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Pavement Icing Warning Systems Laboratory Evaluation of Econolite and Nelson Prototype Devices

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Introduction

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The similarity lies in the sensing of two separate conditions that must occur simultaneously if ice is to be formed, namely low temperature and the presence of adequate moisture; and the switching of warning lights or heating apparatus or both, as in the case of aircraft.

The sensing elements that have been developed for aircraft surfaces and the control of heating on radio towers are very successful in their intended environment and have a long record of reliable performance. However, they are not suitable for imbedment in highway pavements.

The two ice detector systems that will be discussed in this paper are fairly recent devices and both are designed with sensors intended for flush imbedment in roadway pavements. Both are capable of detecting the required conditions of surface moisture and the presence of near freezing temperature. Both systems will furnish an ice alarm by closing a relay and may also operate any other relay controllable function, such as energizing buried heating wires through additional power relays that must be furnished by the user.

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STATE OF CALIFORNIA
HIGHWAY TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

PAVEMENT ICING WARNING SYSTEMS LABORATORY EVALUATION OF ECONOLITE AND NELSON PROTOTYPE DEVICES

67-39

JANUARY 1967

State of California
Department of Public Works
Division of Highways
Materials and Research Department

January 1967

Fed. Prog. No. B-1-30

W. O. 19605 -- 636344

Mr. John L. Beaton
Materials and Research Engineer
Materials and Research Department
Sacramento, California

Dear Mr. Beaton:

Submitted for your consideration is a report of:

PAVEMENT ICING WARNING SYSTEMS

LABORATORY EVALUATION OF ECONOLITE

AND NELSON PROTOTYPE DEVICES

Study made by . . . . . Structural Materials Section
Under general direction of . . . . . E. F. Nordlin
Work supervised by . . . . . J. E. Barton
Tests and report by . . . . . Louis Bourget

Yours very truly,

Eric F. Nordlin
Assistant Materials and Research
Engineer - Structural

LB:mw

This is a report on the Econolite Ice-Moisture Detector and the Nelson Snow Melter Control. Both of these systems are prototype models and are capable of certain variations according to the special requirements of the user or as field experience may disclose a need.

Both systems were tested under laboratory conditions only. The work was performed under the Federal Aid Work Program, Project HPR-1(3), Item B-1-30.

The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the Bureau of Public Roads.

INTRODUCTION

The philosophy underlying the design of ice warning detector systems is broadly similar whether intended for aircraft, radio towers, highway pavements or other environments.

The similarity lies in the sensing of two separate conditions that must occur simultaneously if ice is to be formed, namely low temperature and the presence of adequate moisture; and the switching of warning lights or heating apparatus or both, as in the case of aircraft.

The sensing elements that have been developed for aircraft surfaces and the control of heating on radio towers are very successful in their intended environment and have a long record of reliable performance. However, they are not suitable for imbedment in highway pavements.

The two ice detector systems that will be discussed in this paper are fairly recent devices and both are designed with sensors intended for flush imbedment in roadway pavements. Both are capable of detecting the required conditions of surface moisture and the presence of near freezing temperature. Both systems will furnish an ice alarm by closing a relay and may also operate any other relay controllable function, such as energizing buried heating wires through additional power relays that must be furnished by the user.

SUMMARY AND CONCLUSIONS

Both the Econolite and Nelson systems gave reliable and repeatable ice warning signals when subjected to laboratory cycling of the temperature sensor, in an ice bath, while the moisture sensor was wet; or by cycling the surface wetting of the moisture sensor while maintaining the temperature sensor near freezing, in an ice bath.

Obviously, the sensors can only indicate conditions at their place of imbedment in the pavement. Therefore, in actual service, the sensors should be placed in shaded spots "most likely to freeze first and thaw last" in an ice prone area. If this simple precaution is observed, either system should be capable of reliable application and the equipment choice may be determined by the information required at the particular site.

It is anticipated that the ice warning equipment will be utilized in research projects to be initiated by the Bridge Department. The original proposal for field tests have been deleted in favor of a more comprehensive research project to be performed by the Bridge Department.

exists, as the moisture sensor heating coil normally turns on at 35 degrees F., when the heat control is adjusted according to instructions.

This circuit could be utilized to close a NEAR ICE warning relay in advance of actual ice formation. The relay would have to be added by the user. This relay could also trip a power relay to heater wires in the pavement and prevent ice formation rather than melt the ice after formation.

The Econolite system is not intended for operating from more than the two sensors supplied, although the system could be transferred to another pair of sensors in a different lane by changing the wires.

