

# ELECTRONIC CLOCKS FOR TIMING IRRIGATION ADVANCE

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## INTRODUCTION

One of the basic parameters affecting surface irrigation performance is the rate of water advance in a furrow, basin or border. Rate-of-advance varies with the soil infiltration rate which, in turn, varies both within a given field and with time throughout the irrigation season. Mathematical models can predict rate-of-advance; however, they depend upon a knowledge of the actual field soil infiltration rate which is difficult to accurately measure or predict. Thus, rate-of-advance field data are needed to supplement model predictions and to calibrate the models. Recently, many rate-of-advance studies have been conducted to determine the effect of surge flow on the soil's intake rate and the water advance rate. Water applied intermittently advances to the end of the furrow in less application time for most soils than when applied in continuous streams.

Monitoring rate-of-advance in a number of furrows requires consid-

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Footnotes 1, 2, and 3:

Location should be Kimberly, ID

erable man-hours and several people, particularly if a number of replications are made with intermittent flow. The number of people required to monitor rate-of-advance can be greatly reduced by using water sensors and time recorders spaced down the length of the furrow to record the time that the advancing water front reaches a given point. Low-cost, electronic "stick-on" clocks, modified for this purpose, along with their associated sensor, are described in this paper.

### ELECTRONIC CLOCKS

Stick-on electronic digital clocks are available in many drug and variety stores and can be obtained in quantity for about \$2 each. These clocks were modified by attaching a sensor to serve as a switch between the clock's battery and the clock circuit. One side of the battery is isolated from the clock circuit with a small piece of electrical insulating tape inserted between the battery and its cover plate as shown in Figs. 1 and 2. The battery cover plate serves as the electrical contact for one battery terminal. The stripped ends of wire leads from the sensor are placed on each side of the insulating tape so that one lead makes electrical contact with the battery, and the other makes electrical contact with the battery cover plate. The wire leads are held in place by the clamping action of the cover plate when it is replaced. A knot is tied in each wire lead before it goes through a small hole in the rear clock cover to keep the wires from being pulled loose. As shown in Fig. 1, there is usually space within the clock enclosure where the knots can be tucked out of the way. However, the clocks are made by different manufacturers and some have more room to place the knots than others. Small diameter wire (Alpha 1853-26 Ga or equivalent with thin insulation) was used to minimize the space required. When two single wires were used, they were covered with a small diameter plastic hose to avoid tangling. Two-conductor cable with an insulating jacket, if available, would be more convenient to use. The clocks can be waterproofed by covering them with a liquid latex or plastic dip coating.

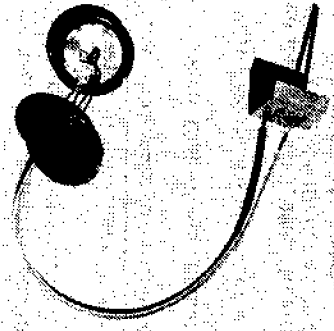


FIG. 1.—Water Sensor and Inside Rear View of Modified Electronic Clock Showing Wire Connections for Sensor

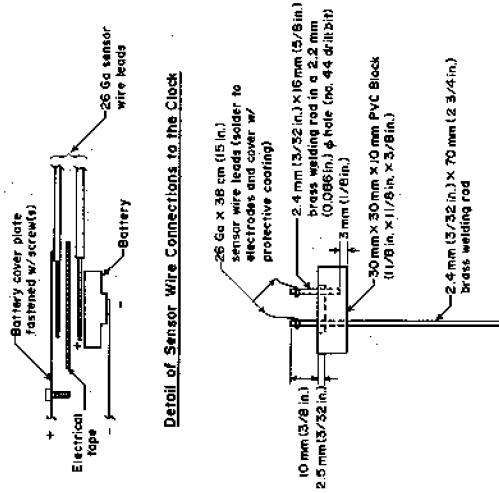
### SENSOR

Water sensors were constructed as shown in Fig. 2. The two sensor electrodes were made from 2.4 mm (3/32 in.) diam brass welding rod. They were pressed through 2.2 mm (0.086 in.) diam holes drilled in a 30 mm (1-1/8 in.) x 30 mm (1-1/8 in.) x 10 mm (3/8 in.) PVC block. The depression in the center of the sensor block was made with a modified 16 mm (5/8 in.) speedbore drill bit. The centering point on the bit was made smaller and shortened to about 3 mm (1/8 in.) length so that the point would not cut through the block. The 38 cm (15 in.) long wire leads from the clock were soldered to the ends of the electrodes with the terminal connections covered with a protective coating such as epoxy or similar material. One sensor electrode extends through the block to provide mechanical support when placed in the furrow. A spot of solder or epoxy was placed on this electrode on the bottom side of the block to prevent its movement in the block when inserted into hard soil.

