carried to failure at a second amplitude.

Conventional repeated-bending fatigue-testing machines were employed. In these machines one end of the specimen is held fixed in a vise while the other end is deflected up and down by means of an adjustable, motor-driven eccentric and crank. The design of the specimen, however, was new and was found to have several advantages over the usual type. Another innovation was a jig that measured the specimen before testing and automatically located the point at which the stress in the specimen would be at a maximum.



A new design of specimen was used in studying the effect of prestress on the fatigue life of aluminum alloys. The special jig measures the specimen and automatically locates the point of maximum stress. The manner in which fracture took place is also shown.