NATIONAL BUREAU OF STANDARDS REPORT

2810

SHIPPING CONTAINERS FOR WHOLE BLOOD

by

C. W. Phillips and P. R. Achenbach

Report to
Military Operations Subcommittee
Committee on Government Operations
U. S. House of Representatives

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

U. S. DEPARTMENT OF COMMERCE
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NATIONAL BUREAU OF STANDARDS
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- Office of Basic Instrumentation
- Office of Weights and Measures.

NATIONAL BUREAU OF STANDARDS REPORT

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SHIPPING CONTAINERS FOR WHOLE BLOOD

by

C. W. Phillips
and
Paul R. Achenbach
Heating and Air Conditioning Section
Building Technology Division

to

Military Operations Subcommittee
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U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

SHIPPING CONTAINERS FOR WHOLE BLOOD

C. W. Phillips and Paul R. Achenbach

ABSTRACT

Tests were made of shipping containers for whole blood manufactured by the Bailey Engineering Co., the Texas Trunk Co., and Hollinger Corporation to determine whether or not they would maintain whole blood at a temperature between 39°F and 50°F for 24 hours in an ambient temperature of 90°F. Two specimens from each manufacturer were compared to provide information for the Military Operations Subcommittee of the House of Representatives. The tests showed that none of the containers met the requirements when chopped ice only was used in the ice cans. When cold water was added to the chopped ice in filling the ice cans to float the ice to the top of the containers and to improve the heat transfer to the ice, all specimens met the requirements. Apparent differences in test results reported by the National Bureau of Standards and the Armed Services Medical Procurement Agency were resolved by a comparison of the methods for charging the ice can.

I. INTRODUCTION

At the request of Congressman Riehlman, Chairman, Military Operations Subcommittee, as indicated in a letter to Dr. Astin, dated July 22, 1953, tests were made to determine the ability of certain blood shipping containers to maintain satisfactory temperatures of liquid samples representing whole blood.

This report also covers additional tests and inspections of blood shipping containers made at the National Bureau of Standards and a comparison of test results obtained at the National Bureau of Standards and at laboratories of the Armed Services Medical Procurement Agency at Fort Totten, New York.

Mr. Paul J. Cotter, of the Military Operations Subcommittee staff, requested the additional tests and inspections not enumerated in the original letter of request.

The comparison of test results obtained at the National Bureau of Standards and at the Armed Services Medical Procurement Agency laboratory was requested by Col. H. F. Currie, Commanding Officer, ASMPA, in order to determine reasons for different results obtained at the two laboratories for apparently similar tests.

II. TEST SPECIMEN

The containers investigated were identified as "Container, Shipping, Insulated, Type 1, M-1," Stock Number 4-186-120, by the Armed Services Medical Procurement Agency. They were designed to be suitable for 24 units of whole blood requiring maintenance of temperature between 39°F and 50°F for at least 24 hours in 90° ambient. The containers were refrigerated by water ice packed in a tin-plated can approximately 7 1/2 inches square and 15 inches high. Depending on size and shape of the individual pieces of ice, the cans held between 17 1/2 and 21 lbs. of ice. Water could then be added to increase the weight (of ice and water) to more than 28 lbs. The ice can was situated in the center of the container and, including the handles, was practically as tall as the internal depth of the container.

The containers tested were manufactured by three firms, Bailey Engineering Co., Hollinger Corporation, and Texas Trunk Co.

The Bailey and Texas Trunk containers had 3-inch insulation thickness, the Hollinger containers had 2-inch insulation thickness.

The internal dimensions of all containers tested were approximately the same, 16 1/2" x 16 1/2" x 16 1/2"." The external dimensions of the Bailey and Texas Trunk containers were approximately 24" x 24" x 24", the Hollinger containers measured approximately 22" x 22" x 22"."

All containers were equipped with two removable wire racks, each capable of holding 12 600cc bottles. The ice cans in the Bailey and Texas Trunk containers were constructed similarly with rigidly-fixed strap-type handles for lifting the cans, the ice can in the Hollinger container was equipped with hinged handles of wire rod which permitted the can to be made taller for the same internal container dimension. As a result, the Hollinger ice can held 4.6 lbs more water than the other two.

Fig. 1 is a photograph of one specimen of each type of container showing the normal position of the ice can, the racks, and the blood bottles inside. This photograph shows the two kinds of handles used in the ice cans by different manufacturers. As identified by the white cards on the front wall of each box the specimens were manufactured by the three companies as follows:

Specimen 5	Texas Trunk Co.
Specimen 6	Hollinger Corporation
Specimen 7	Bailey Engineering Co.

III. TEST PROCEDURE

Initially, two specimens were submitted; one manufactured by the Hollinger Corporation and the other by the Bailey Engineering Co. These boxes were identified as specimens 1 and 2. Two 24-hour tests were made to compare the ability of these two specimens to maintain the desired temperatures in the blood bottles in an ambient temperature of 90°F. The results of these tests were not considered representative, however, and are not reported because Flakice was used for test 1 instead of chopped ice as required by the specification, and the temperature controller failed to maintain an ambient temperature of 90°F for six hours out of the 24-hour test period during test 2.

Another specimen manufactured by Bailey Engineering Co. (identified as specimen 3) was submitted prior to the next test. In test 3, therefore, two Bailey boxes and one Hollinger box were compared using chopped ice and with all three boxes precooled for several hours in an ambient temperature of 40°F prior to the start of the test.

Subsequently, 3 additional specimens manufactured by Bailey Engineering Co., one additional specimen manufactured by Hollinger Corporation, and 3 specimens manufactured by the Texas Trunk Co., were submitted. Two additional tests were made using two specimens from each of the three companies. The specimens were identified as follows:

Fig. 1

Specimen 1	Hollinger Corporation
Specimen 2	Bailey Engineering Co.
Specimen 4	Texas Trunk Co.
Specimen 5	Texas Trunk Co.
Specimen 6	Hollinger Corporation
Specimen 7	Bailey Engineering Co.

