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23 April 1940 NRL Report No. B-1611

NAVY DEPARTMENT

Report of Test

on

Contact Maker, Type N, Class I (Local Switching)

manufactured and submitted
by
Clark Cooper Company
Philadelphia, Pennsylvania

FR-1611

NAVAL RESEARCH LABORATORY
ANACOSTIA STATION
WASHINGTON, D. C.

Number of Pages: Text - 5 Tables - 1 Plates - 3

Authorization: BuEng let.S62-2/L5(1-10-SS) of 22 January 1940.

Date of Test: March and April 1940.

Tested by: _____
F. H. Dunlap, Sr. Engineering Aide

Reviewed by: _____
W. B. Roberts, Chief Engineering Aide
Chief of Section

_____
J. E. Chapman, Lieut.Comdr. U.S.N.

Approved by: _____
H. G. Bowen, Rear Admiral, U.S.N.
Director

Distribution: BuEng-C&R (5)

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Appendices

AUTHORIZATION FOR TEST

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

Reference: (a) BuEng let.S62-2/L5(1-10-SS) of 22 January 1940.
(b) Specification 17C16 (INT) of 1 February 1939.
(c) Manufacturer's Drawing EC-T38.

OBJECT OF TEST

2. The object of this test was to determine how closely the sample Type N, Class 1, contact maker complies with specifications, reference (b), and its suitability for Naval use in engine cooling systems.

ABSTRACT OF TEST

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

Conclusions

The subject contact maker failed to meet the specifications as follows:

(a) Operating range.
(b) Temperature compensation.
(c) Accuracy following endurance.
(d) Accuracy following shock and vibration.
(e) Watertightness.
(f) Electrical clearance to ground.
(g) Condenser not properly insulated from ground.
(h) Terminal block.

This contact maker very nearly complied with the requirements for temperature compensation, due to a design feature which locates the bellows directly on the expansion tube and houses it in a part of the case not greatly affected by the ambient temperature.

The following features of mechanical design are considered unsatisfactory:

(a) The principal adjustment is not readily accessible and may be turned only with a small pin inserted in one of four holes. These shallow holes were badly worn at the end of the test as a result of the few adjustments necessary during the tests.
(b) The dependence upon friction to permit motion of piece 7 relative to piece 8 when making adjustments and the use of the additional nut referred to in paragraph 5. This nut may be intended as a locking device for piece 7, but if so, this prevents adjustment without disassembly.
(c) Much of the instability of the operating point noted during the tests is attributed to unsatisfactory securing of the "micro-switch" and spring adjustment screws. A more positive method of securing the "micro-switch" should be provided.
(d) The sample is not in agreement with drawing, reference (c), in the following respects:

    (1) The threading of piece 6 is not as shown on drawing.
    (2) Piece 17 mismumbered as piece 19.
    (3) Piece 19 not shown.
    (4) Nut referred to in paragraph 5 not shown.
    (5) Micro-switch securing screw not shown.

Recommendations

(a) It is recommended that this contact maker be not approved for Naval use as submitted due to its unsatisfactory mechanical design and failure to comply with the specifications.

(b) It is further recommended that the manufacturer be invited to submit a new sample designed to eliminate the unsatisfactory features noted herein, since the sample submitted demonstrates the possibility of meeting the temperature compensation requirements without employing auxiliary devices in the design.

DESCRIPTION OF MATERIAL UNDER TEST

4. The sample contact maker, covered by photostat of drawing, Plate 1, and photographs, Plates 2 and 3, is designed to close a circuit when the temperature of the liquid in which the expansion chamber is immersed rises above a predetermined setting (100°F to 225°F). It embodies a bellows, apparently operated on the vapor pressure principle by the pressure developed in a metal expansion chamber. The bellows is mounted directly on the expansion chamber and is housed in a tubular case projection, part of which, together with the expansion chamber, is designed to project into the circulating cooling system. This projection is provided with a 3/4-inch (IPS) thread. The threads are not located as shown on Plate 1, but are directly below the hexagonal projection of the case proper, as shown by photograph, Plate 2.

