NATIONAL BUREAU OF STANDARDS REPORT

2108

Model NM2B Electric Drinking Water Cooler

manufactured by

Sunroc Refrigeration Company

by

Henry Karger
C. W. Phillips
P. R. Achenbach

NBS

U. S. DEPARTMENT OF COMMERCE
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NBS PROJECT | **NBS REPORT**

1003-40-4700 December 11, 1952 2108

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Henry Karger
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Heating and Air Conditioning Section
Building Technology Division

to

Philadelphia Quartermaster Depot
U. S. Army
Philadelphia, Pennsylvania

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Abstract

A specimen of Model NM2B electric drinking-water cooler manufactured by the Sunroc Refrigeration Company was tested to determine compliance with Federal Specification OO-C-566b with amendment No. 2, and as modified by the Quartermaster Invitation to Bid No. QM 11-009-52-1048 and Contract No. DA 11-009-QM-18156 dated May 8, 1952. Performance tests only were made in accordance with the specification requirements. The specimen, as submitted, met all requirements of the performance tests except those for the drinking-water thermostat. However, after installation of a second thermostat and some internal adjustment, the requirements of the thermostat tests were also met by the test specimen.

I. INTRODUCTION

In accordance with requests from the Quartermaster Inspection Division, Chicago Quartermaster Depot, in letters dated May 27, 1952, and June 16, 1952, tests of one specimen of Model NM2B electric drinking water cooler manufactured by Sunroc Refrigeration Company, Glenn Riddle, Pennsylvania, were made to determine compliance with Federal Specification OO-C-566b, with Amendment 2 dated January 21, 1952, and as modified by the exceptions in the Quartermaster Invitation for Bids No. QM 11-009-52-1048, and as modified by the exception in Contract No. DA 11-009-QM-18156, dated May 8, 1952.

The performance of the specimen was determined by direct tests as described in the Federal Specification and the pertinent modifications. Special tests described herein were made to determine the performance of certain components. Inspections to determine compliance of the specimen with regard to materials and construction were not requested by the Quartermaster Inspection Division. The tests made did not require any dismantling of the specimen cooler.

II. DESCRIPTION OF TEST SPECIMEN

The specimen water cooler submitted for test was identified as follows:

NBS Test Specimen 85-52, Specification Type I, Size 10
Sunroc Company Model NM2B
Serial Number 218234-0
Code Number 1-10AH1

The specimen cooler was housed in a formed, one-piece steel enclosure which constituted the back and the sides of the cooler. This housing enclosed the condensing unit compartment and evaporator section and provided structural support for the unit. The louvered front panel could be removed, after loosening a screw at the bottom of the panel, by pulling the panel away from the cooler at the bottom and down from the recess formed by the top of the cooler. All of the controls and electric connections were accessible from the front side after the front panel was removed.

A front view of the cooler is shown in Fig. 1. Fig. 2 shows a rear view of the cooler, and the machine compartment is shown in Fig. 3. The dimensions and weight of the cooler were as follows:

Height, in.	44
Width of cabinet, in.	14-3/4
Depth of cabinet, in.	15-1/8
Width and depth of basin top, in.	15-3/4
Weight, including wood shipping base, lb.	147-1/4

III. TEST PROCEDURE

Tests of the specimen were made to determine compliance with the performance requirements of the following paragraphs of the specification, some of which were modified in the Invitation to Bid:

(1)	D-1, E-1, F-3a	Capacity Test
(2)	D-1a, F-3d	Peak Draw Test
(3)	D-1b, F-3b	Maximum Operating Test
(4)	D-6a	Jet of Water
(5)	D-6d	Water Regulator and Valve Test
(6)	D-10d	Refrigeration Control Test
(7)	D-10d(1), F-3e	Freezing Test
(8)	D-11b	Motor Overload Protection Test
(9)	D-13a	Operation at Varying Water Pressure
(10)	D-13b	Drain Capacity
(11)	F-3c, D-11a	Overload Test

All performance tests listed above were conducted in a temperature-controlled room under the general conditions set forth in paragraph F-3a of the Federal Specification, except where the paragraph applicable for a specific test called for a different set of conditions. Temperatures were measured by means of calibrated thermocouples using an electronic, constant-balance type of potentiometer. Accuracy of this instrument was checked at intervals during the tests by means of ice-bath references. Inlet and outlet drinking-water temperatures were measured by thermocouples in thin-walled stainless steel wells four inches long, mounted so the thermocouple junctions were approximately in the plane of the exterior surface of the cooler cabinet. Water-flow rates were determined in a manner that did not interfere with the flow of cooled water through the precooler. Supply water temperatures and pressures were controlled by close-differential mechanical devices.

