6 May 1941

NAVY DEPARTMENT

NRL Report No. B-1735

Report of

Test on Synchronous Motors, Capacitor Type

Manufactured by

The Holtzer-Cabot Electric Company,
Boston, Massachusetts
and
Submitted by
The Electric Tachometer Corporation,
Philadelphia, Pennsylvania.

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

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Authorization: BuShips Ltr. S65-5(DYs-3) of 2 April 1941.

Date of Test: February to April 1941.

Tested and Prepared by: G.K.C. Hardesty, Principal Engineering Aide.

Reviewed by: H. B. Roberts, Assistant Electrical Engineer, Chief of Division.

W. F. Cole, Lieutenant Commander, U.S.N.

Approved by: H. G. Bowen, Rear Admiral, USN, Director.

Distribution:
BuShips (5)

gfw

TABLE OF CONTENTS

APPENDICES

AUTHORIZATION FOR TEST

1. This problem was authorized by reference (a), and other references pertinent to this problem are listed as references (b) to (e) inclusive.

Reference:
(a) BuShips ltr. S65-5(DYs-3) of 2 April 1941.
(b) Specification 17-I-18(INT) of 15 February 1938
(c) Specification RE 13A 488C of 22 August 1936.
(d) Holtzer-Cabot Bulletin 1480-01 of February 1940.
(e) Electric Tachometer Ltr. of 22 April 1941 to NRL.

OBJECT OF TEST

2. The object of this test was to determine conformance of the sample motors and their capacitors with extracts from specifications, references (b) and (c), and their suitability for Naval use.

ABSTRACT OF TEST

3. The sample motors were set up at this Laboratory in suitable test circuits where their performance was carefully observed for compliance with extracts from the specifications. Following a 1000 hour endurance test under loaded conditions, an inspection was made to determine compliance in the matter of materials, design, and workmanship.

4. Three additional capacitors furnished by the exhibitor were subjected to tests extracted from specification, reference (c).

Conclusions

(a) The type RBC ball-bearing motor is superior to the type RMC sleeve-bearing motor when operated with the shaft in a vertical position by reason of retention of lubrication which is inherent with its design. With shafts in a horizontal position, the endurance test showed no differentiation in relative bearing life. The type RBC motor is considered suitable for Naval use in the applications for which designed. Although it does not operate as quietly as the sleeve-bearing type, the noise is not objectionable.

(b) The type RMC sleeve bearing motor was not designed to be operated with the shaft in the vertical position, and the results of this test show that it cannot be so operated without early bearing failure. In all other respects, it was satisfactory.

(c) The capacitors are considered entirely satisfactory for this application, as evidenced by their satisfactory operation in connection with the motors throughout the 1000 hour endurance test. Their compliance with the tests extracted from specification, reference (c), justifies this conclusion.

(d) It is noted that the voltage to which these capacitors are subjected (approximately 180 volts rms) is well within the manufacturer's rating of 220 volts rms.

(e) The paper labels on the capacitors are not satisfactory. All markings should be made on the cases.

(f) A representative of the motor manufacturer, on a recent visit to this Laboratory, stated that his company was prepared to furnish the motor lead wires of a synthetic insulated, color coded, oil resistant design. It is believed that such a change would be desirable as it would avoid the possibility of insulation failure due to deterioration from contact with motor lubricating oil.

Recommendations

(a) It is recommended that the type RBC ball bearing synchronous motor be approved for use in Interior Communication equipment for mounting in any position.

(b) It is recommended that approval of the type RWC sleeve bearing motor be withdrawn in view of the demonstrated superiority of the substitute ball bearing type.

(c) It is recommended that the manufacturer be required to provide oil-resistant insulation of motor lead wires.

DESCRIPTION OF MATERIAL

5. The material submitted for test consisted of a type RBC 2505 ball bearing motor and capacitor, a type RWC 2505 sleeve bearing motor and capacitor, and three additional capacitors. The motors are identical except for voltage, power input, torque ratings, and bearing design. They are of the reversible, capacitor, squirrel-cage, synchronous, induction type. Each motor has a self contained reduction gear train in a separate compartment of the motor housing to reduce the rotor speed of 1800 r.p.m. to a shaft speed of 60 r.p.m. Lubrication of the gears and bearings in this compartment is accomplished through a system of felt oil reservoirs and distributing wicks. The extending work shaft is provided with a sleeve bearing. The manufacturer's Bulletin, Plate 3, gives additional data.

