SNOW SURVEYING BY ELECTRONIC TELEMETRY 1/

By

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The computation of water supply forecasts in the West depends heavily on the variable snow cover on the mountains. Determining the water content of snow with a sampling tube is relatively easy. But, "in place" conversion of snow depth into equivalent inches of water in units for recoding and data transmissions is a difficult assignment. The Water Supply Forecasting Branch concentrated on developing a snow sensor device several years ago as the most pressing item needing attention. Considerable time was spent testing various devices that had possibilities of making good snow sensors. The pressure pillow, one such device frequently used now resulted from early work. Different kinds of pillows are still being tested. Today there is plenty of need for improving sensors for mountain data collection. Early work carried out at the Soil Conservation Service Mt. Hood test site fully demonstrated the feasibility of transmitting forecast information. The electronic system developed and tested on Mt. Hood has been in operation several years and still reports data hourly to our Portland base station. The digital readout is provided by a pulse-operated printer. A continuous "onsite" record of all pillows under test is obtained by using standard recorders which are float operated.

A troublesome component is the transducer or interface circuitry. This is the part of the system that links the sensors to the control and transmitting components. Several versions have been installed and "bugs" are still being encountered.

Prototype systems now in operation at various locations and as planned demonstrate the latitude of initial development work. Several commercial companies and universities have developed and installed segments of systems operated by the Soil Conservation Service.

The simplest installation tested (not in use now) consisted of a 100-milliwatt transmitter which was modulated in proportion to the accumulation in a precipitation gage. The received tone was matched with a standard to determine frequency, which was proportional to the weight of precipitation in the gage. Stations could be read by flying over in a plane or from a vehicle on the ground having line-of-sight to the data site. This system required that the transmitter run continuously. Permanent frequency authorization under these conditions is difficult or impossible to obtain. This work, however, supported the feasibility of obtaining mountain data by remote means at economical costs. Adding receiving equipment at the data sites and interrogation equipment at the base eliminated the need for continuous transmitter operation but added to the complexity and cost of the installation. The interrogation of stations from an airplane also presented problems. Flying conditions delayed trips and proved to be hazardous. Charges were high. These problems directed further automation of the data collection procedure which necessitated installing base and repeater stations.

There are basic differences in the network segments now in operation. These differences are mainly in the encoding and modulating equipment at data sites and the decoding and readout equipment at the base station. Some are the so-called analog systems and others the digital or some version of the digital system. Readout is obtained by frequency count, pulse-operated printers, voltage- or current-operated recorders and standard teletype machines.

This diversified approach to snow surveying and data collection has established the basis for setting standards and specifications for telemetry peculiar to the needs of the Soil Conservation Service and mountain network operation.

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We have supported the idea that a water supply forecaster must have a "feel" for his information and be thoroughly familiar with the characteristics and peculiarities of the area he is forecasting. This requires that he knows what the figures represent. This method of forecasting dictates to some extent the method used for data collection. Operating experience and studies indicate that the most versatile and economical telemetry snow data collection network is one segmented with base stations, repeater stations, and outlying data collection sites. Each snow survey supervisor has full control of network segments and data analysis for his State. This permits the application of local knowledge to the entire process of forecast formula development and forecasts. It permits the timely transfer of information to cooperating agencies and water user groups.