The sensors are imbedded in the pavement with an epoxy mix and must be considered expendable if the equipment is moved to another location.

The Basic Components

There are three basic parts to the Econolite system; the two sensors that have already been mentioned and a weather proof, heavy cast aluminum control box containing the solid state electronic control system. Please refer to Figures 1 and 2.

The sensors are both cylindrical and are equipped with 20 feet of burial cable.

The control box door has a weather gasket and a lock already installed.

The price of the system is $695 and includes one gallon of epoxy potting compound, a curing agent, and some dry sand for the mix to imbed the sensors and cables.

A dry condition at both pavement sensors produces no warning, regardless of temperature, as none is usually required (same as Econolite). A wet condition at both pavement sensors above 34° F produces no warning (Econolite provides a Wet warning).

The Basic Components

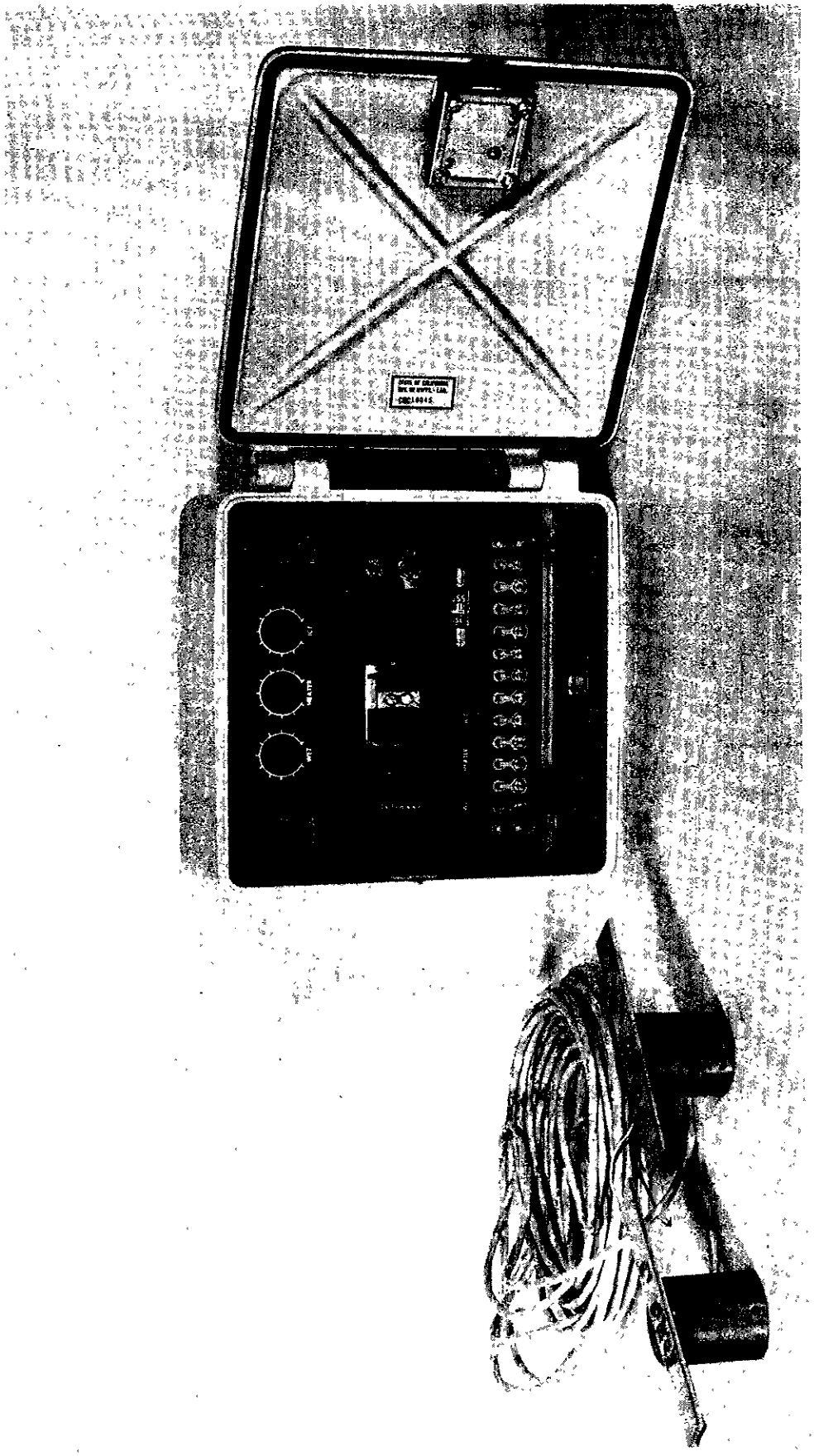
The Nelson basic components include the three sensors already described, plus a junction box and a solid state electronic control unit. Please refer to Figure 3. The price of the system is $250 (the Econolite price is $695). Therefore, where an ice warning is desired and a wet warning is not essential, the Nelson Snow Melter may offer a significant cost savings.