6. The type RBC 2505 ball bearing motor has the rotor mounted in single race ball bearings. An adjustable cork-cushioned thrust-loading feature is incorporated in the motor design to reduce bearing noise. This motor was designed to be operated with its shaft in the vertical or horizontal position. It is rated 115 volts, 9 watts, 60 cycles input, 60 r.p.m., 3 in. oz. torque output.

7. The type RWC 2505 sleeve bearing motor has the rotor mounted in wick lubricated sleeve bearings. It is designed to be operated with the shaft in the horizontal position only. It is rated 110 volts, 8 watts, 60 cycles input, 60 r.p.m., 2 in. oz. torque output.

8. The capacitors were manufactured by the Cornell-Dubilier Corporation and are marked VC-429-A 1 mfd. 220 VAC Lt. Additional information from the exhibitor indicates that they are of the "Dykanol A" filled type and are designed for operation at temperatures up to 200°F. The cylindrical cases are of formed brass, plated, and sealed by soldering. A terminal lug is mounted on an insulating washer on each end of the case. A plated steel mounting lug is soldered to the case.

METHOD OF TEST

9. The sample motors, following tests to determine their electrical characteristics at standard voltage and frequency, and measurement of the resistances of their windings at room temperature, were subjected to further tests in the following order:

(a) A 1000 hour endurance test at 65°C. ambient temperature while loaded to 2 inch ounces torque. Temperature rise measurements were made during this period.

(b) A dielectric strength test of 1500 volts, 60 cycle, alternating potential.

(c) Insulation resistance by 1000 volt "Megger".

10. Because of satisfactory result of previous tests of equipment incorporating motors of almost identical design, the shock, vibration, and similar tests, outlined in specification, reference (b), were not conducted.

11. The three additional capacitors were subjected to the following tests as given in specification, reference (c).

(a) Measurement of capacity by 1000 cycle capacitance bridge.

(b) Determination of direct current leakage at 200 volts, direct potential.

(c) The samples were immersed in a solution of saturated salt water at 65°C. for two hours, followed by immersion in a similar solution at 0°C. for 2 hours. This procedure was repeated for 5 complete cycles. The samples were next immersed in a solution of saturated salt water at 20°C for 24 hours. After removal from this solution, they were washed with fresh water, allowed to dry for one hour, and the direct current leakage was again measured.

12. The tests were concluded with an examination to determine any defects brought out by the tests.

RESULTS OF TEST

13. The following test results were obtained.

(a) Motors

Electrical Characteristics

	Type RNC	Type RBC
Applied Volts (60 cycles)	115	115
Amperes	.093	.094
Watts	10.4	10.4
Volts across capacitor	180 (approx)	180 (approx.)
Resistance of 1-2 winding at 28°C	581 ohms	565 ohms
Resistance of 2-3 winding at 28°C.	1150 ohms	1135 ohms

Endurance

The type RNC sleeve bearing motor stalled after a 312 hour run at 65°C. when mounted shaft down, due to a lubrication failure in the rotor sleeve bearings. After cleaning and lubricating the bearings thoroughly, the motor was run for 688 hours with the shaft horizontal without further trouble.

The type RBC motor operated satisfactorily throughout a 1000 hour endurance test at 65°C. During this period, it was operated with

the shaft down for 312 hours and with the shaft horizontal for the remainder of the period. No additional lubrication was required during the test.

The highest temperature rise observed during the endurance test (motor loaded to 2 inch-ounce torque) was 37.5°C. for the type RWC motor and 38.5°C. for the type RBC motor.

Both motors withstood a one minute dielectric test of 1500 volts, 60 cycles, alternating potential (at room temperature) at the end of the endurance test. Following this, the insulation resistance, as indicated by a 1,000 volt "Megger" was greater than 200 megohms.

(b) Capacitors

The two capacitors supplied with the motors functioned satisfactorily at a temperature at 65°C. when used in conjunction with the motors during the 1000 hour endurance test.

Test results of the three additional capacitors were as follows:

(Before immersion)

No. 1 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 0.032 microamperes.
No. 2 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 0.022 microamperes.
No. 3 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 0.026 microamperes.

Note: Leakage from terminals to case was not readable.
Allowable leakage is 0.8 microamperes per microfarad.