Specimens 1 and 2 were the same units previously used for tests 1-3 and the remaining four specimens were among those not previously tested here.

For tests 4 and 5 the boxes were arranged in two rows in the test room as shown in Fig. 2. They were supported on 2 x 4-inch timbers to permit air circulation underneath the specimens. Three thermocouples were used in each specimen in corner bottles, two in the upper layer, and one in the lower layer. Corner bottles were used because they would undoubtedly warm up faster and the maintaining of a satisfactory blood temperature was required in each individual bottle. Room temperature was controlled from and recorded at a station centrally located in the room as shown in Fig. 2. The forced circulation of air in the test room was baffled to limit the velocity around the specimens.

For test 4 the boxes were precooled to a temperature of 75° in the same room whereas in test 5 they were precooled to 40°F. For test 4 the ice cans were filled with chopped ice, drained of free water, and then weighed. In test 5 the same procedure was used except that the cans were filled with water at a temperature of 40°F after weighing the ice charge and then weighed again to determine how much water was added. About 15 minutes were required to warm the test room air from 75°F to 90°F in test 4 whereas about 50 minutes were required to raise the room temperature from 40°F to 90°F in test 5.

At the end of each test the water was drained from the ice cans and the remaining ice weighed to determine the meltage of ice during the test.

Cold water at a temperature of approximately 40°F was used in place of whole blood to fill all bottles during this series of tests since the specific heat of blood would be nearly the same as for water.

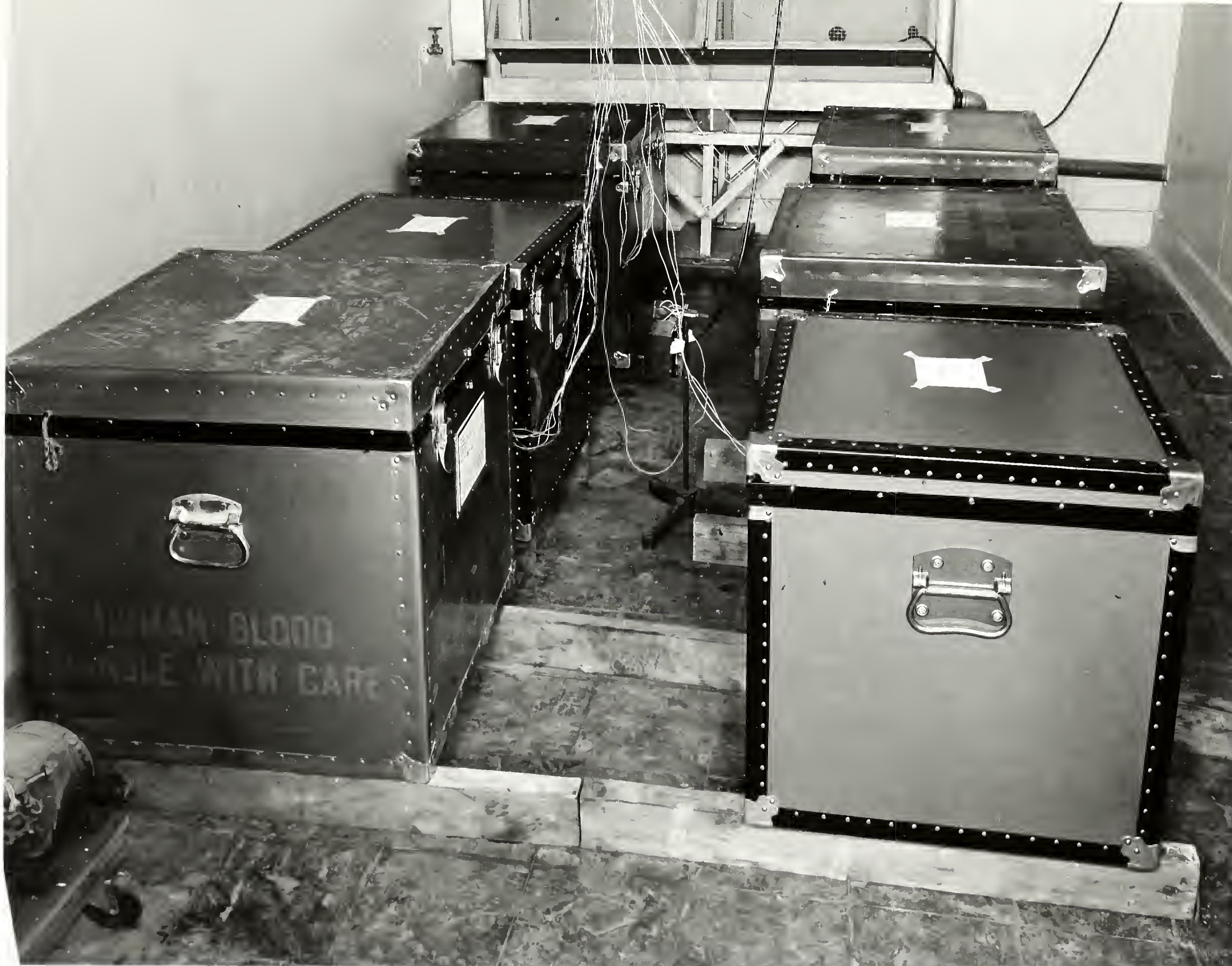


Fig. 2

Specimens 2 and 7 manufactured by the Bailey Engineering Co. were cut in half after the tests were completed to observe and record differences in the materials and construction methods used, if any. Photographs of cut sections of specimens 2 and 7 are attached as Figs. 3 and 4, respectively.

IV. TEST RESULTS

Performance Tests

The results obtained during tests 3, 4 and 5 are summarized in Tables 1-3. Only three specimens from two manufacturers were available when test 3 was made whereas six specimens from three manufacturers were available for tests 4 and 5.

