



Pacific Southwest Forest and Range  
Experiment Station - Berkeley, California  
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## THE FUEL TEMPERATURE COUNTER

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Fuel temperature is and has always been difficult to measure. To understand better the problem of fire and fire weather behavior, it is important to measure this variable. We have developed for field use a new fuel temperature counter which can be used to obtain such measurements quickly and easily. This electronic recording instrument is easy to construct and operate, is highly portable, has low power requirements, and will operate up to 2 weeks without attendance. It consists of three fuel temperature sensors, a pulse generator, a timer, and an accumulating counter (figs. 1 and 2).

The sensors are made from three thermistors, wired in series, and each placed in a hole drilled through a wood dowel which simulates fine fuels. Three dowels are inserted into a styrene ring 120 degrees apart, and the unit is sealed with wax. The sensor is fitted with a 3-inch brass spike for insertion into the ground.

The pulse generator (fig. 3) consists of a unijunction transistor, two amplification transistors, two capacitors, two resistors, a trimming potentiometer, and a diode arranged on a small Vector board--all sealed in wax and placed in a plastic container. The unijunction transistor produces the pulses. The capacitance and resistance in the emitter circuit determine the pulse repetition. Part of the resistance can be adjusted by the trimming potentiometer. The other part varies with the temperature of the fuel. The capacitance is fixed. The higher the resistance, the longer the time interval required to bring the emitter voltage up to the firing point of the unijunction transistor. The output pulse is then amplified and fed into a counter which records pulses for a predetermined time interval.

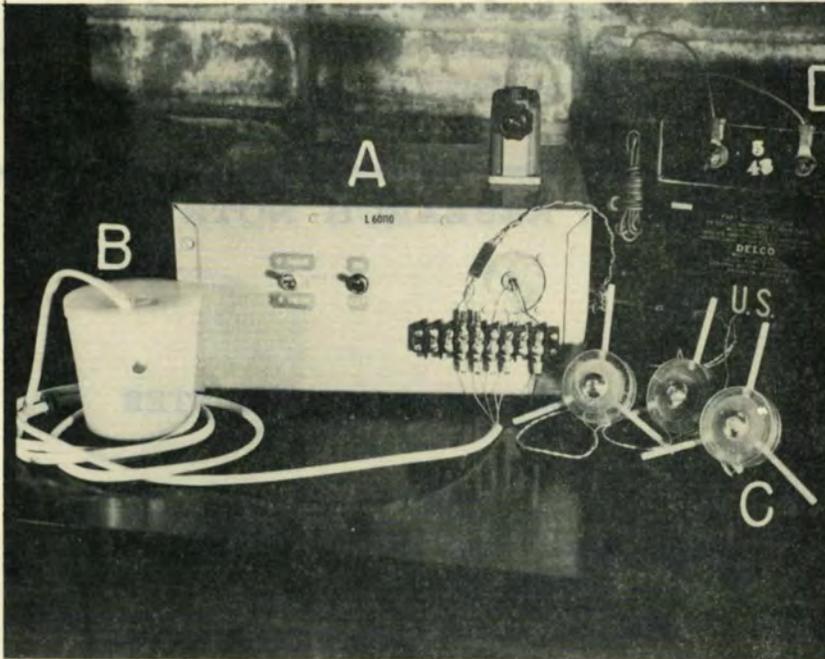


Figure 1.--The fuel temperature counter consists of A a counter-timer, B a pulse generator, C sensors, and D a 24-volt battery.