(After immersion)

No. 1 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 0.060 microamperes.
No. 2 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 0.065 microamperes.
No. 3 Capacity 1.04 Mfd., leakage at 200 V.D.C. - 1.670 microamperes.
No. 1 Leakage from terminals to case - 1.51 microamperes.
No. 2 Leakage from terminals to case - 0.073 microamperes.
No. 3 Leakage from terminals to case (greater than 1 milliampere)

Note: Allowable leakage 2.0 microamperes per microfarad.
Failure of 40 percent of samples tested may result in the rejection of the lot.

CONCLUSIONS

14. The type RBC ball-bearing motor is superior to the type RWC sleeve-bearing motor when operated with the shaft in a vertical position by reason of retention of lubrication which is inherent with its design. With shafts in a horizontal position, the endurance test showed no differentiation in relative bearing life. The type RBC motor is considered suitable for Naval use in the applications for which designed. Although it does not operate as quietly as the sleeve-bearing type, the noise is not objectionable.

15. The type RWC sleeve bearing motor was not designed to be operated with the shaft in the vertical position, and the results of this test show that it cannot be so operated without early bearing failure. In all other respects, it was satisfactory.

16. The capacitors are considered entirely satisfactory for this application, as evidenced by their satisfactory operation in connection with the motors throughout the 1000 hour endurance test. Their compliance with the tests extracted from specification, reference (c), justifies this conclusion.

17. It is noted that the voltage to which these capacitors are subjected (approximately 180 volts rms) is well within the manufacturer's rating of 220 volts rms.

18. The paper labels on the capacitors are not satisfactory. All markings should be made on the cases.

19. A representative of the motor manufacturer, on a recent visit to this Laboratory, stated that his company was prepared to furnish the motor lead wires of a synthetic insulated, color coded, oil resistant design. It is believed that such a change would be desirable as it would avoid the possibility of insulation failure due to deterioration from contact with motor lubricating oil.

PLATE I

HE ELECTRIC TACHOMETER CORPORATION

Manufacturers of
SPEED INDICATORS and RECORDERS
ELECTRIC and MECHANICAL COUNTERS

P. VAN SANTEN KOLFF, PRESIDENT

S. E. Cor. Broad and Spring Garden Sts.
PHILADELPHIA

REFERENCE

April 22, 1941.

Naval Research Laboratory,
Anacostia Station,
Washington, D. C.

Gentlemen:-

This will acknowledge receipt of your letter of April 18th quoted as follows:-

> "This is to acknowledge receipt of your three Cornell-Dubilier, Type VC-429A, condensers in connection with the test of Holtzer-Cabot types R.B. C. and R.W.C alternating-current synchronous motors.
>
> The specifications, under which the condensers are being tested, necessitate knowing their rated d.c. working voltage, of which we have no information. Upon receipt of the above mentioned information we will forward the complete report to the Bureau of Ships within a week."

The motor manufacturer states that these condensers have no "rated d.c. working voltage". They do carry a normal a.c. voltage rating of 220 volts, 60 cycles, and are guaranteed not to break down with 440 volts a.c. 60 cycles. They are subjected to a factory production test of 1200 volts d. c. for a period of 10 seconds, and the average insulation resistance runs from a guaranteed minimum of 500 megohms up to as high as 800 megohms. We are informed that the insulation resistance is still approximately 200 megohms after the application of 500 volts d.c. for a period of 3 minutes. We draw attention to the fact that in service these capacitors are never subjected to d.c. voltage.

Trusting this is the information you require, we remain,

Very truly yours,
THE ELECTRIC TACHOMETER CORPORATION

S. Hamilton,
Engineer

RG

WHITE 2

GEAR-MOTORS

Capacitor Type Synchronous Motors

RWC-2505 RWC-2510

The Holtzer-Cabot Electric Co.