Tables 1 and 2 show that none of the blood boxes maintained the bottle temperature at 50°F or below during a 24-hour period in an ambient temperature of 90°F when only chopped ice was placed in the ice can. Precooling the boxes to 40°F did not significantly lengthen the time required for the bottles in the upper layer to reach a temperature of 50°F. The results for specimens 1 and 2 in Table 2 are not consistent with the results for the same two specimens in Table 1. In test 4, summarized in Table 2, specimen 2, manufactured by the Bailey Engineering Co. maintained the temperatures below 50°F much less time than did the other five specimens including specimen 7, manufactured by the same company. In test 3, summarized in Table 1, specimen 2 maintained a temperature of 50°F a little longer than the other two specimens. Some inconsistencies in the results for duplicate tests are to be expected when water is not added to the chopped ice because of possible differences in time and direction of the settling of the ice mass in the can.

When the ice cans were filled with water at a temperature of 40°F after filling them with chopped ice, all six specimens maintained bottle temperatures below 50°F for 24 hours. These results are shown in Table 3 for test 5. The improved performance of the boxes in test 5 is attributed to the fact that the water caused the ice to float at the surface throughout the test and the water provided a better heat transfer medium than the chopped ice at the interior surface of the can. The chopped ice melted away from the inner surface of the can leaving an air gap through which the transfer of heat had to take place when the water was not added.

Fig. 3

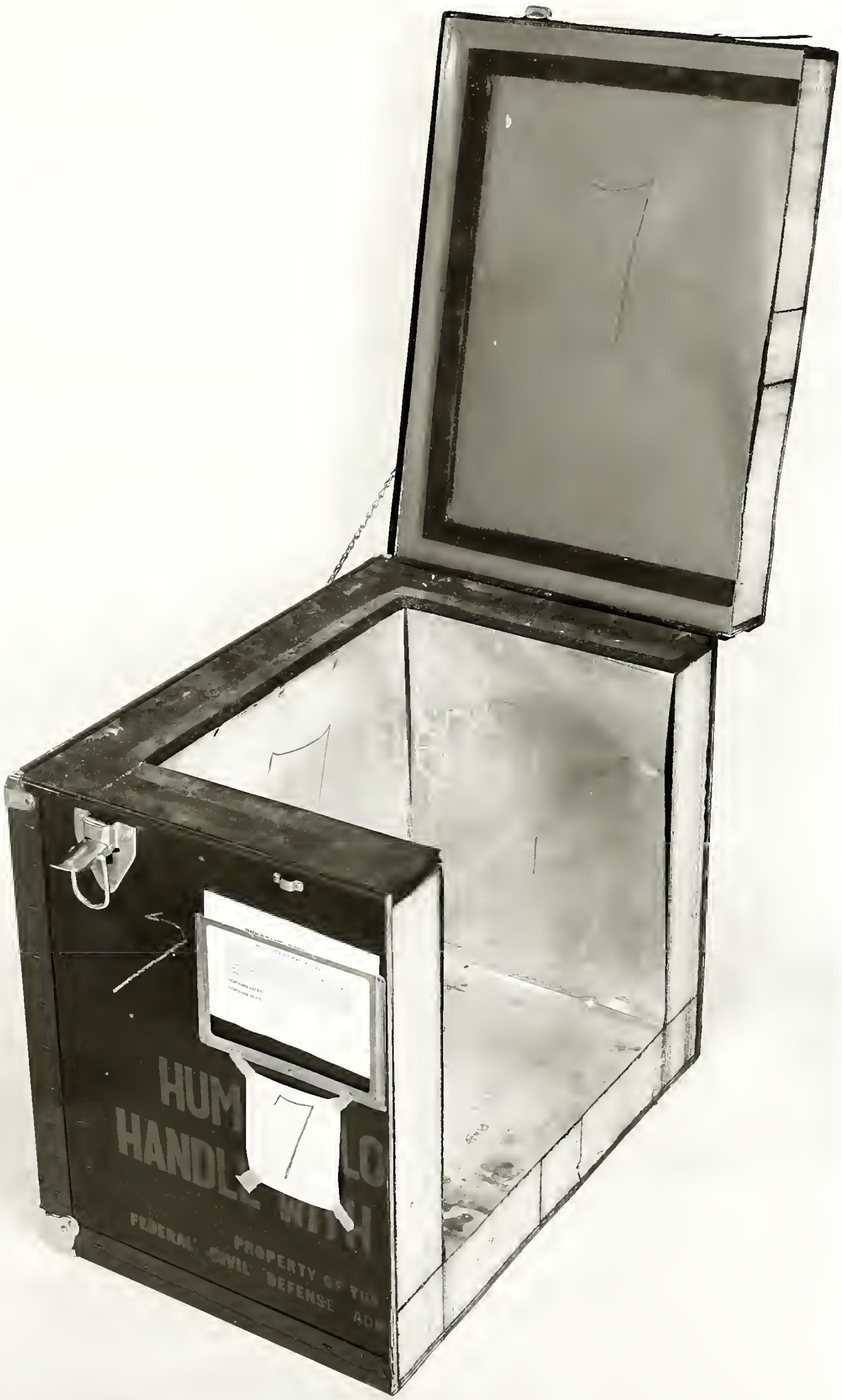


Fig. 4

53449-2

TABLE 1

PERFORMANCE OF BAILEY AND HOLLINGER SHIPPING CONTAINERS FOR WHOLE BLOOD [a]

TEST NO. 3

Specimen No.		1	2	3
Manufacturer		Hollinger Corp.	Bailey Mfg.Co.	Bailey Mfg. Co.
Chopped Ice Charge	lb.	19.6	17.5	17.2
Water Added to Ice Can	lb.	0	0	0
Total Charge	lb.	19.6	17.5	17.2
Ice Melted during Test [b]	lb.	12.2	8.6	9.2
Ice Remaining at End of Test	lb.	7.4	8.9	8.0
Time for Warmest Bottle to Reach 50°F [c]	hr.	10	12 1/4	11 1/2
Temp. of Warmest Bottle after 24 hr. at 90°F.	°F	54.3	54.2	54.2
Avg. Temp. of 4 Bottles on Top Layer after 24 hrs. at 90°F.	°F	53.0	53.4	53.3

[a] Boxes were precooled to 40°F prior to starting the test.
[b] Includes ice melted during 40 min. warmup period for room.
[c] After room temp. reached 90°F.

