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Report

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of

Test of Weston Elapsed Time Indicator.

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AUTHORIZATION

1. This work was authorized by Bureau of Engineering letter, reference (a). Other pertinent correspondence is listed in references (b) and (c).

Reference: (a) BuEng. ltr. F42-1/22 (10-10-W8) of 29 June 1936.
(b) Specifications for Electrical Indicating Instruments, 17-I-12a.
(c) Engineering report submitted with indicator, dated 18 May 1936.

OBJECT OF TEST

2. The object of the test was to determine the suitability of the elapsed time indicator submitted by the Weston Electrical Instrument Corporation for Naval use in ascertaining the life of vacuum tubes in radio transmitters. In addition, changes or extensions in specifications, reference (b), properly to describe instruments of this type which will be suitable for Naval use are suggested.

ABSTRACT OF TEST

3. The instrument was tested to determine its accuracy as a means of measuring elapsed time, its range of operating voltage, its ability to operate satisfactorily at extreme ambient temperatures and under conditions of excessive humidity. The effect of intense vibration on the operation of the indicator was also observed.

Conclusions

(a) This elapsed time indicator is considered suitable for Naval use.

(b) The counter type dial is considered to be more easily readable than the type having four circular dials with pointers for indicating thousands, hundreds, tens and units.

Recommendations

It is recommended that this elapsed time indicator be considered suitable for Naval use.

MATERIAL UNDER TEST

4. The instrument under test was an elapsed time indicator, Weston Model 691, Type 2. Its appearance is shown in Plate 1. The following description is quoted from reference (c), paragraphs 1 and 2.

"The Model 691 Type 2 consists primarily of a Telechron motor, with a 60-1 gear drive to a Veeder counter mounted in a bakelite case, matching the standard 3" line of round instruments. Although the zero corrector is not used it was left in position in order to more nearly harmonize in front appearance with the regular 301 type of instrument.

"The rotor system of the Warren Telechron motor is sealed in a metal housing with a tablespoon of oil in such a way as completely to protect the iron rotor and its gear train from dust, moisture and mechanical strain. The 1 r.p.m. output of the motor unit drives a 60-1 worm and spur gear connected directly to a Veeder counter. One-tenth hour intervals are registered on the red section and up to 9999.9 hours on the whole section."

This meter case is a Navy standard 3-1/2" type; the instrument operates on a 60 cycle, 110 volt supply. The overall depth is 4-1/2".

METHOD OF TEST

5. The instrument was operated continuously for several periods of time and the elapsed time as indicated by it was compared with that as given by a chronometer. Its voltage range was determined by noting the potential at which the instrument would readily start. The instrument was operated in a temperature controlled chamber at temperatures between -13 and +50°C. and the circuit opened and closed at voltages between 90 and 130 volts to determine if operation was satisfactory. The indicator was operated for 72 hours in a humidity chamber at a relative humidity of approximately 90% and a temperature of 50°C. and its time keeping accuracy checked, together with its ability to start at a potential of 90 volts. At the end of this humidity exposure the insulation resistance across the terminal bushings was measured by the use of a 1000 volt megger. The instrument was subjected for one hour to vibration of varying frequency and of an amplitude of approximately 1/16" while mounted in a panel with meter face in a vertical plane.

DATA RECORDED DURING TEST

6. The data recorded are given in the "Results of Test."

DISCUSSION OF PROBABLE ERRORS

7. The errors in the observed values lie within the limits given below.

Applied voltage	± 1%
Ambient temperature	± 1°
Relative humidity	± 5%
Chronometer error	± 2 seconds
Error in reading the elapsed time indicator	± .02 hour

RESULTS OF TEST

8. The elapsed time indicator was operated on the 60 cycle, 110 volt city supply for several periods during which the elapsed time as indicated by it was compared with that from a chronometer. Some of the results are given below.

Total Elapsed Time - Hours

<u>Chronometer</u>	<u>Elapsed Time Indicator</u>
1.4	1.4
16.9	16.9-
23.25	23.2+
167.2	167.18
15.56	15.55
39.64	39.65
73.9	73.92

It can be seen that the instrument is satisfactory as a means of measuring elapsed time when the supply voltage frequency is 60 cycles per second. As to the operating voltage, the device started and operated satisfactorily at voltages between 50 and 130 volts at ordinary room temperatures.

9. The instrument also operates satisfactorily at temperatures from -13 to +50°C., starting readily at any potential above 70 volts. The temperature of the instrument did not become excessively high when the ambient temperature was 50°C.

10. During the 72 hour humidity test at a relative humidity of 90% and a temperature of 50°C., the instrument operated continuously and satisfactorily. The elapsed time of 73.92 hours given in the table above was observed during the humidity exposure. At the end of this test the insulation resistance across the terminal insulating bushings was measured to be approximately 400 megohms.

11. The instrument was mounted in a vertical panel and subjected to a high degree of vibration on a vibration test table. The frequency of vibration was varied as well as the amplitude. The instrument operated satisfactorily and without damage at an amplitude of vibration of approximately 1/16" which was applied for more than one hour.

