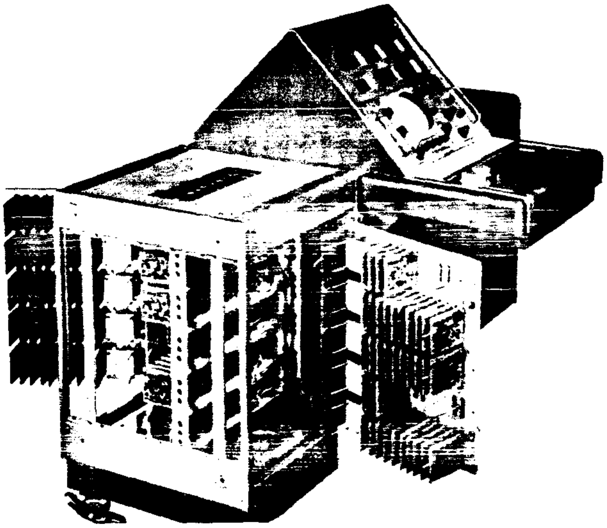
LORAN-C CLOCK TIMING SYSTEM

A SYSTEM for controlling the time rates of widely separated clocks has been developed by G. Hefly, R. R. Doherty, R. F. Linfield, Thomas L. Davis, and Earl L. Berger of the Navigation Systems Section, at the Bureau's Boulder, Colo., Laboratories. The system utilizes radio signals from existing long-range navigation stations (Loran-C) operated by the U.S. Coast Guard, located at various points on the East Coast and compares them with an accurate master clock or frequency standard located at a central station.

First use of Loran-C to synchronize clocks to one microsecond (1 μsec) at widely separated locations was achieved on November 1, 1961, when clocks at Naval Observatory time stations at Washington, D.C., and Richmond, Fla. (near Miami), were synchronized. To insure 1 μsec accuracy the two Loran-C receivers used by the Naval Research Laboratory were temporarily brought side by side. A difference in receiver delay of 4.0 μsec was found and allowed for.

By synchronizing Loran-C with the highly accurate uniform time source maintained at the Naval Observatory in Washington, D.C., the technique is expected to provide—ultimately to large areas of the world—the precise time so necessary to the progress of space science. Scientists from four government agencies, the Coast Guard, the National Bureau of Standards, Naval Observatory, and Naval Research Laboratory, are cooperating in developing techniques and instrumentation for obtaining precise time from Loran-C.



The heart of the Loran–C system. Panel immediately above oscilloscope contains a 15-digit visual display covering one microsecond to hundreds of days.

The early work at Boulder was sponsored by the Ground Electronics Engineering and Installation Agency of the Air Force. Additional studies on propagation are being sponsored by the Coast Guard and Naval Observatory.

The time synchronization was tested in Octob using the East Coast Loran-C chain, which w veloped and established as an aid to navigatio Bureau furnished engineering services to desi build Loran-C clocks and an ultra high frequen ing distribution system to demonstrate fea Loran-C, as a navigation and timing system, can both position and time simultaneously. The n tem is considered a long step forward in imp the future accuracy of tracking guided missil space rockets, and in the precision of data retur tracking stations from satellites.

In the world of science, precise time—measu of events that occur in the millionth part of a sec is a pressing need. In the majority of timing a tions a problem exists in setting two or more clo agree with one another. The greater the requi for agreement between the clocks and the grea distance between them, the more difficult the pr becomes. Clocks cannot be synchronized by e radio timing signals, other than Loran-C, to les a millisecond at widely separated locations.

The Loran-C navigational system consists of a transmitter at a convenient central location and transmitters at widely separated locations whic slaved to track the master. A chain of Loran-C mitters functions as a clock system which is in tionally synchronized to better than a microseco

In the East Coast Loran-C chain, the master s is located at Cape Fear, N.C., and two slave sta are located at Martha's Vineyard, Mass., and J Inlet, Fla. Synchronization of this chain by the Observatory with its uniform time source beg May 1961, and time synchronization is availab potential users within range of this chain.

The NBS scientists have presented a plan for i range timing synchronization which would provide only a needed link between the Atlantic and P missile ranges but also an excellent navigational sy over the continental United States.

Additional scientific and commercial uses of a cise timing system with direct or indirect mil applications are:

1. The positioning of high-altitude aircraft fro ground by using the UHF pulse technique.
2. The location of thunderstorms by precisely m uring the location of the lightning discharge.
3. The accurate position-fixing of nuclear detona by similar means.
4. Relating with increased precision astronom observations made at widely separated points.
5. The precise measurement of time variations high-frequency transmissions such as WWV and urnal variations of very low frequency transmiss such as NBA as an aid to better understandin propagation phenomena.
6. The similar measurement on forward scatte other types of communication systems.