5. Movement of the bellows is opposed by a helical spring, piece 9. By turning adjusting screw, piece 8, adjusting nut, piece 7, will move and vary the compression of this spring. Friction between spring, piece 9, and adjusting nut, piece 7, as well as between spring, piece 9, and rod, piece 10, is relied upon to prevent rotation of the adjusting nut and permit vertical motion when the adjusting screw is turned. A second nut, located on the adjusting screw above the adjusting nut, is provided for a purpose which is not clear. This nut is not shown on Plate 1.

6. Movement of the bellows is communicated to the plunger of a normally open "micro-switch" by spring, piece 17, guided by rod, piece 10. The switch is mounted on frame, piece 3. Screw, piece 5, is apparently provided to permit additional adjustment of the "micro-switch."

7. The switch contacts are protected with a 0.1 mfd 400 volts, d-c working voltage condenser. Solid copper wire, insulated with varnished fabric tubing, is employed.

METHOD OF TEST

8. The contact maker was so mounted on the cover of an insulated watertight tank, that the entire expansion chamber projected into the tank. The tank was provided with an inlet and outlet and connected to a pump to provide forced circulation of the water used as a heat conducting medium. By the use of immersion heaters and a cooling coil, suitable temperatures and rates of temperature rise could be obtained.

9. This assembly, with the exception of the cooling coil and pump, was placed in a compartment where the ambient temperature was maintained at 50° F for the first part of the test and at 158° F for the latter part. The contact maker was tested for accuracy as received. The operating point (123.8° F) was determined by raising the temperature of the conducting medium at the rate of 0.4° F per minute at an ambient temperature of 104° F (mid-point of ambient range). Before the start of each test for accuracy, the contact maker housing had been subjected to the required ambient temperatures for at least two hours and the expansion chamber to

100° F for a least 15 minutes. The temperature was indicated by a precision thermometer extending from the tank and located near the expansion chamber. The operating point was checked after endurance, shock and vibration, overtemperature, and hydrostatic tests.

10. The operating range was then determined in an oil bath, after which the expansion chamber was subjected to an overtemperature test at 300° F for five minutes, followed by a hydrostatic test of 50 pounds per square inch.

11. Tests for dielectric strength, insulation resistance, and watertight integrity, concluded the test.

RESULTS OF TESTS

12. The results of the tests were as follows:

Requirements	Test Values
Contact load: Switch shall be capable of breaking a load of 4 amperes, 0.5 P.F., 115 volts, 60 cycles.	Complied.
Endurance test: Shall operate 48 hours, "one complete cycle each 5 minutes."	Complied.
Operating range: Shall be adjustable over a range of 100° F to 225° F.	* 86° F to 217° F.
Accuracy: Operating point shall not vary more than ± 2-1/2° F.	* See Table 1.
Shock and vibration tests: Paragraph F-2e.	* Operating point changed. See Table 1.
Dielectric: Shall withstand 1500 volts alternating potential for one minute between electrical parts and ground.	Complied.
Insulation resistance: Shall be not less than 10 megohms at 500 volts.	Complied, 100+ megohms by 500 volt megger.
Overtemperature test: Expansion chamber shall be subjected to a temperature of 300° F for five minutes without damage.	Complied. See Table 1.

Requirements	Test Values
Expansion chamber: Shall be designed for operation when submerged in a liquid at or less than 50 lb./sq.in. Shall be of corrosion-resisting material such as to minimize electrolysis when submerged in hot salt water in the presence of copper.	Unaffected by 50 pound hydrostatic test. Silver soldered or brazed brass bulb threaded into bronze housing.
Watertight integrity: Shall be submerged in 3 feet of water for one hour without the entry of water into the case.	*Leaked 30 cc at cover, piece 1, threads.
Clearance: There shall be not less than 1/4-inch between electrical circuits and ground unless separated by at least 1/8-inch of approved insulating material.	*Less than 1/4-inch between terminal of "micro-switch" and frame, piece 3; also between terminals and ground. Condenser case insulated from ground by means of paper case only.
Dimensions: Shall not exceed the following: Width - 4-5/16 inches Depth - 3-3/4 inches Length - 9 inches Weight - Not specified.	Complied. Width - 3-3/4 inches Depth - 3-9/16 inches Overall length - 8-1/8 inches Weight - 3 pounds.
Attachment to piping system: Shall be threaded 3/4-inch (IPS) and shall not project into the system more than 4-1/2 inches.	Complied. 4-1/2 inches, including thread.
Nameplates: Shall be in accordance with ND Spec. 42N2.	Complied. Corrosion-resisting material.
Terminal block: Shall be of phenolic material equipped with 9-S-1841-L terminals.	*Phenolic material used, but of unsatisfactory design.