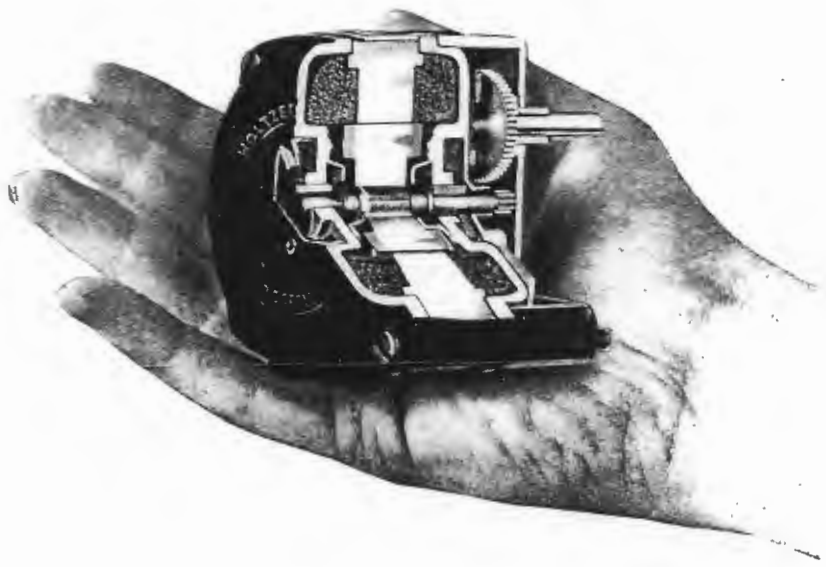
BOSTON, MASSACHUSETTS

CHICAGO NEW YORK PHILADELPHIA

BULLETIN 1480-01
FEBRUARY, 1940

FLAT

GENERAL DESCRIPTION



The RWC–25 size motor is a precision-built small gear-motor. The illustration indicates how compactly the various internal parts are arranged. This efficient utilization of the cubical space results in the maximum output of mechanical energy at low speed for the size of the motor — consistent with good design in regard to lubrication, wearing surfaces, and strength of parts. The motor is of the single value capacitor type, recognized as the most efficient and ideal type of single phase motor.

STANDARD STOCK MOTORS

Motor: Type RWC–2505, synchronous capacitor type, 110 volts, 60 cycles, totally enclosed, sleeve bearings, 3 color coded leads 12″ long.

Gearing: Spur gear train integral with motor; standard output speeds 1, 2, or 60 RPM.

Capacitor: Supplied with motor for separate mounting.

SPECIAL DESIGNS

The type RWC–2510 is available where the output required is greater than that of the RWC-2505 — see data on next page.

Motors without gear reduction may be supplied, with shaft speed of 1800 RPM on 60 cycles.

The following items indicate other features available in motors built to order:

Induction type (non-synchronous)
Odd frequencies
Special windings for such purposes as high torque, intermittent duty, dynamic braking
Automatic brake
Special output speeds
Special mounting arrangement
Special shaft or shaft location
Pinion on output shaft
Special lubrication arrangement

TECHNICAL DATA

Motors are of the conventional single value capacitor design with slotted stators and squirrel cage rotors, and are wound for operation on 110 volts, single phase, A.C. Motors can be supplied for other voltages on special order.

RATINGS FOR SYNCHRONOUS MOTORS:

Frame	Motor R. P. M.	FREQ.	Watts Input	OUTPUT TORQUE OUNCE INCHES 1 RPM	2 RPM	60 RPM
RWC–2505	1800	60	9	75	60	3
RWC–2505	1500	50	9	75	60	3
RWC–2505	1500	25	9	75	60	3
RWC–2510	1800	60	11	—	—	6
RWC–2510	1500	50	11	—	—	6
RWC–2510	1500	25	11	—	—	6

TORQUES: Torques shown above are normal full load values. The minimum torque at which the motor will pull out of synchronism is 2 times rated full load, when operated on rated voltage and under normal temperature conditions. Motors will start and operate at synchronous speed on voltages within plus or minus 10% of rating on loads corresponding to the above torques.

INDUCTION MOTORS: Rated torques for induction motors are twice synchronous ratings, except not to exceed 75-ounce inches. Speed of induction motors at full load approximately 95% of synchronous speed.

BEARINGS AND LUBRICATION: Bronze Sleeve Bearings. All motor bearings, felt wick lubricated. 1 and 2 RPM gear trains, splash lubricated. 60 RPM gear trains, felt wick lubricated. Motor bearings and gear trains lubricated with a special oil available in three-ounce cans.

GEAR REDUCTION: All spur gears, cut to close tolerances on gear hobber. Pinions all steel; high speed gears bakelite; low speed gears steel.

ROTATION: Motors are of the three lead reversible type.