TABLE 2

PERFORMANCE OF SIX SHIPPING CONTAINERS FOR WHOLE BLOOD [a]

TEST NO. 4

Specimen No.		1	2	4	5	6	7
Manufacturer		Hollinger Corp.	Bailey Mfg.Co.	Texas Trunk Co.	Texas Trunk Co.	Hollinger Corp.	Bailey Mfg.Co.
Chopped Ice Charge	lb.	18.8	18.0	17.5	18.4	20.6	19.3
Water Added to Ice Can	lb.	0	0	0	0	0	0
Total Charge	lb.	18.8	18.0	17.5	18.4	20.6	19.3
Ice Melted during Test [b]	lb.	11.3	9.7	9.8	9.8	11.9	9.7
Ice Remaining at End of Test	lb.	7.5	8.3	7.7	8.6	8.7	9.6
Time for Warmest Bottle to Reach 50°F [c]	hr.	11 1/2	6 3/4	13 3/4	11 3/4	11 1/4	14 1/2
Temp. of Warmest Bottle after 24 hrs. [c]	°F	53.3	56.2	52.4	52.7	53.1	51.9
Avg. Temp. of 2 Bottles in Top Layer after 24 hours	°F	52.6	55.8	52.3	52.6	52.8	51.5

[a] Boxes were precooled to 75°F prior to starting the test.

[b] Includes ice melted during 15 min. warmup period for room.

[c] After placing ice can in box. Includes 15 min. warmup time.

TABLE 3

PERFORMANCE OF SIX SHIPPING CONTAINERS FOR WHOLE BLOOD[a]

TEST NO. 5

Specimen No.		1	2	4	5	6	7
Manufacturer		Hollinger Corp.	Bailey Mfg.Co.	Texas Trunk Co.	Texas Trunk Co.	Hollinger Corp.	Bailey Mfg.Co.
Chopped Ice Charge	lb.	19.8	17.9	17.3	19.3	20.1	17.8
Water Added to Ice Can	lb.	12.2	10.1	11.0	8.8	11.4	9.9
Total Charge	lb.	32.0	28.0	28.3	28.1	31.5	27.7
Ice Melted During Test[b]	lb.	14.0	12.4	10.4	11.8	13.2	11.6
Ice Remaining at End of Test	lb.	5.8	5.5	6.9	7.5	6.9	6.2
Time for Warmest Bottle to Reach 50°F	hr.	None reached 50°F in 24 hours					
Temp. of Warmest Bottle after 24 hrs. at 90°F[c]	°F	49.0	49.8	47.2	48.1	48.3	47.7
Avg. Temp. of 2 Bottles in Top Layer after 24 hrs. at 90°F[c]	°F	48.7	49.8	47.2	48.1	48.3	47.4

[a] Boxes were precooled to 40°F prior to starting the test.
[b] Includes ice melted during 1 hr. warmup time for room.
[c] Does not include warmup period for room.

Specimen 2 was also significantly poorer in maintaining temperatures below 50°F than the other specimens in test 5. After 24 hours in an ambient temperature of 90°F the warmest bottle in specimen 2 had reached a temperature of 49.8°F whereas the warmest bottle in the other boxes ranged from 47.2°F to 49.0°F.

Figs. 5-10 show the temperatures observed in two corner bottles in the top layer and one corner bottle of the bottom layer in the six specimens during the 24-hour period of test 4 when the boxes were precooled to 75°F. Similar data are shown for test 5 in Figs. 11-16 when the boxes were precooled to 40°F and cold water was used to fill the ice cans after charging them with chopped ice. In most cases the two top bottles did not differ in temperature by more than 1°F at any time during the test. In test 5 the bottle in the bottom layer was about 3°F cooler than those in the top layer, whereas in test 4 the disparity of temperature in the two layers was greater than 3°F during the last 12 hours of the test. It will be observed that the bottle temperatures decreased about 1°F during the first two hours of test 5 when the boxes were precooled to 40°F whereas a decrease in temperature was not observed at the beginning of test 4 with the boxes cooled to 75°F.

Tables 1-3 show from 2 to 3 lbs. more ice meltage for the Hollinger boxes than for those manufactured by the other two companies. This is undoubtedly the result of the thinner insulation used in the boxes manufactured by Hollinger Corporation. In general, the Hollinger boxes maintained as low a bottle temperature with 2 inches of insulation as did the other boxes with 3 inches of insulation. The ice cans in the Hollinger Corporation boxes were a little taller than those in the other boxes were though the interior height of all three makes of boxes was the same. This greater can height was possible because of the different handle design. The greater height gave the Hollinger can greater ice capacity and also placed the top of the ice charge at a higher level with respect to the top layer of bottles than did the shorter cans. This probably contributed to better cooling of the top layer of bottles and to a somewhat greater air convection in the boxes.

On the average 2 lbs. more ice was melted per box during test 5 than during test 4. This result also indicates that more effective heat transfer to the ice was obtained when the ice cans were filled with water and shows why lower bottle temperatures could be maintained.

V. INSPECTION OF BAILEY BOXES

Specimens 2 and 7 manufactured by the Bailey Engineering Co. were cut in half to make comparisons of the materials and methods of assembly. Fig. 3 is a photograph of specimen 2 and Fig. 4 is a photograph of specimen 7 showing the cross sections of these two specimens.

Analyses of materials were not made for chemical composition but the following differences were apparent.