* Denotes failure to comply with the specification.

CONCLUSIONS

13. The subject contact maker failed to meet the specifications as follows:

(a) Operating range.
(b) Temperature compensation.
(c) Accuracy following endurance.
(d) Accuracy following shock and vibration.
(e) Watertightness.
(f) Electrical clearance to ground.
(g) Condenser not properly insulated from ground.
(h) Terminal block.

14. This contact maker very nearly complied with the requirements for temperature compensation, due to a design feature which locates the bellows directly on the expansion tube and houses it in a part of the case not greatly affected by the ambient temperature.

15. The following features of mechanical design are considered unsatisfactory:

(a) The principal adjustment is not readily accessible and may be turned only with a small pin inserted in one of four holes. These shallow holes were badly worn at the end of the test as a result of the few adjustments necessary during the tests.

(b) The dependence upon friction to permit motion of piece 7 relative to piece 8 when making adjustments, and the use of the additional nut referred to in paragraph 5. This nut may be intended as a locking device for piece 7, but if so, this prevents adjustment without disassembly.

(c) Much of the instability of the operating point noted during the tests is attributed to unsatisfactory securing of the "micro-switch" and spring adjustment screws. A more positive method of securing the "micro-switch" should be provided.

(d) The sample is not in agreement with drawing, reference (c), in the following respects:

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(2) Piece 17 misnumbered as piece 19.
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(4) Nut referred to in paragraph 5 not shown.
(5) Micro-switch securing screw not shown.