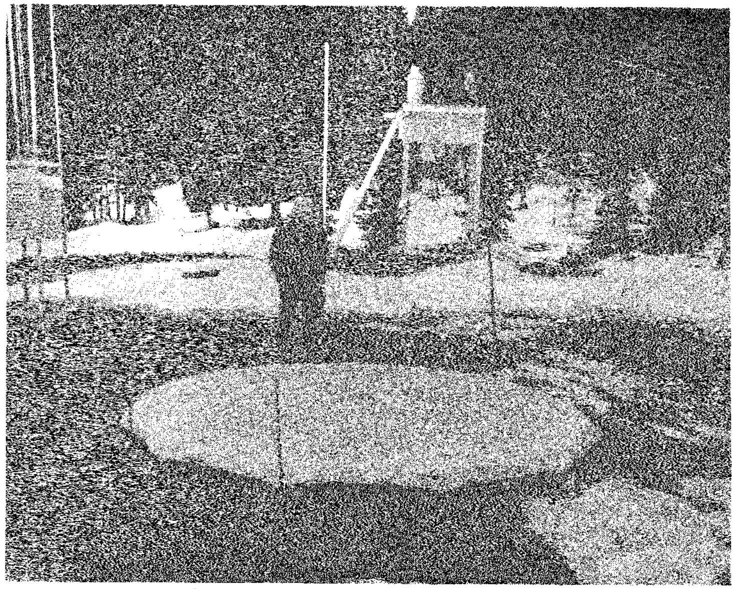
The Soil Conservation Service has prototype systems in operation in seven States with electronic telemetry equipment installed on 33 sites. Fifty-four pressure pillows are installed at data collection sites and 50 of these are connected to "onsite" recorders.

It is likely that some standardization of equipment, operating requirements, and specifications would prove to be beneficial to data collection agencies.

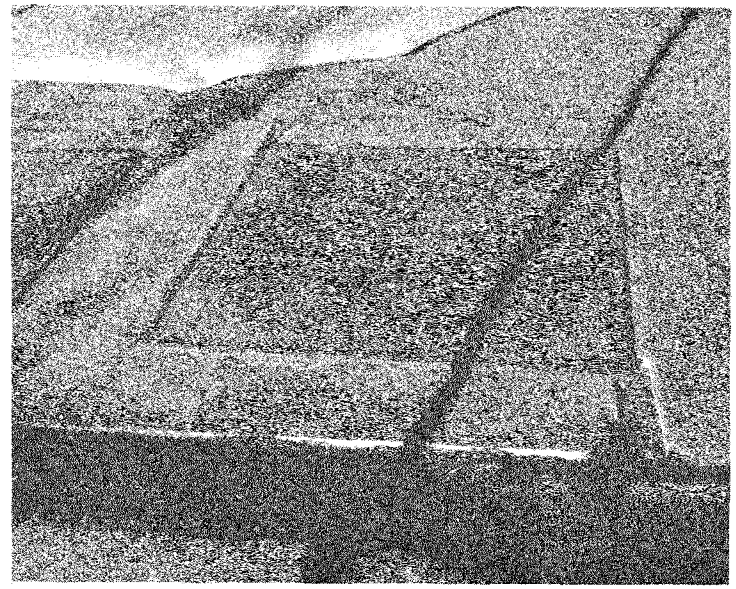
Stated in simple terms a telemetry system should have the capability of providing "real time" information about conditions at a mountain data collection site. The snow surveyor is primarily concerned with the accuracy of readout, stability of the system, and the ease with which the volume of incoming information can be processed. Operation of sensors and telemetry under winter conditions at high mountain elevations imposes severe requirements for trouble-free operation. Trouble-free operation is a must because at some locations it is impractical to provide maintenance during the winter months. Commercial AC power is not available at most sites, thus requiring special consideration for DC power sources and low consumptive-use equipment.

The technical force handling data has a job too. It determines the significance of reported data and projected plans for data collection. Telemetry systems can be operated to provide great volumes of data, much of it being repetitive. Therefore, some rules and judgment must be followed to collect and process only the data having some significance or value. Realistic studies should point out those stations which are significant for operations and those needed to back up or supplement data from the key stations. A lengthy period of record may be required to make these determinations.