A good grade of dense plywood 3/8 in. thick was used for the body section in specimen 2 whereas a poorer grade of plywood about 19/64 in. thick was used in specimen 7. A 3-ply gum or fur plywood, 3/8 in. thick, was required by the specification.

The insulation in specimen 7 consisted of smaller pieces of semi-rigid polystyrene fitted together whereas a single piece was used for each surface in specimen 2.

The heat-sealed envelope of a moisture-vaporproof material required by the specification was present in specimen 2, but was replaced by an asphaltic vapor barrier in specimen 7.

The top edge of the body section in specimen 2 was faced with monocellular sponge rubber as required by the specification whereas specimen 7 was faced with sponge rubber.

The nails used to join the panels of the plywood containers were not cement-coated in either specimen as required and the spacing was greater than 5 in. on both specimens.

The fiber coverings on the outside of both containers were stapled at 3 in. intervals where the coverings overlapped the tops of the containers instead of 2 in. as required by the specification.

All horizontal reinforcing angles on both specimens were stapled at 3 in. intervals instead of tacked at 1 1/2 in. intervals with brass tacks.

Some of the aluminum sheets on the interior of the body section and the fiber liner of the lid had become loosened from the insulation in specimen 7 whereas those panels were securely cemented to the insulation in specimen 2. The loosening of these linings can be seen in Fig. 4.

VI. MILITARY OPERATIONS SUBCOMMITTEE HEARING

On July 30, 1953 the results obtained in these whole blood shipping containers in tests 2 and 3 and a part of the results from test 4, which was only partially completed at that time, were presented to the Military Operations Subcommittee of the House of Representatives in an open hearing. All of the results reported showed that none of the shipping containers met the requirements of the specification when the ice cans were filled with chopped ice only.

The Armed Services Medical Procurement Agency presented tests data from similar tests showing that the containers manufactured by Bailey Engineering Co. met the requirements of the specification.

The opinion was expressed that the presence of some water in the ice can during the tests made by the Armed Services Medical Procurement Agency would assist in maintaining temperatures below 50°F for a longer time.

VII. VISIT TO THE LABORATORY OF THE ARMED SERVICES MEDICAL PROCUREMENT AGENCY AT FORT TOTTEN, N. Y.

At the request of Col. H. F. Currie, Commanding Officer, Armed Services Medical Procurement Agency, a visit was made at their laboratory to explore the reasons for the different results obtained on similar specimens of shipping containers manufactured by the same company as reported at the hearing of the Military Operations Subcommittee on July 30.

The results of this comparison are summarized in Memoranda I and II and Table 4 prepared jointly during this visit. It is believed that these memoranda and Table 4 satisfactorily explain the differences between the test results with the possible exception of a comparison of columns 5 and 6 with column 11 in Table 4.

For the test summarized in columns 5 and 6 the ice cans were completely filled with cold water after charging them with chopped ice. For the test summarized in column 11 some water was carried into the ice can while filling it with ice, but the ice can was not filled with water. Yet in all three cases temperatures in the blood bottles were maintained below 50°F for 24 hours. Thus, the question arises, Is a partial filling with water as effective as a complete filling with water?

The ice cans of the Bailey containers hold between 17 and 20 lbs. of ice depending on the size of the pieces. An additional 10 lb. of water will fill the can. Thus, for the test summarized in column 11 of Table 4 somewhere between 3.5 and 6.5 lb. of water must have been scooped into the ice can while filling it. Therefore, the water line in the can was at about mid-height at the start of the test. As the ice melted the ice level was lowered and the water level rose above mid-height. If all of the ice had melted the 23.6 lbs of water would have been 80 % of the water capacity of the can. Thus, it is apparent that a partial filling with water after charging with ice would be helpful in maintaining satisfactory temperatures in the bottles. After considerable ice had melted in such a case, the remainder would float at the water surface providing cooling at a fairly high level in the shipping container.

6 August 1953

MEMORANDUM FOR THE RECORD (I)

SUBJECT: Comparison of tests by National Bureau of Standards and Armed Services Medical Procurement Agency on Container, Shipping, Insulated Type 1, M-1, Stock No. 4-186-120

1. The attached tabulation summarizing the results of various tests made by ASMPA and NBS on samples of Blood Shipping Containers shows comparable results under comparable test conditions. For example, NBS test, column 4, favorably compares with ASMPA test column 8 and NBS tests, columns 6 and 7, favorably compare with ASMPA test, column 9.

2. The data presented on 30 July 1953 before the House Committee from apparently identical tests which indicated significantly different results were, in fact, the results of different test procedures, the important difference being the manner of loading the ice container.

3. Tests conducted in which the ice container was filled with water after being loaded to capacity with ice, columns 6, 7 and 9, clearly indicate compliance with performance requirements for all boxes tested by both laboratories.

4. Tests conducted wherein water was drained from the ice container after it was filled with ice showed, columns 4 and 8, that the boxes uniformly failed to comply.

5. Tests conducted at ASMPA laboratory, columns 11 and 12, data from which have been examined by the undersigned, indicates compliance with the specification. In these tests the water carried into the ice can during filling was not drained off prior to the test. Data furnished to the undersigned indicate that this manner of loading is typical of field use.