12. The current drawn by the motor at a potential of 115 volts was approximately 55 milliamperes. The power consumed was therefore approximately 6.3 watts. During the tests the instrument was operated a total

of 362 hours without any failure or trouble. One or two drops of oil were visible on the outside of the rotor housing after the temperature test. When this was wiped off, no more oil appeared although the indicator was operated for several hundred hours thereafter.

13. The counter type of indicating dial is very easily read at a glance. This feature is decidedly to be preferred to the type provided with 4 dials (thousands, hundreds, tens and units) all of which must be read to obtain the indication of the instrument.

DISCUSSION OF SPECIFICATIONS FOR ELAPSED TIME INDICATORS

14. While the information available at this Laboratory with respect to the types of elapsed time indicators used in radio transmitters is rather meager, it appears that at least the four following types are employed:

- (a) Westinghouse total time meter, Style 638846A, USN Type CAY 22199, 120 volts, 60 cycles, 3-1/2" diameter, approximately 4" in depth. Flush panel mounting, 4 dials. Used in TBK transmitter.
- (b) Westinghouse instrument. Size and type not known. Four dials. Operates by clock mechanism which is wound electrically. 110 volt, 60 cycle supply rectified by copper oxide rectifier. Used in TBF transmitter.
- (c) Westinghouse front panel mounting type. Extends probably 4" on front of panel and has a diameter of perhaps 5". Four dials. Used in TAH transmitter.
- (d) General Electric tube hour meter. Counter type indicator, 110 volts, 60 cycles. Size not definitely known, but believed to be greater than 3-1/2" diameter. Used in TBA transmitter.

It will be observed that instrument (a) above conforms to the type which is the subject of this report, in having the indicating mechanism housed in a 3-1/2" flush mounting meter case, while (d) is similar to the meter under test in having a counter type indicator, but is believed to be of larger size.

15. If specifications should be prepared standardizing on a 3-1/2" diameter flush mounting case, styles (c) and possibly (d) would be eliminated, while to require a counter type of indicator would eliminate styles (a) to (c). Obviously the intent of the Bureau with respect to these considerations will affect the specifications to be drawn.

16. Elapsed time indicators should conform to the general requirements of the specifications, reference (b), such as those regarding material, workmanship and construction, finish, marking, etc., including

the applicable requirements for a.c. switchboard instruments given in section 5(f) with the following amendments:

- (a) In place of jewels mentioned in par. 4(hhh), suitable metal bearings should be specified.
- (b) If the terminal studs are of sufficient diameter and strength, they may be tapped and threaded and supplied with screws and lock washers (as in the case of the instrument under test) instead of being threaded the full length and provided with nuts as required by par. 5(f)(4)(a).
- (c) In addition to the dimensional requirements, given in Table IV for 3-1/2" meters, the overall depth of the assembled instrument (including the meter case and the attached mechanism and terminals) should not exceed 4-5/8".

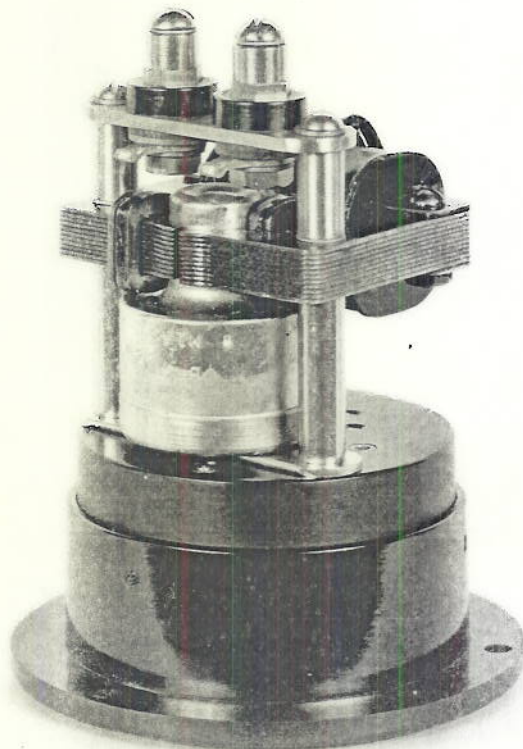
17. The following additions to reference (b) for this type of instrument are suggested. The instrument shall indicate the total elapsed time in hours up to 9999 hours during which its terminals are connected to an a.c. source of the specified frequency, and of the specified voltage $\pm 20\%$. It shall be automatically reset to zero after operating 10,000 hours. It shall operate continuously or intermittently at any temperature from -10 to $+50^{\circ}\text{C}$. in a relative humidity of 90% and under intense vibration (1/16" amplitude) without damage, overheating, or loss of accuracy in measuring elapsed time. All moving parts shall be suitably protected and lubricated so as not to require attention, and wear shall be reduced to a minimum. The indicator scale shall be easily readable.

18. If it is desired to secure instruments similar to the indicator under test, a specification should be added requiring a synchronous motor suitably geared to a counter mechanism.

CONCLUSIONS

19. This elapsed time indicator is considered suitable for Naval use.

20. The counter type dial is considered to be more easily readable than the type having four circular dials with pointers for indicating thousands, hundreds, tens and units.



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Plate 1