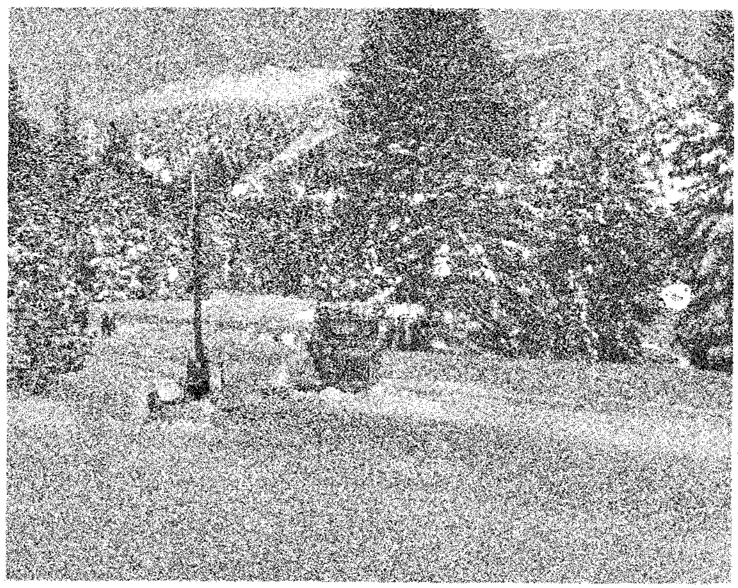
Acquiring "real time" data from the mountain at any time interval greatly enhances the knowledge of the forecaster. This advancement should greatly assist in predicting the water supply outlook, potential flood flows, rate of runoff, and drought. Efficient use of water begins with a knowledge of the snow on the mountains.



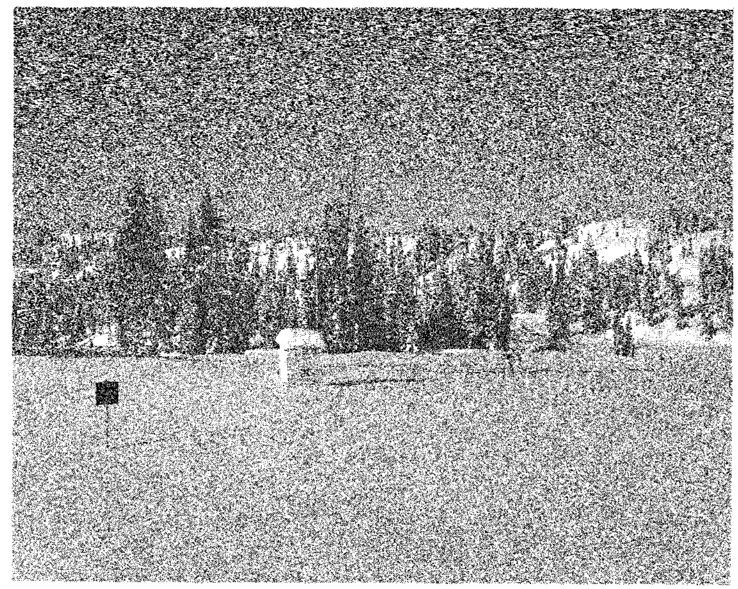
Data collection site, Park Range near Steamboat Springs, Colorado. Electronic telemetry equipment is powered by batteries. Solar cells are used to charge batteries. The data site is interrogated from base statio at Steamboat Springs.



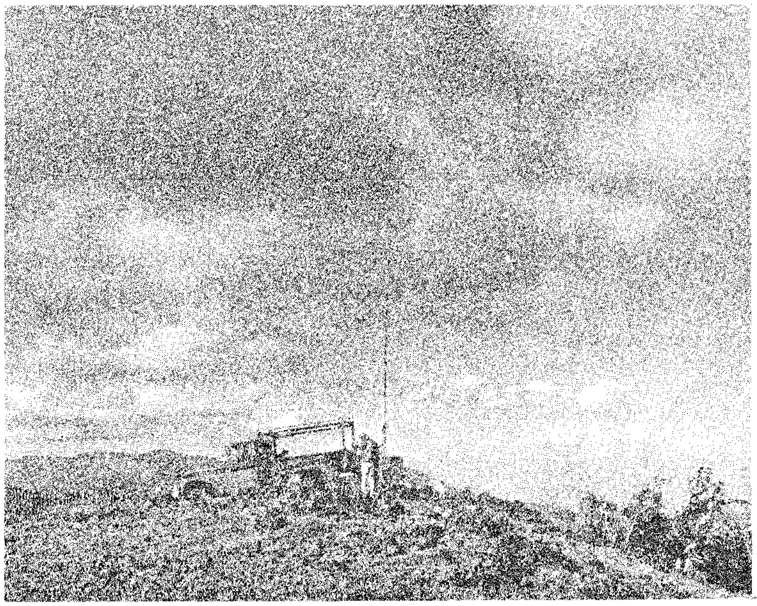
One type of metal snow pillow being tested at the Garden City Summit Snow Course in Utah. The installation is on a rigid base.