Final Remarks

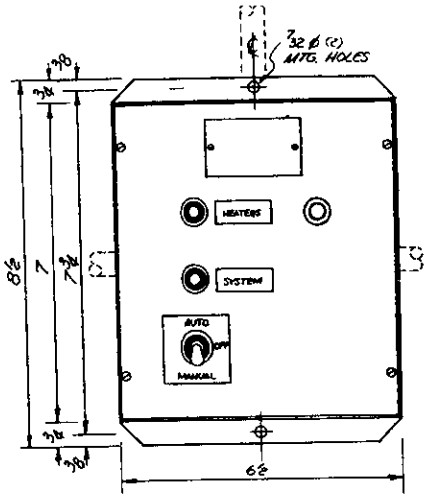
Both the Econolite and Nelson systems were equipped with very positive acting temperature sensors. The moisture sensors required some presence of ions in the water for proper operation of either system. This should not be a problem in a practical roadway installation where some amount of water contamination is always present at the roadway surface. However, neither system would detect the presence of ordinary Sacramento tap water unless a few granules of salt were added.

As stated in the Summary, both of the systems yielded reliable and repeatable ice warnings during cycling of the temperature sensor in an ice bath while the moisture sensor was wet; or by cycling the surface wetting on the moisture sensor while maintaining the temperature sensor near freezing in the ice bath. The sensors can only indicate conditions at their place of imbedment in the pavement. Therefore, the sensors should be placed in a shaded spot that is most likely to freeze first and thaw last, in an ice prone area.