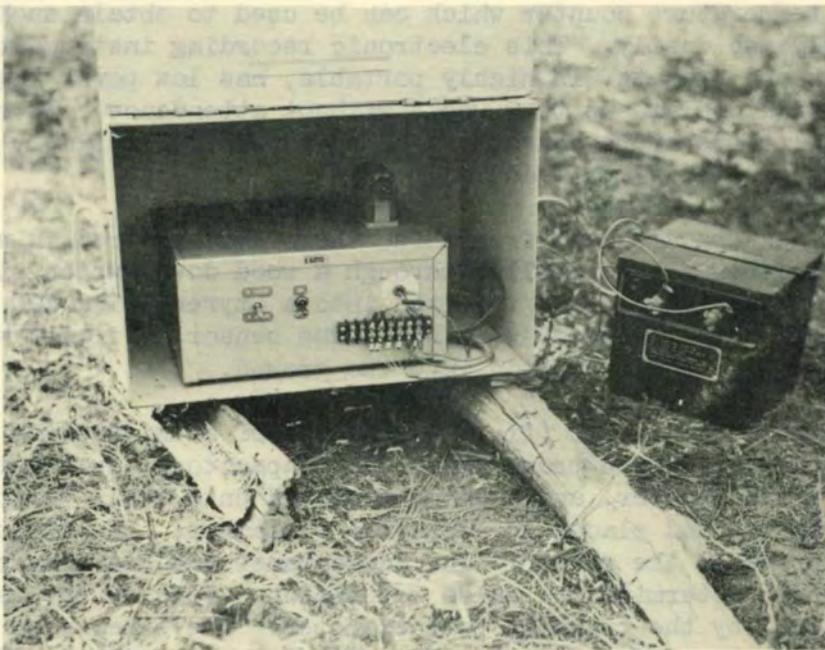


Figure 2.--The fuel temperature counter installed in the field. The pulse generator is buried 3 feet to keep the temperature constant. The counter-timer is protected by the metal carrying case.

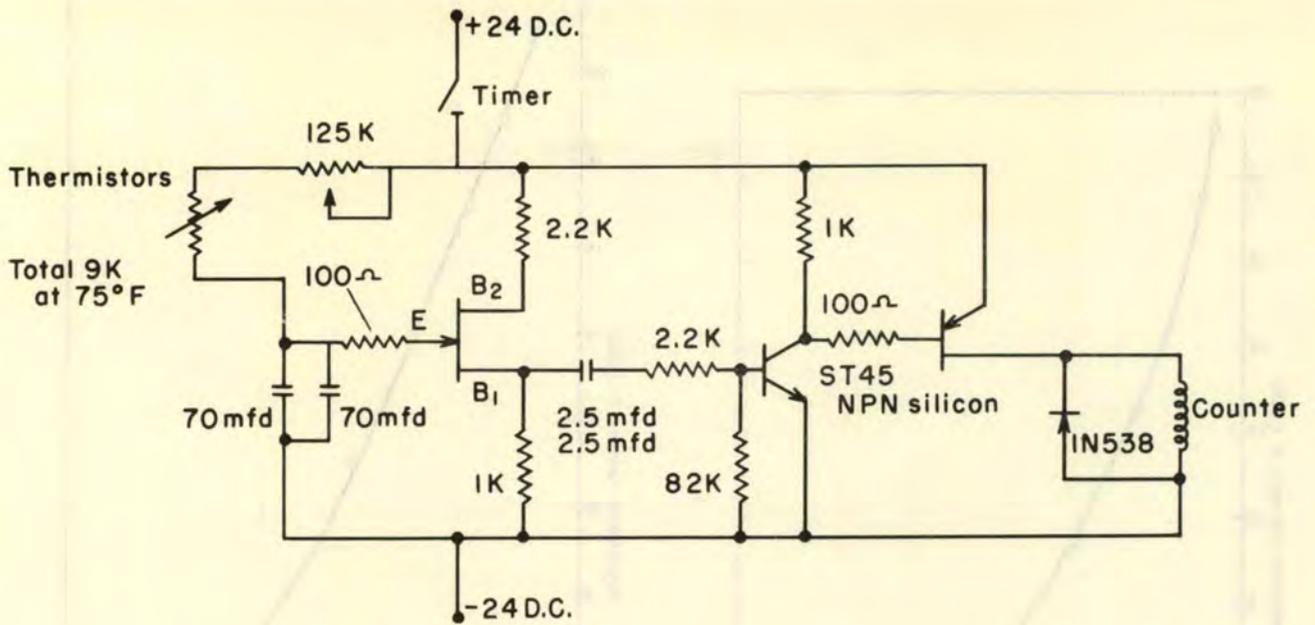


Figure 3.--Schematic diagram of pulse generator-amplifier.