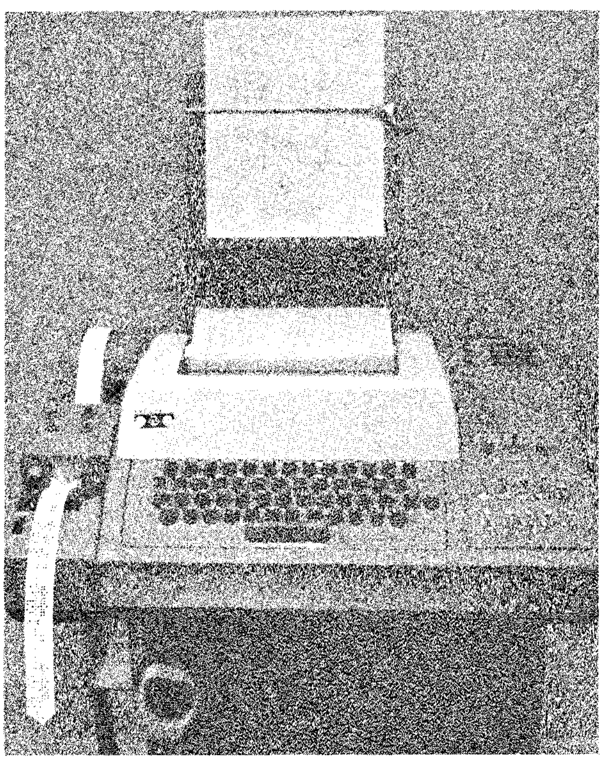
Hagens Meadow Snow Course, Nevada. A snow pressure pillow is connected to an electronic telemetry system. The station is interrogated from the Reno base station.



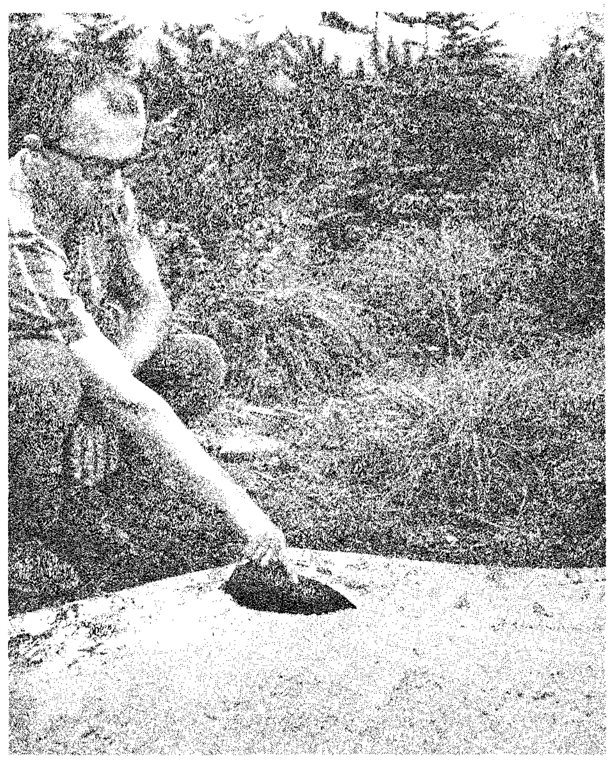
Snow pillow installed and ready for winter snowfall. Information is sent by radio to a base station in Steamboat Springs, Colorado, 10 miles away.



Snow Valley Peak repeater station near Reno, Nevada. Information from data site is relayed through this station to the base station at Reno.



Recently installed (1957) automatic telemetry readout component - Oregon State office, Portland. Presently receives data from snow courses 240 miles away.



Rubber snow pillow at the Willamette Pass snow course, Oregon. Tom George, Assistant Snow Survey Supervisor for Oregon, holds a rip in the pillow made by an inquisitive elk. Damage to pillows by wild animals is a problem.