Additional information on the test procedure for particular tests is included with the report of the test results to further clarify how the results were obtained in cases where the specification did not provide adequate details.

IV. TEST RESULTS

The following paragraphs show the results obtained on the cooler specimen during the performance tests listed under the section on Test Procedures.

(1) Capacity Test (Paragraphs D-1, E-1, F-3a)

Table 1, which follows, summarizes the results obtained during the capacity test and compares the observed performance with the specification requirements. The entry entitled "Drinking Water Flow Rate, Corrected for 30°F Temperature Difference, Gallons per Hour" gives the calculated water flow rate for a 30°F difference between supply and drinking water temperatures when the actual difference during the test was not exactly 30°F. Table 1 shows that the observed capacity of the specimen cooler exceeded the required capacity for Type I, Size 10 coolers.

TABLE 1. CAPACITY TEST OF SPECIMEN NBS 85-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	90	89.8
Electric Power Input, watts	-	298
Terminal Voltage	115	115
Total Current, amps	-	3.6
Drinking Water, Inlet temp., °F	80	80.2
Drinking Water, Outlet temp., °F	50	50.0
Drinking Water, temp. diff., °F	30	30.2
Spill through precooler, %	60	60.4
Drinking Water Flow Rate, observed, gph	-	10.5
Drinking Water Flow Rate, corrected for 30°F temp. difference, gph	9.0 (minimum)	10.6

(2) Peak Draw Test (Paragraphs D-1a, F-3d, modified)

The specification required that 37-1/2 percent of the required hourly capacity shall be drawn off in 15 minutes. The water temperature at the beginning of the 15-minute period must not be lower than 45°F or higher than 50°F and shall not rise more than 10 degrees at any time during the 15-minute period. The water must be drawn off, beginning immediately after the compressor-motor cuts off in a normal cycle, in not less than three or more than six equal intervals per gallon of required draw-off capacity. The water must be drawn off at a rate of not less than 1/2 gallon per minute per bubbler. It was assumed that in accord with general requirements of paragraph F-3a, 60% of the cooled water should be allowed to flow through the precooler as water was being drawn.

For this test, the specimen was equipped with a self-closing, hand-operated valve adjusted to permit water to flow at a rate of 1/2 gallon per minute when opened. Water was drawn off in 54 equal samples, each consisting of a 40% portion, drawn first, and a 60% portion, drawn second. The 40% portion, representing water consumed, was poured into a container for subsequent weighing. The 60% portion was poured into a vessel of low thermal mass immediately prior to each subsequent draw. This vessel allowed the 60% portion to flow into the precooler during the time required for the entire subsequent draw.

A second thermostat was installed in the specimen cooler by representatives of the Sunroc Refrigeration Company in connection with the thermostat requirements. Peak draw tests were made with each of the two thermostats furnished, and compliance with peak draw requirements was observed in both cases. Using

thermostat #1, a temperature rise of 9.4°F was observed, the initial outlet drinking water temperature being 49.6°F. Using thermostat #2, a temperature rise of 9.4°F was again observed, with the initial outlet drinking water temperature being 49.8°F.

(3) Maximum Operating Test (Paragraphs D-1b, F-3b)

The specification required that the cooler should start and operate satisfactorily, and should be tested for at least 8 hours of continual operation under conditions of 110°F ambient temperature, 100°F inlet water temperature, 50°F outlet drinking-water temperature, and, it was assumed in accord with paragraph F-3a, with 60% spill through the precooler.

The cooler was operated for eight hours under the above conditions. At the conclusion of the test, the cooler was turned off and left idle for five minutes and then restarted to determine whether or not it would start satisfactorily without causing the motor overload mechanism to operate. The cooler started and operated satisfactorily during this test. Table 2 shows the average conditions maintained during the maximum operating test.