The timer consists of a clock, microswitch, and stepping switch all mounted in a metal box. The clock closes a microswitch every hour, thereby moving a 24-contact stepping switch ahead one position. The contacts are wired together so that an average temperature can be taken for the period of from noon to 4 p.m. or from 8 a.m. to 4 p.m.

Pulses accumulate on a standard 24-volt electrically powered counter. The counter is attached to the top of the box housing the timer.

The fuel temperature counter is based on the principle that thermistors change resistance as temperature changes. The resistance of the sensors controls the rate at which the pulses accumulate on the counter.

The sensors were calibrated in a controlled oven. Curves were then plotted, showing the relation between fuel temperature and resistance (fig. 4). We replaced the sensors with fixed precision resistors in order to measure the relation between resistance and pulses per unit of time (fig. 5). We then combined these two curves to give us the relationship between temperature of the sensors and pulses per unit of time (fig. 6). The number on the counter can be converted to average fuel temperature (°F.) for a given unit of time by using these data.

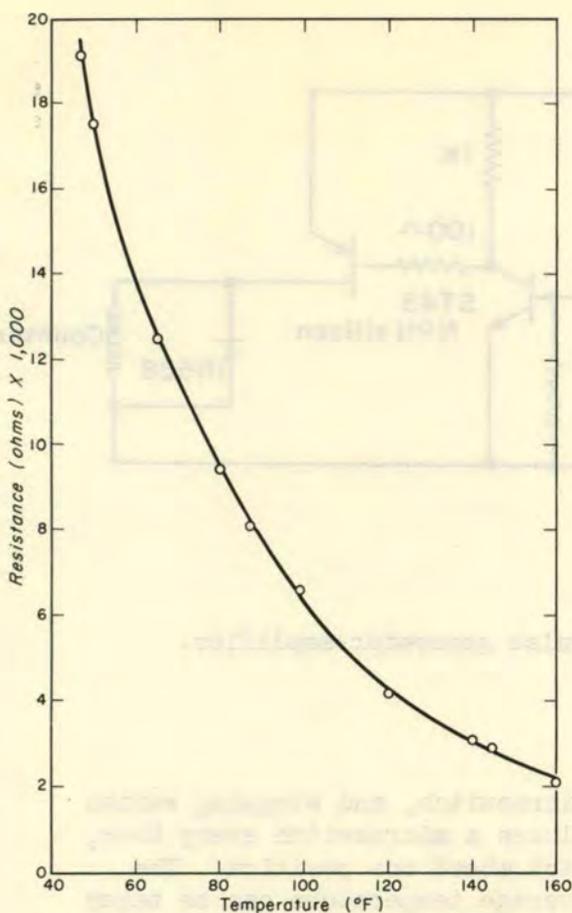


Figure 4.--Relationship between resistance (ohms) of sensors and temperature (°F.).

