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NAVY DEPARTMENT

Report of Test

on

Tachometer, Type B, Class b.

Submitted by

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1942.

Date of Test: January - February 1943.

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### AUTHORIZATION FOR TEST

1. This problem was authorized by reference (a), and another reference pertinent to this problem is listed as reference (b).

References: (a) BuShips Ltr. S69-(6)(350) of 28 October 1942.  
(b) Specification 18T22 of 1 November 1940.

### OBJECT OF TEST

2. The object of this test was to determine conformance of the sample tachometer with specification, reference (b), as Navy type B, class b, and its suitability for Naval use.

### ABSTRACT OF TEST

3. The sample tachometer was set up at this Laboratory in conjunction with suitable test equipment and its performance was carefully observed for compliance with the specification. An inspection to determine compliance in the matter of materials, design, and workmanship, concluded the test.

## CONCLUSIONS

(a) The sample tachometer is of simple, rugged construction, but fails to comply with specification, reference (b), as type B, class b, in the following respects:

- (1) The error in the speed indications of the instrument at 4000 and 5000 r.p.m. was greater than the allowable error of 1 per cent of full scale linear distance.
- (2) The pointer did not come to rest within 3 seconds, after the spindle was engaged with a driving shaft as required.
- (3) It is necessary to insert a tachometer head in the proper socket in the drive body according to the direction of rotation of the driving shaft.
- (4) No means is provided to permit adjustment for compensation of errors.
- (5) Two tachometer heads are provided to cover the speed range of 50 to 5,000 r.p.m. in lieu of a single dial and pointer assembly as specified in paragraph E-2e of the specification.
- (6) The weight and dimensions are slightly in excess of the values allowed.
- (7) No extension rod is provided.
- (8) A durable instruction card was not provided.

RECOMMENDATIONS

(a) That the subject tachometer, as submitted, be considered NOT SATISFACTORY for Naval use, in view of the several deficiencies noted in "Conclusions".

## DESCRIPTION OF MATERIAL UNDER TEST

4. The sample, submitted by Stewart-Warner Corporation as a Navy Type B, Class b Tachometer, is a portable, hand-held type.

5. The instrument consists of a drive body and two indicating heads, covering the ranges of 50 to 500 r.p.m. and 500 to 5,000 r.p.m. There are four sockets, two on each side of the drive body, into which the heads may be inserted. Two of these sockets provide the proper gear ratios for the two speed ranges. Not only must a head be placed in the proper socket for its speed range, but it must be placed in a socket selected on the basis of the direction of rotation of the tachometer shaft.

6. Each tachometer head consists of a permanent (split cylinder) magnet rotating with the tachometer head shaft, a pivoted aluminum cylinder, zero positioned by a spiral hair spring, a calibrated dial, and a pointer connected to the cylinder. As the magnet rotates, it sets up eddy currents in the cylinder and displaces it through an angle depending on the speed. A brass shielding cylinder is assembled between the magnet and the aluminum cylinder. A steel cylinder serves as the outer enclosure of this sub-assembly.

7. Further details are shown in photographs, plates 3, 4, and 5.

## METHOD OF TEST

8. The following tests were conducted in the order listed:

- (a) Accuracy
- (b) Damping
- (c) Vibration
- (d) Magnetizing
- (e) Endurance
- (f) Accuracy

## RESULTS OF TEST

9. The test results obtained were as follows:

### Requirements

Accuracy: Para. E-2b. The error shall be within  $\pm 1$  per cent of full scale linear distance at any point on the scale when the tachometer is operated in the vertical or horizontal positions.

Damping: Para. E-2c. Pointer shall steady within 3 seconds after the spindle is engaged with a driving shaft rotating at a constant speed approximately equal to the full scale reading of the tachometer.

Vibration: Para. F-2D(4). Shall withstand 30 vibrations per second at a double amplitude of 0.015 inch for 3 hours.

### Test Values

\*Unsatisfactory at higher speeds (4,000 and 5,000 r.p.m.). See Table 1 and Plate 1.

\*Unsatisfactory.

Complied.

No apparent damage with vibration successively applied in two principal planes.

RESULTS OF TEST (Cont'd)

Requirements

Magnetization: Para. F-2d(5). The error of the tachometer, while operating at 50% full scale reading in a unidirectional field having a flux density in free air of approximately 1000 lines per square inch, shall be within  $\pm 1$  per cent of full scale linear distance.