TABLE 2. MAXIMUM OPERATING TEST OF SPECIMEN NBS 85-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	110	109.9
Electric Power Input, watts	-	314
Terminal Voltage	115	115
Total Current, amps	-	3.8
Drinking Water, Inlet Temp., °F	100	99.7
Drinking Water, Outlet Temp., °F	50	50.1
Drinking Water, Temp. Diff., °F	50	49.6
Spill Through Precooler, %	60	60.0
Drinking Water Flow Rate, observed, gph	-	4.0
Drinking Water Flow Rate corrected for 50°F temp. Difference, gph	-	4.0

(4) Jet of Water (Paragraph D-6a)

The position of the jet of water relative to the orifice, guard, and cooler basin was observed and was found to be in compliance with the specification requirements.

(5) Water Regulator and Valve Test (Paragraph D-6d)

The specimen cooler was equipped with an adjustable, automatic water-pressure regulating valve and a hand-operated, push-button type, self-closing stop valve. These two valves together with the bubbler and bubbler guard formed an integral mechanism. The adjustment for the pressure-regulating valve was accessible by removing the hexagonal nut holding the push-button on the bubbler assembly. Adjustments could then be made with a screw-driver. The bubbler assembly could be removed from the cooler by hand without breaking the cooling unit insulation.

Observations were made of the stream height, throw distance, and rate of water discharge on the cooler specimen for inlet water pressures of approximately 20 psig and 75 psig. The results are summarized in Table 3 below.

Water did not spurt from the bubbler of the specimen cooler when the stop valve was opened except when purging air during the initial filling of the cooler. No objectionable splashing of the drinking water on the cooler top was observed.

TABLE 3. WATER PRESSURE REGULATOR PERFORMANCE
COOLER SPECIMEN NBS 85-52

Supply Water Pressure, psig	20	75
Stream Height above nozzle, in.	3-1/4	4-1/4
Stream Height above guard, in.	1-1/2	2-1/2
Throw distance from nozzle, in.	5-1/2	6
Rate of Water Flow, gal/hr	19.2	21.6

(6) Refrigeration Control Test (Paragraph D-10d modified)

The specimen cooler was equipped with a thermostat which controlled the operation of the compressor motor. The thermostat was readily accessible for adjustment and servicing when the front panel of the cooler was removed, and could be replaced without breaking the main insulation of the cooling unit housing.

Adjustment of the thermostat could be affected by turning a knob. The thermostat caused the cooler to deliver colder water when this knob was turned in a clockwise direction, and caused delivery of warmer water if the knob was turned in a counterclockwise direction.

The specification requirement as modified in Amendment 2 stated in part:

> "Unless otherwise specified, the temperature control of the water shall be adjustable between 45° and 55°F and shall have a differential of not more than plus or minus 5°".

This requirement was interpreted by this Bureau to mean that a thermostat would be in compliance if at some condition of flow it would produce water at a control point temperature of 45°F at some one setting of the knob, and at a control point temperature of 55°F at some other setting of the knob, with a differential not to exceed plus or minus five degrees. In concurrence with representatives of the Sunroc Company, the rate of water withdrawl for this test was set at 1/2 of the required hourly capacity of the cooler, or approximately 4-1/2 gallons per hour.

Accordingly, two 6-ounce samples of water were withdrawn from the cooler through the bubbler every minute and fifteen seconds for the duration of the thermostat test. The first of these samples was discarded into the drain of the cooler, and the temperature of the second sample was recorded. The test was thus continued for 30 minutes, which was sufficient time to cause several thermostat cycles to occur. The test was conducted in an ambient temperature of 90°F, and the inlet water temperature to the cooler was maintained at 80°F.

Under the above conditions, and with the original thermostat in the test specimen, the average water temperature observed at the highest setting of the thermostat was 47.7°F, and the maximum observed deviation from this average was 4.3°F. At the lowest setting of the thermostat, the average observed water temperature was 39.6°F, and the maximum deviation from the average was 2.4°F. This thermostat did not meet the requirements of paragraph D-10d because the range of adjustment did not reach up to 55°F. A second thermostat was installed on the cooler by representatives of the Sunroc Refrigeration Company. A test with this thermostat showed an average water temperature of 52.6°F at the highest setting, with the maximum deviation being 4.4°F, and an average water temperature of 42.9°F at the lowest setting, the maximum deviation being 3.1°F. This second thermostat did not meet the specification requirement for the same reason as the first specimen. An internal range adjustment was then made by representatives of the Sunroc Refrigeration Company on the second thermostat. A test then indicated an average water temperature of 55.8°F for the highest setting and 45.0°F for the lowest setting of the thermostat. The maximum deviations from the average were 2.8°F and 3.9°F, respectively, for the two settings. This test indicated compliance with the requirement of the specification.