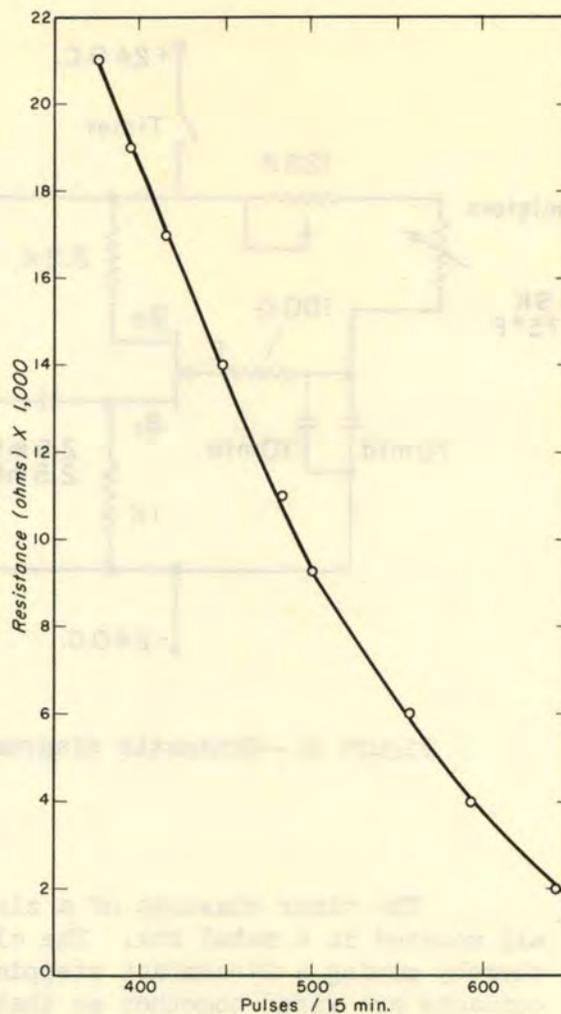


Figure 5.--Relationship between resistance (ohms) of bridge and pulses per 15-minute units.

To use the counter in the field, insert the spikes on the sensors into the ground so that the dowels are parallel with the surface. The distance between the dowels and the surface will depend on the individual study as fuel temperature is related partially to this distance. Bury the pulse generator 3 feet deep so as to keep the temperature constant. The timer is set to take 4- or 8-hour readings. The accumulation on the counter is read after a set period of time and converted to the average fuel temperature for that period. To take instantaneous readings, connect the sensors directly to an ohmmeter and convert resistance to fuel temperature.

The fuel temperature counter can be used in any study dealing with the temperature of duff and small fuels, such as fireclimate, seedling survival, and ecological studies.

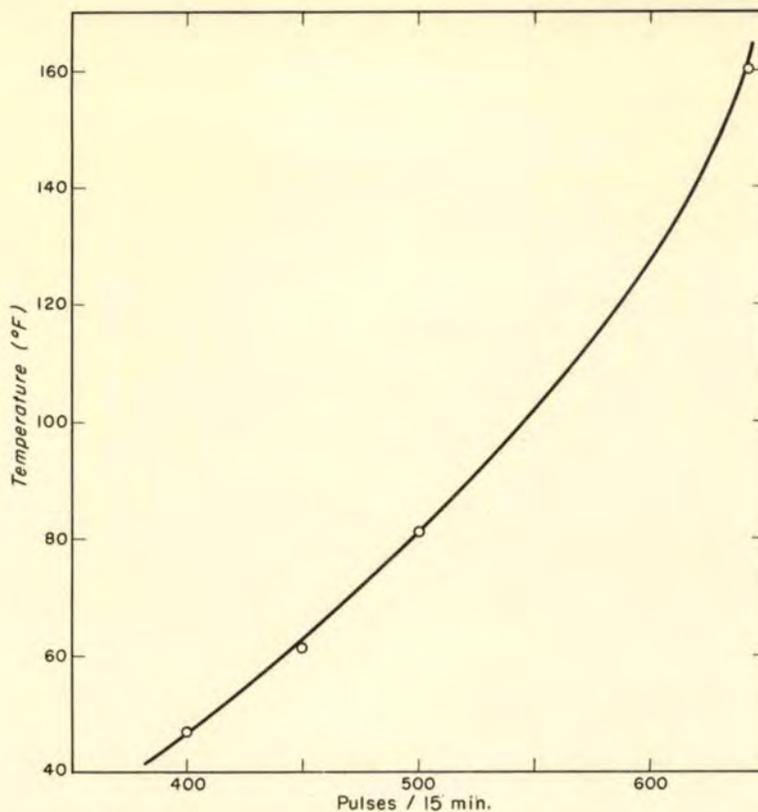


Figure 6.--Relationship between temperature of sensors and pulses per unit of time.

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1. A numbered series, U.S. Forest Service Research Papers.
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The Research Note series formerly published by this Station closed with the release of Research Note No. 211, 1962.