7. The surveying of offshore islands and remote areas.

8. The investigation of Loran-C sky waves to give a better understanding of low-frequency ionospheric conditions.

9. Providing precise time from a single Loran-C clock, which could be made economically feasible for a variety of users in industry and research by the application of VHF or UHF distribution systems. A relatively inexpensive receiver could be used by those located within range of the distribution system. Existing facilities such as TV transmitters could be used for this purpose.

TWO TENSILE CRYOSTATS DEVELOPED

TWO TENSILE CRYOSTATS, capable of making tests at temperatures as low as 4.2 °K. have been developed by the Cryogenic Engineering Laboratory of the Bureau's Boulder, Colo., Laboratories. The first of these devices, designed by R. M. McClintock and K. A. Warren, is capable of sustaining tensile forces up to 5,000 lbs.[1] The second, designed by R. P. Reed, has a load capacity in excess of 10,000 lbs.[2] The two cryostats differ not only in capacity, but in construction and operation as well. Both offer the advantages of simplicity, safety, and low consumption of liquefied gas.

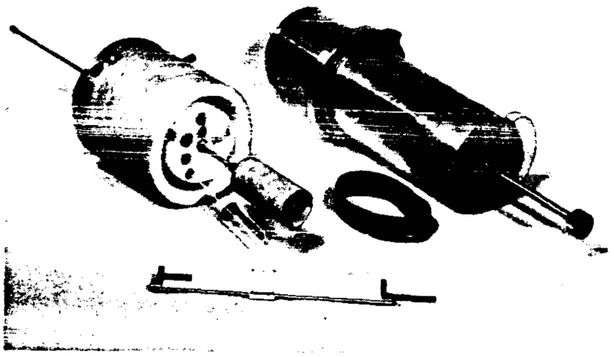
The rapid growth of cryogenic engineering has increased the need for information concerning the properties of materials at low temperature. This is true not only of the fluids normally used to achieve low temperatures, but of the many materials which may be used in low-temperature installations. Of special interest is the effect of extreme cold on metals—a factor to be considered in the design of facilities for producing, transporting, and storing liquefied gases.

5,000-Pound Device

The cryostat having a capacity of 5,000 lbs. is used with standard tensile equipment. The tension linkage extends completely through a stainless steel Dewar and the specimen is submerged in liquid cryogen during low-temperature runs. The major modification of the equipment is the extension of the tension linkage through the vacuum space between the walls at the bottom of the Dewar. Force is transmitted across the vacuum space through a stack of metal washers, this arrangement having been found to result in less heat flow than a solid rod of the same dimensions. To further reduce heat flow into the bottom of the cryostat, the region where the linkage passes through the bottom of the outer shell of the cryostat can be surrounded with liquid nitrogen. A stainless steel bellows is welded to the bottom of the inner shell to permit specimen alinement with the universal-type linkage joint enclosed within the vacuum space and to allow for thermal contraction.

The top of the flask is closed during runs by a rigid foamed polystyrene cover which extends about 6 in. into the cryostat and which surrounds the outer walls to the same depth. A gastight seal is formed between the lower end of the cover and a ring soldered around the outside of the cryostat by means of a thin rubber sleeve. A tube for filling and emptying the cryostat runs down through the cover. The transfer line extends down through this tube during filling and is removed and the hole corked during runs to reduce heat flow. A fluid-level float, various electrical leads, and the upper tension rod also pass through gastight seals in the cover. There is a depression in the cover which may be filled with liquid nitrogen to further reduce heat flow into the cryostat during helium runs.

When determinations are to be made at the temperature of a particular liquid, the cryostat is filled with the liquid to cover the specimen. The cryostat is precooled with liquid nitrogen prior to a helium run. When tests are to be made at temperatures intermediate to the boiling points of various liquids, an open-bottom plastic gas chamber is attached to the upper tension rod to surround the specimen; when the cryostat is filled with liquid, the sample remains in a gaseous atmosphere. Heat is then supplied to the specimen by small electric heaters on the upper and



Tensile cryostat in which the tension linkage extends through a metal Dewar. At left is the foamed polystyrene cover, with the upper tension linkage (center of cover) and liquid-level float running through it. The metal Dewar is at right, showing lower tension linkage, liquid nitrogen reservoir, and vacuum fitting. The rubber sleeve is used to make the junction between top and bottom gastight.