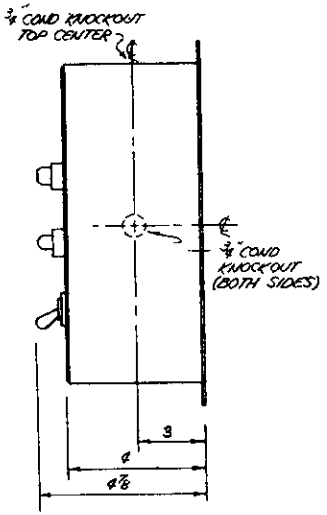
Figure 1



ECONOLITE ICE-MOISTURE DETECTOR SYSTEM

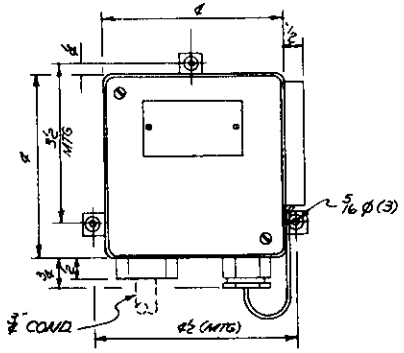


FRONT VIEW

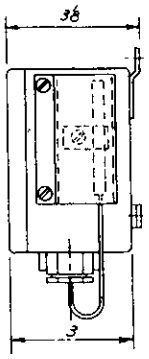


SIDE VIEW

SNOW CONTROLLER

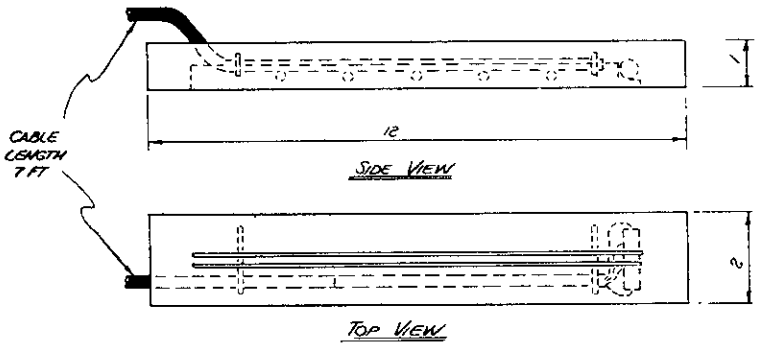


FRONT VIEW

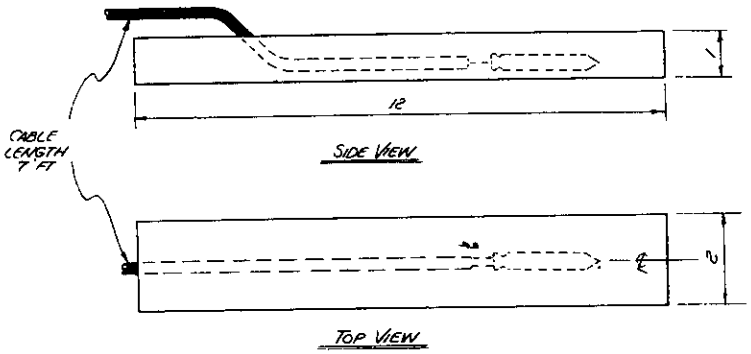


SIDE VIEW

AIR TEMPERATURE SENSOR



MOISTURE SENSOR



GROUND TEMPERATURE SENSOR

COURTESY OF NELSON ELECTRIC MANUFACTURING CO.