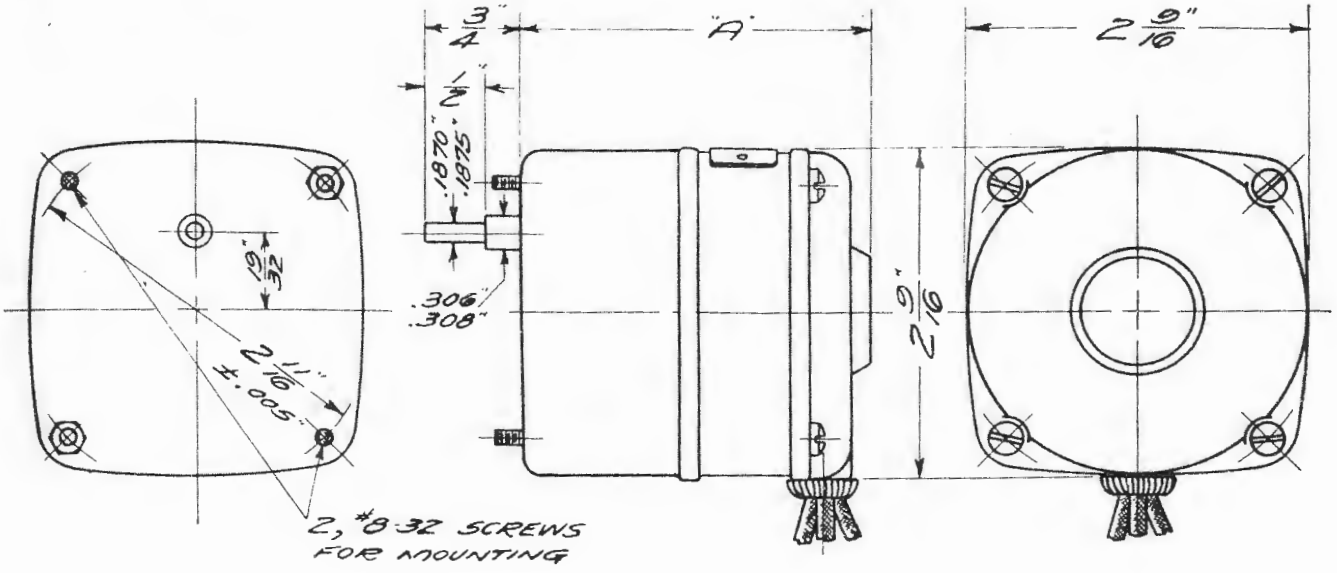
MOUNTING: Motor is arranged for mounting by means of two machine screws 180 degrees apart extended through the gear case. The output shaft bearing is extended and machined on the outside diameter, for locating the motor accurately when mounted.

WEIGHTS: RWC–2505 — 60 RPM ..... 30 ounces.
RWC–2505 — 1 and 2 RPM ..... 33 ounces.
RWC–2510 — 60 RPM ..... 44 ounces.

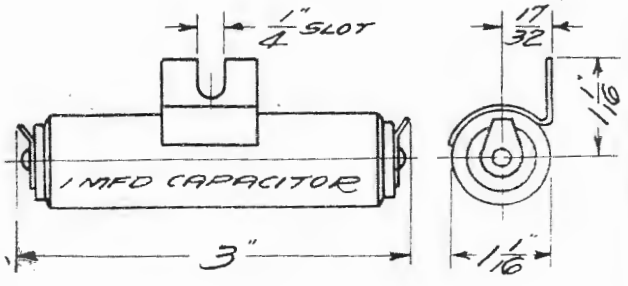
GENERAL: Horizontal operation only.
Allowable dead weight loading close to bearing on output shaft 4 lbs. at 1 or 2 RPM, 1 lb. at 60 RPM.

CAPACITOR: Oil filled type, for separate mounting.

DIMENSIONS



FRAME	R.P.M.	"A"	CAPACITOR FOR 60 CYCLE MOTOR
RWC 2505	60	2 7/16"	1 MFD.
RWC 2505	1 & 2	2 11/16"	1 MFD.
RWC 2510	60	3 3/16"	See Below



ADDENDUM

Sept. 3, 1940

The standard 115 volt, 60 cycle, type RWC-2510 motor is supplied with 1.2 MFD capacitor, dimensions being the same as view to the left except length 3 1/2" overall. Rated input 10 watts.

Note standard voltage rating recently adopted by NEMA is 115 volts.

PLATE 3D