

# Brief Description of Ranger Lunar Seismograph\*

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12046

*NASw-81*

**Summary**—It is hoped that before long the United States will safely land a Ranger instrument package containing a seismometer on the Moon.

Waves from moonquakes, if they occur, and meteoric impacts will be detected, telemetered to Earth and registered for study.

From the seismograms may be deduced information concerning the Moon's near surface and interior structure. This paper is an abbreviated description of instrumentation for the experiment.

**I** NSTRUMENTATION for performing the Ranger lunar landing seismic experiment is the product of several institutions. The Ranger spacecraft is carried into lunar trajectory by the Atlas-Agena rocket combination. The spacecraft itself is built in the Jet Propulsion Laboratory, California Institute of Technology. Within the spacecraft is a survival sphere containing the seismometer amplifier, data telemetry, temperature control devices, righting devices, batteries, etc., assembled by Aeronutronic Division of Ford Motor Company. Centrally located within the sphere is the seismometer developed by the California Institute of Technology Seismological Laboratory under a National Aeronautics and Space Administration contract, for the Ranger experiment. All devices within the sphere are designed to survive impacts of 3000 G.

The seismometer consists of mass suspended by a spring such that its free period is 1 second. Damping is about critical. Ground signal induced motion of the mass relative to its frame of suspension generates an electrical signal in the coil of a velocity transducer. This is amplified, compressed, and applied to a frequency modulated sub-carrier oscillator which phase modulates the data telemetry transmitter. Transmission is continuous and no data is stored.

On reception at the Jet Propulsion Laboratory Deep Space Instrumentation Facilities, the signal is demodulated and the sub-carrier tape recorded. Playback of the tape through a discriminator, expander and filters

\* Received August 22, 1962. Contribution No. 1089, Division of Geological Sciences, California Institute of Technology, Pasadena, Calif.

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extracts the seismometer signal, which is analog registered on conventional drum type seismograph recorders.

Contained within the seismometer is a device for magnetically displacing the mass about  $10^{-5}$  mm for several seconds. The displacement and release generates a characteristic pulse doublet in the output transducer and indicates functioning of the system. Also included is a means of automatically adjusting the mass suspension attachment. This permits operation in any attitude from horizontal to vertical at lunar gravity and is triggered if the mass comes in contact with a position limit stop.

The system is capable of magnifying motion of the lunar surface by as much as  $1.7 \times 10^6$ . Peak magnification occurs at about 4 cps. Data pass band is 0.05–5 cps.

The seismometer unit is cylindrical in shape with dimensions of 4.37 inches in diameter and 5.25 inches in length. Its weight is roughly 7.5 lb.

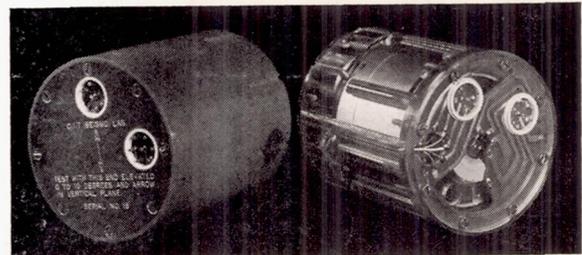


Fig. 1.

Fig. 1 is a photo of a flight unit seismometer with a transparent model. Modified versions have been constructed for operation at Earth G.

## REFERENCES

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Reprinted from the PROCEEDINGS OF THE IRE  
VOL. 50, NO. 11, NOVEMBER, 1962

PRINTED IN THE U.S.A.