Endurance: Para. F-2D(7). Shall operate satisfactorily for 100 hours at 75 per cent of full scale reading.

Accuracy at the end of all tests: Para. F-2d(8). Errors shall be within  $\pm 1$  per cent of full scale linear distance.

Direction of Rotation: Para. D-2. Shall be designed to indicate on the same scale, without change or adjustment, regardless of the direction of rotation of the driving shaft.

Compensation for error: Para. D-3. Means shall be incorporated in the design of the tachometer mechanism to permit adjustment to compensate for errors without redrafting the scale.

Dial and pointer assembly: Para. E-2e. Shall consist of a single dial and a single pointer.

Weight and Dimensions: Para. E-2j.  
Length: 8 inches.  
Width: 4-3/8 inches.  
Depth: 2-3/8 inches.  
Weight: 25 ounces.

Accessories: Para. E-2m.

Test Values

Complied.

Complied.

\*Unsatisfactory at higher speeds (4,000 and 5,000 r.p.m.). See Table 2 and Plate 2.

\*Unsatisfactory. It is necessary to remove the tachometer head from one position to another on the Drive Body.

\*Unsatisfactory. No means provided for compensation of errors.

\*Two tachometer heads provided to cover range.

Unsatisfactory.  
Length: 5-7/8 inches.  
Width: 3-3/8 inches.  
\*Depth: 3-3/8 inches.  
\*Weight: 28 ounces.

\*No extension rod provided.

\*Denotes failure to comply with the specification.

## CONCLUSIONS

10. The sample tachometer is of simple, rugged construction, but fails to comply with specification, reference (b), as type B, class b, in the following respects:

- (1) The error in the speed indications of the instrument at 4,000 and 5,000 r.p.m. was greater than the allowable error of 1 per cent of full scale linear distance.
- (2) The pointer did not come to rest within 3 seconds, after the spindle was engaged with a driving shaft as required.
- (3) It is necessary to insert a tachometer head in the proper socket in the drive body according to the direction of rotation of the driving shaft.
- (4) No means is provided to permit adjustment for compensation of errors.
- (5) Two tachometer heads are provided to cover the speed range of 50 to 5,000 r.p.m. in lieu of a single dial and pointer assembly as specified in paragraph E-2e of the specification.
- (6) The weight and dimensions are slightly in excess of the values allowed.
- (7) No extension rod is provided.
- (8) A durable instruction card was not provided.

TABLE 1

## ACCURACY TEST RESULTS BEFORE ALL OTHER TESTS

| Direction       | Driven<br>RPM | Horizontal       |                  | Vertical         |                  |
|-----------------|---------------|------------------|------------------|------------------|------------------|
|                 |               | Indicated<br>RPM | Percent<br>Error | Indicated<br>RPM | Percent<br>Error |
| 50 - 500 RPM    |               |                  |                  |                  |                  |
| CW              | 100           | 100.0            | 0                | 98.4             | -0.32            |
| CCW             | 100           | 100.6            | +0.12            | 98.4             | -0.32            |
| CW              | 200           | 198.8            | -0.24            | 198.2            | -0.36            |
| CCW             | 200           | 199.2            | -0.16            | 197.4            | -0.52            |
| CW              | 300           | 297.6            | -0.48            | 298.8            | -0.24            |
| CCW             | 300           | 297.6            | -0.48            | 298.0            | -0.40            |
| CW              | 400           | 398.0            | -0.40            | 400.4            | +0.08            |
| CCW             | 400           | 397.2            | -0.56            | 401.6            | +0.32            |
| CW              | 500           | 498.2            | -0.36            | 501.2            | +0.24            |
| CCW             | 500           | 495.8            | -0.84            | 498.8            | -0.24            |
| 500 - 5,000 RPM |               |                  |                  |                  |                  |
| CW              | 600           | 600              | 0                | 598              | -0.04            |
| CCW             | 600           | 600              | 0                | 599              | -0.02            |
| CW              | 700           | 700              | 0                | 698              | -0.04            |
| CCW             | 700           | 700              | 0                | 699              | -0.02            |
| CW              | 800           | 800              | 0                | 799              | -0.02            |
| CCW             | 800           | 800              | 0                | 800              | 0                |
| CW              | 900           | 900              | 0                | 898              | -0.04            |
| CCW             | 900           | 900              | 0                | 898              | -0.04            |
| CW              | 1000          | 1000             | 0                | 995              | -0.10            |
| CCW             | 1000          | 1000             | 0                | 995              | -0.10            |
| CW              | 2000          | 1999             | -0.02            | 1999             | -0.02            |
| CCW             | 2000          | 2000             | 0                | 1997             | -0.06            |
| CW              | 3000          | 3001             | +0.02            | 2999             | -0.02            |
| CCW             | 3000          | 2999             | -0.02            | 2998             | -0.04            |
| CW              | 4000          | 3900             | *-2.0            | 3940             | *-1.20           |
| CCW             | 4000          | 3910             | *-1.8            | 3965             | -0.70            |
| CW              | 5000          | 4800             | *-4.0            | 4822             | *-3.76           |
| CCW             | 5000          | 4860             | *-2.8            | 4845             | *-3.10           |

