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NOTE ON THE OPERATION OF THE STANDARD ELECTRIC TIMER FROM STORAGE BATTERIES BY USE OF A CURRENT CONVERTER*

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*Subtask under Psychophysiological Studies, AMRL Project No. 6-95-20-001, Subtask, Climatic Effects on Psychophysiological Abilities.

RESEARCH AND DEVELOPMENT DIVISION
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NOTE ON THE OPERATION OF THE STANDARD ELECTRIC TIMER FROM STORAGE BATTERIES BY USE OF A CURRENT CONVERTER*

by

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ABSTRACT

NOTE ON THE OPERATION OF THE STANDARD ELECTRIC TIMER FROM STORAGE BATTERIES BY USE OF A CURRENT CONVERTER

OBJECT

To assess the feasibility of using a current converter to drive a Standard Electric Timer in situations where line alternating current is not available.

RESULTS AND CONCLUSIONS

The extent of error resulting from operation of a Standard Electric Timer from a Carter Rotary Converter, Type E-1016-CW4 was determined. The clutch mechanisms of the 2 clocks were connected to give simultaneous operation. One was operated from line alternating current and one from 24-volt storage batteries and a Carter converter. One thousand pairs of readings between 0 and 5 seconds were taken and compared by the method of correlation. A Pearson r of 0.99991 was obtained and an equation was developed for estimating "true" times from those given by the converter driven clock.

The process was repeated on a smaller scale (100 pairs of observations) with a Carter type E-1025-C converter as a check on the generality of the findings. Essentially the same results were obtained. It was concluded that driving a timer with the current converters introduces little variable error and that the constant error may vary with the converter employed and its power supply.

RECOMMENDATIONS

The constant error resulting from use of a particular combination of converter and power supply should be determined before they are employed in collecting data.

When electric timers are operated from current converters the direct current power supply should be monitored carefully to preclude voltage changes.

For maximum precision, converters with frequency regulators should be obtained.

Submitted 14 January 1956 by:
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NOTE ON THE OPERATION OF THE STANDARD ELECTRIC TIMER FROM STORAGE BATTERIES BY USE OF A CURRENT CONVERTER

I. INTRODUCTION

In a variety of experimental situations, it might be desirable to operate an electric timer from a direct current source. As an example, in studying operator tasks in a tank or other vehicle where line alternating current is not available, the use of time scores might be necessary. The Standard Electric Timer is particularly advantageous in such a situation since its electric clutch mechanism is adaptable to a variety of needs. In order to ascertain the accuracy of time measures with this type of power supply, an extensive test of some of the equipment available in this laboratory was conducted.

II. EXPERIMENTAL

A. Equipment

Two type S-1A Standard Electric Timers were used. The 2 clutches were connected to a DPST toggle switch so that both clocks operated simultaneously when the switch was thrown. An ordinary 117-volt a. c. outlet in the laboratory was used as a standard power source. Two heavy duty 12-volt Delco storage batteries were connected in series and provided a 24-volt d. c. supply. These were connected to a Carter Rotary Converter, type E-1016-CW4. A type E-1025-C converter was given a less extensive test.

B. Procedure

Inaccuracies in the electric timer primarily should be a function of fluctuation in the frequency of the converter output. Consequently, the stability of the output frequency was checked with a cathode-ray oscilloscope. During this test the converter was driven by a highly accurate d. c. power supply. Some fluctuations from rated frequency were noted, but since they were of an irregular nature they could not be utilized to make corrections in time readings. Also, as would be expected, it was noted that changes in the d. c. (input) voltage resulted in frequency changes in the output current.

A preliminary test was conducted to determine the extent of between-clock error when both were driven by line current. When

operated simultaneously, the 2 gave results which were identical to within as great a degree of accuracy as their scales could be read.

An extensive test was performed next to determine how much, if any, error resulted from the use of the type E-1016-CW4 current converter. One timer was operated from the converter output and the second from line current. Both clocks were simultaneously activated 1,000 times and the readings from each were recorded. All of these readings were for time intervals of less than 5 seconds duration and were distributed as shown in Table 1.

TABLE 1

Time Interval	No. of Pairs of Reading	r
.01 to 1.00 sec	200	0.99926
1.01 to 2.00 sec	200	0.99821
2.01 to 3.00 sec	200	0.99729
3.01 to 4.00 sec	200	0.99632
4.01 to 5.00 sec	200	0.99580

Since experience had shown that the stability of the converter's output was in part a function of preliminary warm-up, it was set in operation for at least 20 minutes before readings were made. In order to assure that a voltage drop as a result of discharging the storage batteries did not affect the results, a VTVM was placed in parallel with the load after every 100 readings. No voltage drops were found.

A second test of 100 readings was run under identical conditions except for substitution of a Carter type E-1025-C converter. This was done in order to test the generality of the results obtained with the type E-1016-CW4 instrument.

III. RESULTS AND CONCLUSIONS

The time readings from the 2 clocks were compared by means of Pearson product-moment correlation. This method was utilized in order to obtain a measure of degree of variable error, and permit a mathematical correction to eliminate bias from readings obtained from converter-operated timers.

The obtained correlation coefficient for all 1,000 pairs of readings was 0.99991. The regression equation for estimating "true" times from those given by the converter driven clock is:

$$X' = .998\ Y - .624^*$$

It is obvious, of course, that the longer the timers are permitted to run, the greater will be the opportunity for error to become manifest. As a check on the effect of this axiom, correlation coefficients were computed for readings from each of the 5, 1-second time intervals. These are shown in Table 1. With respect to time, a distinct downward trend in correlation is recognizable which tends to decelerate during the last time interval. When regression equations are written for each of these 5 values, however, the predictions obtained do not differ substantially from those resulting from the equation given above. Consequently, the use of one equation rather than 5 seems justified.

These results have a simple and straight-forward meaning. The extremely high r's indicate very little variable error. The differences between clock readings may be attributed, therefore, almost exclusively to constant error and thus may be corrected readily.

To check the generality of these results, 100 pairs of readings were taken with a Carter type E-1025-C converter. The obtained r was 0.99984 and the regression equation for estimating "true" times from those given by the converter-driven clock is:

$$X' = .954\ Y + 1.124$$

It will be noted again that there is minimal variable error although a different converter gives a different error constant.

IV. RECOMMENDATIONS

The constant error resulting from use of a particular combination of converter and power supply should be determined before they are employed in collecting data. The predictive equations given in this report should be limited in use to results obtained from the converters and d.c. source here employed and for intervals of 0 to 5 seconds only.

*For simplicity of calculation, time scores (read to hundredths of a second) were multiplied by 100 - thus eliminating decimal places - and this procedure, consequently, should be followed in utilizing this formula.

Timers should not be operated from storage batteries connected to an operating generator - as in an automotive vehicle - since voltage changes produced by the generator will certainly affect the timer operation.

The output of the d. c. source used to operate clocks through a converter should be monitored to preclude voltage changes.

Where very precise measures are desired, converters with frequency regulators should be purchased. They should be selected to match the power factor, voltage, frequency and load requirements of the equipment to be operated.

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