6. It is recommended that the test procedure in the specification for stock No. 4-186-120 be clarified.

FOR NATIONAL BUREAU OF STANDARDS:

/s/ C. W. Phillips
C. W. PHILLIPS
Mechanical Engineer, Heating and Air Conditioning Section, Nat'l Bureau of Standards

FOR ARMED SERVICES MEDICAL PROCUREMENT AGENCY:

/s/ B. D. Pile
B. D. PILE
Chief, Engineering Branch, Eng. Dev. Div. ASMPA

7 August 1953

MEMORANDUM FOR THE RECORD (II)

SUBJECT: Telephone Conversation between Lt. James H. Parker, MSC, USN, Blood Processing Laboratory, Travis AFB, Cdr. C. V. Timberlake, MSC, USN, ASMPA, and Mr. C. W. Phillips, National Bureau of Standards

1. A telephone call to Lt. Parker of the Blood Processing Laboratory, Travis Air Force Base, revealed that the technique used for filling the ice cans of the Blood Shipping Containers, Type 1, M-1, is as follows:

> The cans are filled with crushed ice by a "sugar scoop". It is estimated that 20 to 23 pounds of ice, depending upon the size of the can, is used. When the can is filled with ice, it is placed in the blood shipping container, without dumping any water out that might have resulted from ice melting during filling. The only time water is dumped from the ice can is when a delay of an hour or so occurs before the blood shipping container is actually on the way by air shipment.
>
> Lt. Parker further stated that he had 1100 to 1400 blood shipping containers in the circuit from Travis Air Force Base to Japan and that many of Type 1, M-1, blood shipping containers have made as many as 8 to 10 round trips to Japan and the most have made at least 3 or 4 round trips. Lt. Parker further stated that, to date, they had not a single report of whole blood arriving in Japan which had spoiled due to lack of proper refrigeration.
>
> Lt. Parker further stated that he had accompanied a shipment (or shipments) of whole blood to Japan using subject containers and that temperatures taken en route by recording devices never exceeded 50° Fahrenheit. It was further stated that ice cans were usually refilled at only one stop (Honolulu). Cans were not refilled at other stops unless the plane was forced to make a prolonged stop.

/s/ C. V. Timberlake

C. V. TIMBERLAKE
Cdr., MSC, USN
Chief, Mat. Stds. Div., ASMPA

cc: Mr. C. W. Phillips
National Bureau of Standards

TABLE 4

NBS-ASMPA COMPARISON TESTS OF CONTAINER, SHIPPING, INSULATED

(INCLOSURE WITH MEMORANDUM FOR THE RECORD, DATED 6 AUGUST 1953)

COLUMN	NBS 1	2	3	4	5	6	7	ASMPA 8	9	10	11	12
CONTAINER IDENTIFICATION	BAILEY BOX #2 TEST #3	BAILEY BOX #3 TEST #3	BAILEY BOX #2 TEST #4	BAILEY BOX #7 TEST #4	BAILEY BOX #2 TEST #5	BAILEY BOX #7 TEST #5	TEXAS TRUNK BOX #5 TEST #5	BAILEY T.I. 16344	BAILEY T.I. 16344	BAILEY T.I. 16344	BAILEY T.I. 15352	TEXAS TRUNK (TESTED 4 AUG 53)
BOX PRECOOLED (OR CONDITIONED)	TO 40° F.	TO 40° F.	75° F.	75° F.	TO 40° F.	TO 40° F.	TO 40° F.	80° F.	TO 40° F.	TO 40° F.	TO 40° F.	TO 40° F.
PRECOOLING OF BOTTLES TO 40° F.	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
ICE CHARGE – LBS	17.5	17.2	18.0	19.3	17.9	17.8	19.3	17.0	20.7	20.6	–	–
ICE PLUS WATER CHARGE – LBS	–	–	–	–	28.0	27.7	28.1	–	26.8	–	23.6	23.6
ICE MELTED – LBS	8.6 (25.4 HRS)	9.2 (25.5 HRS)	9.7** (23.8 HRS)	9.7** (23.5 HRS)	12.4*** (25.3 HRS)	11.6*** (25.0 HRS)	11.8*** (25.0 HRS)	8.0 (24.0 HRS)	–	12.7 (30.0 HRS)	–	–
ICE REMAINING AT END OF TEST – LBS	8.9	8.0	8.3	9.6	5.5	6.2	7.5	9.0	–	7.9	12.2	9.5
TYPE OF ICE	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED	CHOPPED
ICE CONTAINER DRAINED AFTER FILLING WITH ICE	YES	YES	YES	YES	–	–	–	YES	–	NO	NO	NO
WATER ADDED TO CONTAINER AFTER FILLING WITH ICE	NO	NO	NO	NO	YES	YES	YES	NO	YES	NO	NO****	NO****
TIME FOR WARMEST BOTTLE TO REACH 50° F. (HRS)	12 1/4*	11 1/2*	7**	14**	–	–	–	12	–	–	–	–
TEMPERATURE OF WARMEST BOTTLE AT END OF 24 HRS (° F.)	54.2*	54.2*	56.1**	51.9**	49.5***	47.5***	48.1***	51.5	47	49	49.2	48.5

(ASTERISKS REFER TO NOTES ON THE FOLLOWING PAGE.)

NBS-ASMPA Comparison Tests of Container, Shipping, Insulated
Incl. with Memo. for the Record, dtd 6 Aug 53

* Does not include 1 hour during which test room temperature was raised from 40° F. to 90° F.

** Test period includes 50 minutes when ambient was at 75° and warming up from 75° to 90° F.

*** Test period includes approximately 1 1/4 hours at 40° ambient and warming from 40° ambient to 90° F. ambient.

**** Water carried in with ice in filling with scoop not poured out, but with no additional water added.

NOTES:

1. Test ambient was 90° F. in all cases.

2. NBS Box No. 2 supplied by Committee - Civilian Defense (Bailey)

3. NBS Box No. 3 supplied by Committee (Bailey)

4. NBS Box No. 7 received by NBS from Mechanicsburg (Bailey)

5. NBS Box No. 5 received by NBS from Mechanicsburg (Texas Trunk)

6. ASMPA T.I. 16344 - sample from Mechanicsburg (Bailey)

7. ASMPA T.I. 15352 - sample from plant (Bailey)

8. ASMPA - marked 4 Aug 53 - sample from depot stock (Texas Trunk)

TEST 4

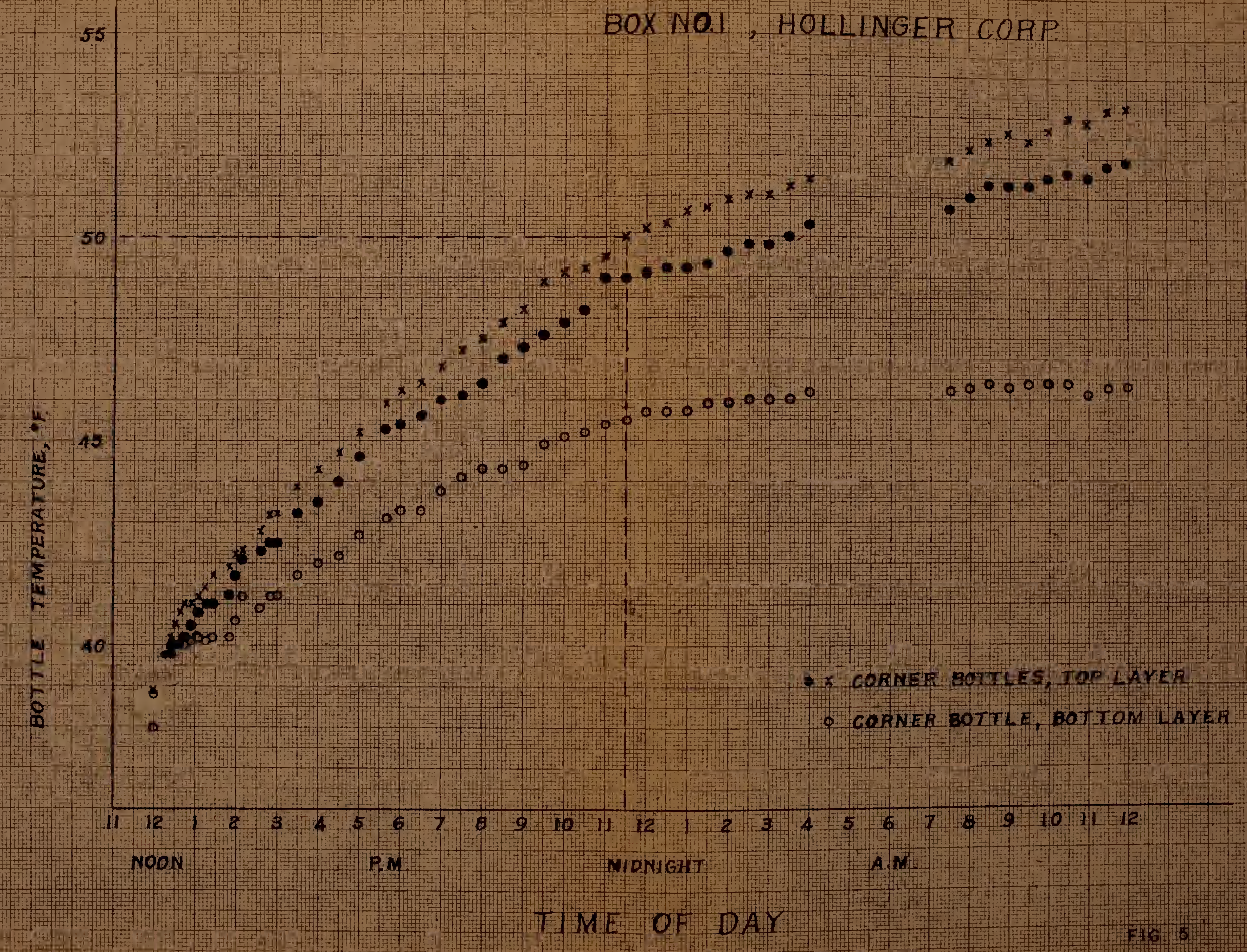

BOX NO.1 , HOLLINGER CORP.
BOTTLE TEMPERATURE, °F
55
50
45
40
11
12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
P.M.
MIDNIGHT
A.M.
TIME OF DAY
● x CORNER BOTTLES, TOP LAYER
○ CORNER BOTTLE, BOTTOM LAYER

FIG. 5

TEST NO. 4

BOX NO. 2, BAILEY MFG. CO.