(7) Freezing Test (Paragraph D-10d(1) modified)

The specimen cooler had an additional thermostat to serve as a protective device against freezing. This thermostat was non-adjustable. Three freezing tests were made, the first in an ambient temperature of 50°F, the other two in an ambient temperature of 35°F. The primary drinking-water thermostat was shunted, and the cooler was operated under the above conditions. Operation of the secondary thermostat was observed during all three of the tests, no freeze-ups occurred, and drinking water could be drawn from the cooler at the conclusion of each test.

(8) Motor Overload Protection Test (Paragraph D-11b)

Paragraph D-11b states in part: "Motors shall be protected in case of failure of the starting mechanism or excessive overload by a thermal protective device of proper current rating, which shall open the circuit before the motor windings reach a temperature that will injure the motor."

The specimen cooler was equipped with such a device. To determine the protection afforded, two tests were made, both in a 90°F ambient temperature, with supply water flowing steadily through the cooler at a rate slightly in excess of 30 gallons per hour. First, the power lead to the starting winding of the motor was disconnected. The cooler was then energized electrically, and measurements were made of the motor running winding resistance immediately following each cutout of the overload protector. The overload protector was allowed to function until successive temperatures observed at the time of cutout were no longer increasing and the temperature rise of the winding was computed on the basis of the highest resistance observed. The highest motor-winding temperature computed under these conditions was 175°F. Second, the condenser fan was disconnected, the air flow over the condenser was blocked, and the cooler was allowed to continue in operation. The motor winding reached steady state temperatures in approximately 1 hour, and the protective device did not function during the test. The test was terminated at this time, and the average conditions attained under steady state operation are summarized in Table 4 below:

TABLE 4. OPERATING CONDITIONS OF COOLER DURING SECOND MOTOR OVERLOAD PROTECTION TEST

Temperature of Compressor Dome, near protective element, °F	148.3
Temperature of Inlet Water to Cooler, °F	80.1
Temperature of Outlet Water from Cooler, °F	70.9
Temperature of Ambient Air, °F	88.8
Temperature of Running Winding of Motor, °F	155.0
Compressor Motor Current, amps	4.2

Based on present accepted practice in the design of hermetic motor-compressor units, it is the opinion of this Bureau that the compressor motor of the cooler was adequately protected against overload and against excessive temperatures caused by motor overload.

(9) Operation at Varying Water Pressures (Paragraph D-13a)

As required by the specification in paragraph D-13a, the cooler operated satisfactorily when connected to a water supply system at pressures ranging from 20 psig to 75 psig. The capacity test described under section 1 of the Test Results was made with a supply water pressure of approximately 27 psig. The performance of the water regulator and valve under supply water pressures of 20 psig and 75 psig is discussed under section 5 of the Test Results.

(10) Drain Capacity (Paragraph D-13b)

The drainage system of the specimen cooler was apparently free of internal trappings and did not cause stoppage of water in the bubbler basin.

(11) Overload Test (Paragraph F-3c, D-11a)

The specimen cooler was tested in accordance with the requirements of paragraph F-3c of the specification, which calls for 4 hours of continuous operation in 100°F ambient temperature with water drawn at the rate of 300 percent of the required hourly capacity and 60% spill through the precooler. The inlet water temperature was held at approximately 80°F. The results of this test are summarized in Table 5, which follows.

The specimen cooler operated satisfactorily and without any indication of breakdown. The temperature rise of the motor running winding was determined by the resistance method and computed by the formula given in paragraph 4.2.3 of Federal

Specification CC-M-636a, dated October 29, 1951. Table 5 shows that the temperature rise of the motor winding was well below the permissible rise for totally enclosed motors in this specification.

It is pointed out that Federal Specification CC-M-636a does not carry any reference to motors integral to a hermetically-sealed refrigeration compressor. It is believed that the coil-winding temperature rise limits for totally-enclosed type motors should serve as a guide to assist in judging hermetic motors.

TABLE 5. OVERLOAD TEST OF SPECIMEN NBS 85-52

Performance Characteristics	Required Performance	Observed Performance
Ambient Temperature, °F	100	100.1
Drinking Water Inlet Temp., °F	-	80.1
Drinking Water Outlet Temp., °F	-	68.5
Ratio of Drinking Water Flow to Required Capacity, %	300	301
Spill through precooler, %	60	60.5
Electric Power Input, watts	-	351
Terminal Voltage	115	115
Temp. Rise of Motor Windings, °C	65* (maximum)	28.2

* Permissible temperature rise for totally-enclosed fractional-horsepower in Federal Specification CC-M-636a.