Notes: Each reading is the average of five readings.  
Individual readings were essentially the same  
as average.

Percent error is based on full scale linear distance.

\* Exceeds tolerance.

TABLE 2

## ACCURACY TEST RESULTS AFTER ALL OTHER TESTS

| Direction       | Driven<br>RPM | Horizontal       |                  | Vertical         |                  |
|-----------------|---------------|------------------|------------------|------------------|------------------|
|                 |               | Indicated<br>RPM | Percent<br>Error | Indicated<br>RPM | Percent<br>Error |
| 50 - 500 RPM    |               |                  |                  |                  |                  |
| CW              | 100           | 100.4            | +0.08            | 97               | -0.60            |
| CCW             | 100           | 100.8            | +0.16            | 97.2             | -0.56            |
| CW              | 200           | 198.4            | -0.32            | 197.4            | -0.52            |
| CCW             | 200           | 200              | 0                | 197.4            | -0.52            |
| CW              | 300           | 298              | -0.40            | 299.2            | -0.16            |
| CCW             | 300           | 298              | -0.40            | 300              | 0                |
| CW              | 400           | 399              | -0.20            | 402.6            | +0.52            |
| CCW             | 400           | 398              | -0.40            | 404.2            | +0.84            |
| CW              | 500           | 498              | -0.40            | 500.4            | +0.08            |
| CCW             | 500           | 497.6            | -0.48            | 502              | +0.40            |
| 500 - 5,000 RPM |               |                  |                  |                  |                  |
| CW              | 600           | 600              | 0                | 576              | -0.48            |
| CCW             | 600           | 600              | 0                | 550              | -1.00            |
| CW              | 700           | 700              | 0                | 679              | -0.42            |
| CCW             | 700           | 700              | 0                | 677              | -0.46            |
| CW              | 800           | 800              | 0                | 780              | -0.40            |
| CCW             | 800           | 800              | 0                | 777              | -0.46            |
| CW              | 900           | 900              | 0                | 880              | -0.40            |
| CCW             | 900           | 900              | 0                | 882              | -0.36            |
| CW              | 1000          | 1000             | 0                | 982              | -0.36            |
| CCW             | 1000          | 1000             | 0                | 960              | -0.80            |
| CW              | 2000          | 2006             | +0.12            | 1994             | -0.12            |
| CCW             | 2000          | 1996             | -0.08            | 1990             | -0.20            |
| CW              | 3000          | 2996             | -0.08            | 2996             | -0.08            |
| CCW             | 3000          | 3004             | -0.08            | 2994             | -0.12            |
| CW              | 4000          | 3945             | *-1.10           | 3935             | *-1.30           |
| CCW             | 4000          | 3945             | *-1.10           | 3930             | *-1.40           |
| CW              | 5000          | 4840             | *-3.20           | 4745             | *-5.10           |
| CCW             | 5000          | 4835             | *-3.30           | 4807             | *-3.86           |

Note: Each reading is the average of five readings.  
Individual readings were essentially the same  
as average.

Percent error is based on full scale linear distance.

\* Exceeds tolerance.

ACCURACY CURVES FROM TABLE 1  
 HIGH RANGE: 500-5000 R.P.M.  
 CW  
 CCW