Table 1

Operating Points of Sample Contact Maker during Tests

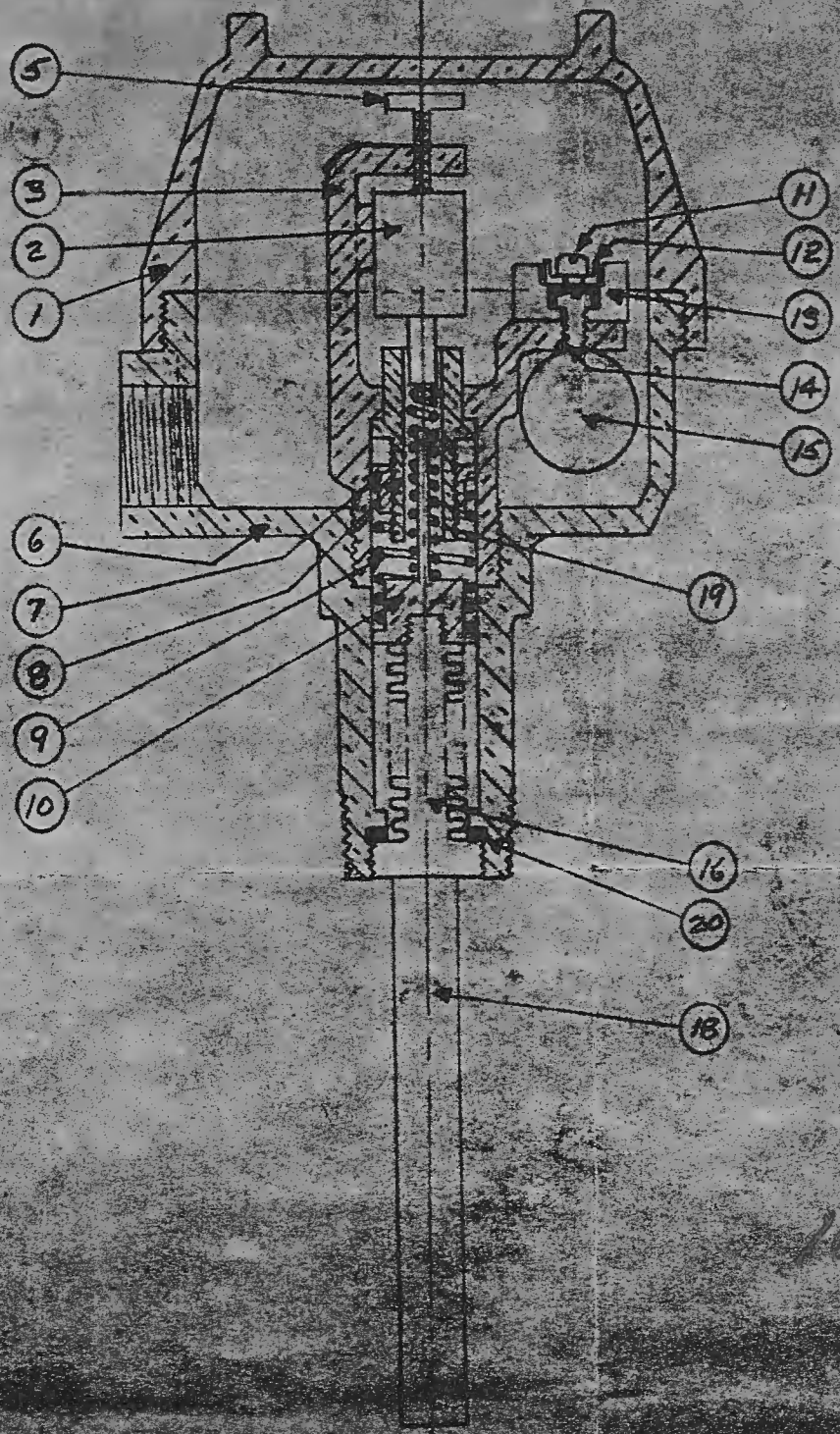
Condition	Ambient Temp. °F	Approx. Rate of Temp. Rise °F/min.	Contacts Closed °F	Approx. Rate of Temp. Drop °F/min.	Contacts Opened °F	Differential °F	Error in °F based on reference point of 123.8° F
At start of test	104	0.4	*123.8	1.8	118.4	5.4	-
		1.0	124.2	2.1	117.9	6.3	+0.4
		2.0	124.6	6.8	117.8	6.8	+0.8
		3.1	125.3	7.1	118.2	6.1	+1.5
		4.3	125.6	6.0	118.3	7.3	+1.8
		5.2	126.0	6.0	118.6	7.4	+2.2
	158	0.3	120.3	2.4	115.5	4.8	-3.5
		0.9	120.4	2.3	113.6	6.8	-3.4
		2.0	123.5	3.0	117.6	5.9	-0.3
		3.6	124.4	3.5	117.0	7.4	+0.6
		4.6	125.2	3.0	118.0	7.2	+1.4
		5.0	125.3	2.4	118.4	6.9	+1.5
	50	0.5	121.1	1.5	115.1	6.0	-2.7
		0.7	121.0	1.2	114.9	6.1	-2.8
		3.7	122.4	3.7	115.1	7.3	-1.4
		4.4	122.0	6.0	113.1	8.9	-1.8
After endurance test	104	0.7	119.6	5.0	110.5	9.1	-4.2
		1.1	119.2	0.9	112.8	6.4	-4.6
		1.6	120.2	2.0	111.7	8.5	-3.6
		4.4	121.0	5.0	112.2	8.8	-2.8
		5.0	120.8	2.8	112.5	8.3	-3.0
	158	0.4	119.3	3.0	112.0	7.3	-4.5
		0.8	119.9	3.0	112.0	7.9	-3.9
		3.8	121.3	4.0	111.5	9.8	-2.5
		5.0	121.4	4.0	111.8	9.6	-2.4
	50	1.0	121.4	1.4	114.9	6.5	-2.4
		3.0	122.8	1.9	115.3	7.5	-1.0
		4.6	123.0	2.0	115.2	7.8	-0.8
		5.0	122.5	4.0	113.0	7.5	-1.3
After shock and vibration tests	158	0.7	109.1	1.8	104.3	4.8	-14.7
		5.0	110.0	1.5	105.4	4.6	-13.8
After tightening switch screw	158	1.1	**111.5	5.5	106.0	5.5	-
		5.0	113.2	2.6	107.5	5.7	+1.7
After retest of shock and vibration	158	1.4	103.5	1.0	98.2	5.3	-8.0