MATERIAL	FINISH	TOLERANCE
MAT'L SPEC.	FIN SPEC	SCALE

OUTLINE DIMENSIONS & REQUIRED OPERATING EQUIPMENT

CL. 300

CONFIDENTIAL PROPERTY OF NELSON ELECTRIC MFG. CO. TULSA OKLAHOMA

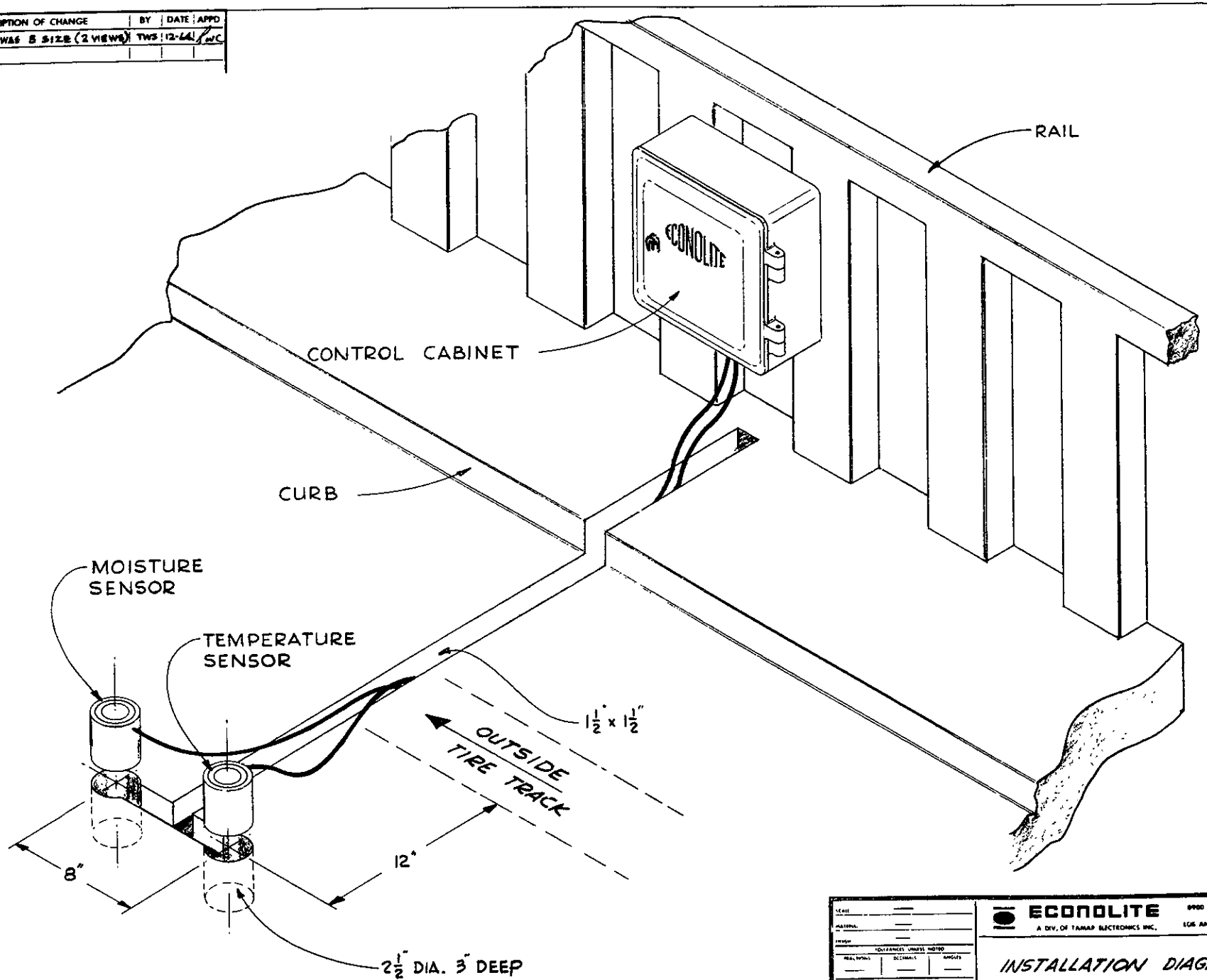
REF:	
DISTRIBUTION	
S. FILE	X
PR. FILE	X PRINT RACK
TRV. SO.	
CAD	D/L
FINISH	

GA-933 R0

DWG. GA-933

Figure 3

REV	DESCRIPTION OF CHANGE	BY	DATE	APPD
A	REDRAWN, WAS B SIZE (2 VIEWS)	TWS	12-64	



COURTESY OF ECONOLITE

DRAWN	J.K.	5-11-64
CHECKED	TWS	5-64
APPROVED	W.S.	5-64

ECONOLITE
A DIV. OF TAMAR ELECTRONICS INC.
8900 BELLANCA AVE
LOS ANGELES 45 CALIF

INSTALLATION DIAGRAM
ICE & MOISTURE DETECTOR

PART NO. 018-7008
DRAWING NO. C-018-7008
REVISION A

Figure 2

The principal differences in the two systems tested are discussed in detail in the text, but briefly they are as follows:

> The Econolite system furnishes both a wet warning and an ice warning signal, from pavement imbedded sensors controlling the amplifiers and relays. An ice warning will revert to a wet warning if the ice is melted by salt application.
>
> The Nelson system furnishes an ice warning signal (only) and was designed to control electrical heating wires. The ice warning will remain on when the ice is melted by salt application if the pavement temperature remains below 32 degrees F. An optional air temperature probe permits an early ice warning signal and the energizing of heater wires in advance of actual freezing at the pavement surface.

THE ECONOLITE ICE-MOISTURE DETECTOR

Function

The Econolite Ice-Moisture Detector can identify three specific surface conditions: dry, wet, and ice. Two sensors are employed. The one for moisture has an internal heater to prevent freezing. The one for temperature has a dual function: freezing temperature indication but with moisture override to indicate when the ice has been melted from salt or natural causes.

A dry condition at both sensors produces no warning, regardless of temperature, as none is normally required.

A wet condition at both sensors at any temperature will close a relay to furnish 115 volts AC at 5 amperes to a pair of output terminals. This may activate a WET warning sign or any other relay controllable function.

An ice condition will transfer the relay voltage to other output terminals for activating an ICE warning sign or any other relay controllable function.

If the ice melts on the surface of the unheated temperature sensor, the relay reverts to a WET warning condition.

The equipment will return to a no signal condition when both ice and wet hazards cease to exist.

Optional Possibilities

The Econolite is not designed to give an advance warning of near ice conditions before the actual freezing occurs on the surface of the temperature sensor, yet the possibility

THE NELSON SNOW MELTER CONTROL

Functions

The Nelson Snow Melter control can identify two specific surface conditions: the absence or presence of conditions favoring ice formation. There is no WET warning provided. Three sensors are employed. The sensor for detecting moisture at the moisture at the pavement surface has an internal heater at one end (the sensor has a rectangular solid shape). The sensor for detecting pavement temperature has a similar shape and closes a thermal switch at 33.8 F. The third sensor is an air temperature probe with an adjustable setting and is located off of the highway. Its use is optional. Additional temperature sensors, of either ground or air type, may be connected in parallel without modifying the equipment.

The air temperature probe and the ground temperature sensor are connected in parallel, and together are in series with the moisture sensor. If either air temperature or ground temperature drops to near freezing conditions while the moisture sensor is wet, a relay is closed to furnish 2.0 amperes of current (max.) at 115 volts AC on the output terminals of the control unit. This can activate an ICE warning or a heater system through external power relays designed to handle the load.

The air temperature sensor can be omitted if desired. The primary purpose of the air sensor is to permit activation of a heater system in advance of actual ice formation on the pavement, if desired. When so used, an ICE warning is given, even though the ice may be prevented from forming.