V. CONCLUSION

The specimen cooler, as submitted, met all the requirements of the performance tests made, with the exception of the thermostat test. However, after installation of another thermostat and some internal adjustment, the requirements of the thermostat tests were met by the specimen cooler.

FIG. 1

IG. 2

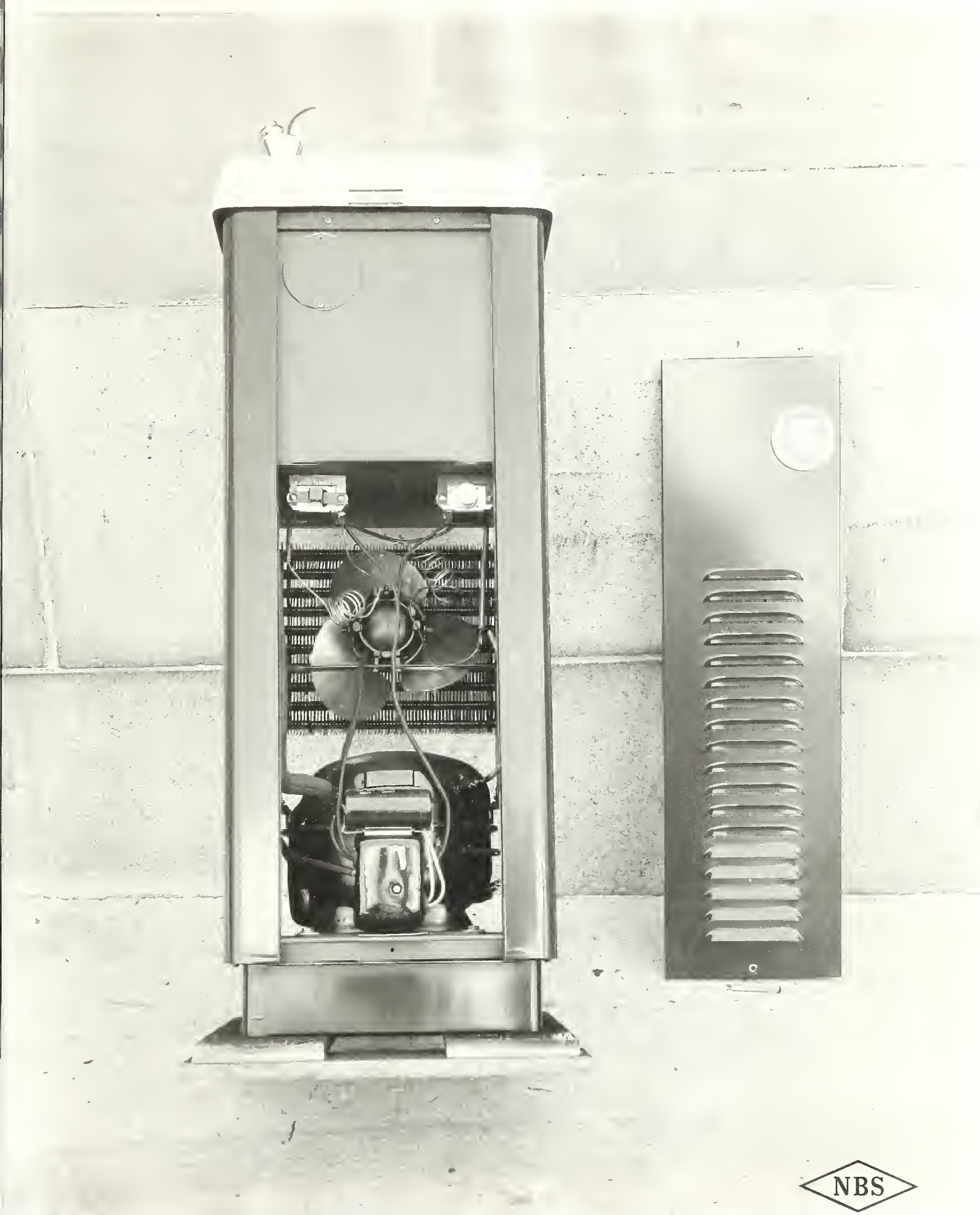

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FIG. 3

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