*Reference point determined as noted in paragraph 9.
**New reference point.

Plate 1

Plate 2

Plate 3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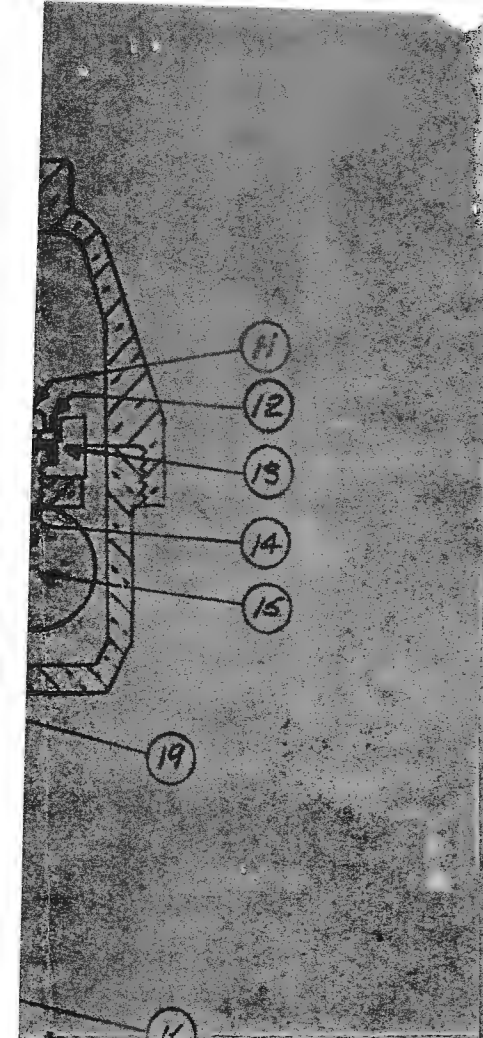
LIST OF MATERIAL

QUANTITIES ARE FOR ONE

	NAME OF PIECE	QTY.	MATERIAL	REMARKS	DRAWING NUMBER C.C.CO.
	[illegible]ER	1	[illegible]	4CBB	
2	SWITCH		SOLID	SWITCH CO TYPE WS2	
3	FRAME	1	BRONZE	4CBB	
4	LOCK	1	BRONZE	4CBB	
5	SCREW	1	BRASS	COMM.	
6	HOUSING	1	BRONZE	4CBB	
7	ADJUSTING [illegible]	1	BRASS	COMM.	
8	ADJUSTING [illegible]	1	BRASS	COMM.	
9	SPRING	1	STEEL	4754	
10	ROD	1	BRASS	COMM.	
11	FILL. HD. SCREW [illegible]	2	BRASS	4255	HOUSE PLATE
12	TERMINALS	2	COPPER	9-S-1841	
13	TERMINAL BLOCK	1	[illegible] MATERIAL	17PS	
14	FILL HD. SCREW [illegible]	1	BRASS	4255	
15	CONDENSER	1	CORNELL DUBILIER CO. CAT. NO. DTCPI. 600 VOLTS .1 MFD.		
16	BELLOWS ASSEMBLY	1	BRONZE	COMM.	
17	SPRING	1	STEEL	4754	CND. PLATE
18	BULB	1	BRASS	COMM.	
19	NAME PLATE	1	[illegible] CAST	42 NZ	
20	GASKET	1	[illegible]	30 P 14	



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CLARK COOPER COMPANY

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