Once a technician becomes familiar with the technique, the clock-sensors can be assembled quite rapidly. One person can assemble approximately 40 units/day.

### FIELD USE

The sensors can be rapidly installed in a test furrow or downfield in a border or basin by one person while measuring the distance from the inlet. The sensor is placed in the furrow or on the ground with the top of the block level with the ground surface at the point where the advancing water front is to be monitored (Fig. 3). A rack can be used to



Detail of Sensor Wire Connections to the Clock

Water Sensor

FIG. 2.—Diagram of Water Sensor and Its Electrical Connections to Electronic Clock

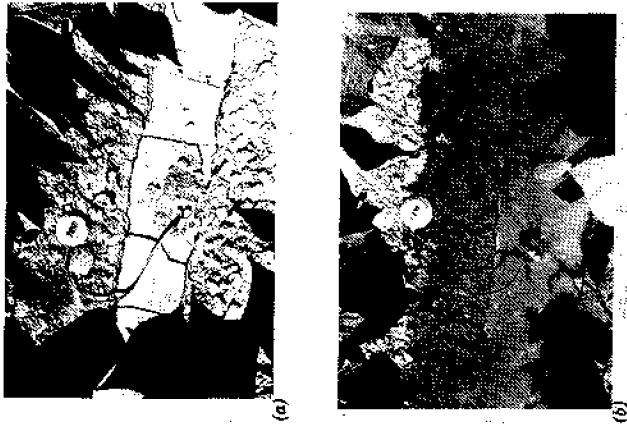


FIG. 3.—Clock Sensor In Furrow: (a) Before Irrigation; (b) During Irrigation

facilitate carrying and handling of the sensors, if desired.

The amount of electrical current required to operate a clock is minutely small. Therefore, the depression in the sensor block must be dry so as not to provide an electrical conducting path when the sensor is installed. Since the soil can dry considerably and still conduct enough current to operate the clock, considerable time can usually elapse after irrigation is completed before the clock-sensors are picked up when the block depression fills with water and soil. However, when trash is present, they should be picked up as soon as practical, since the sensors tend to catch trash which can block the furrow and may cause erosion around the block.

When used in furrows, the clocks are laid on the ridges to keep them dry. In basins or borders, the clocks could be supported by a stake or mounted directly on an enlarged version of the sensor to keep them above the water. Since the clocks are not waterproof, they should be protected from rainfall should it occur. When the advancing water front reaches the water-sensor, the water completes the electrical circuit between the electrodes, and the clock is immediately turned on, as shown in Fig. 3. The clocks are designed to turn on at 1:00 a.m. Only about 1% of those we have obtained started at another time.

To determine the advance time, the time of day at the beginning of irrigation,  $T_1$ , is recorded in 24-hr format, as well as the time of day,  $T_2$ , at which the clock-sensor is picked up. The time displayed by the sensor clock,  $t_d$ , must be noted before the clock is picked up, or the electrical circuit may be broken, causing the display to go blank and the

time to be lost. The clock time,  $T_c$ , is recorded as the display time minus the one hour turn-on time,  $(t_d - 1)$ , (also in 24-hr format if  $(t_d - 1)$  exceeds 12). Thus, the advance time,  $T_x$ , to any point downfield is determined from

$$T_x = T_2 - (T_1 + T_c) \dots \dots \dots (1)$$

in which the hours and minutes are added algebraically, individually. The clocks can be picked up and re-installed to monitor advance further downfield by cleaning and drying the block depression to interrupt the electrical current path.

These clock sensors were used in surface irrigation water advance studies during the summer of 1984. They were reliable and greatly facilitated obtaining field data with a limited number of personnel. They were also useful in reducing the amount of walking necessary when there was full crop cover in the field which made it difficult to both walk through the crop and visually observe the advancing water front.