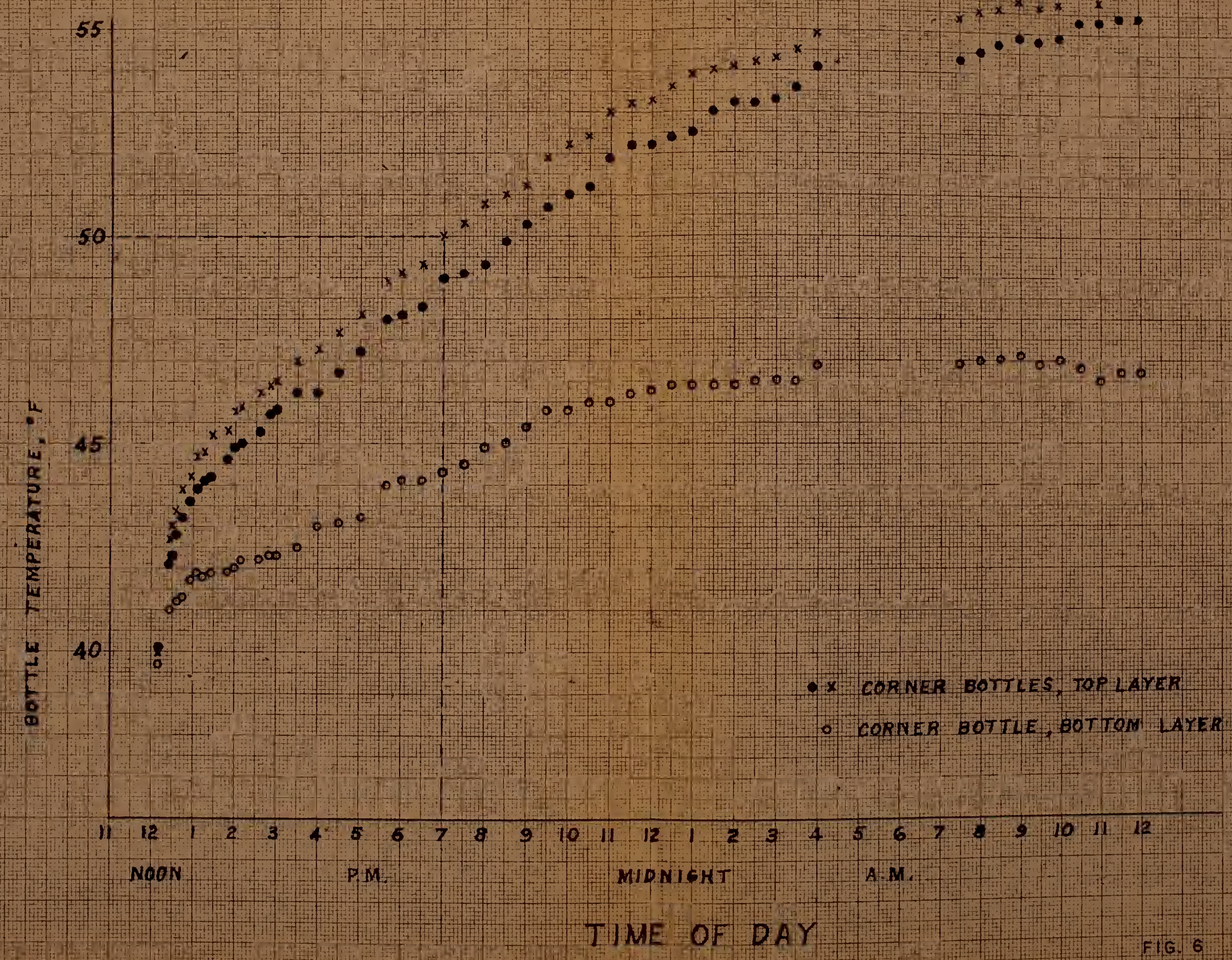


FIG. 6

TEST 4

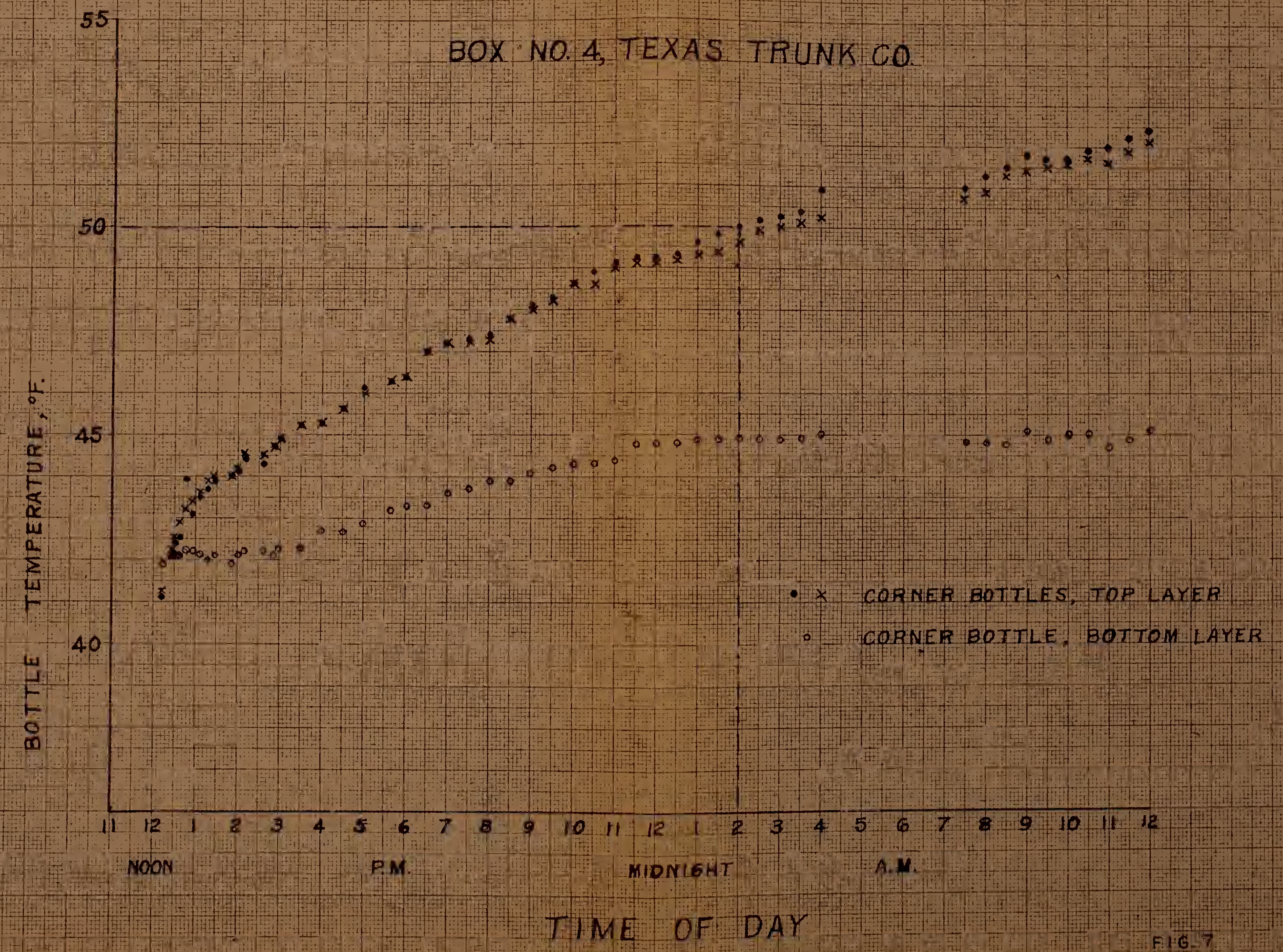
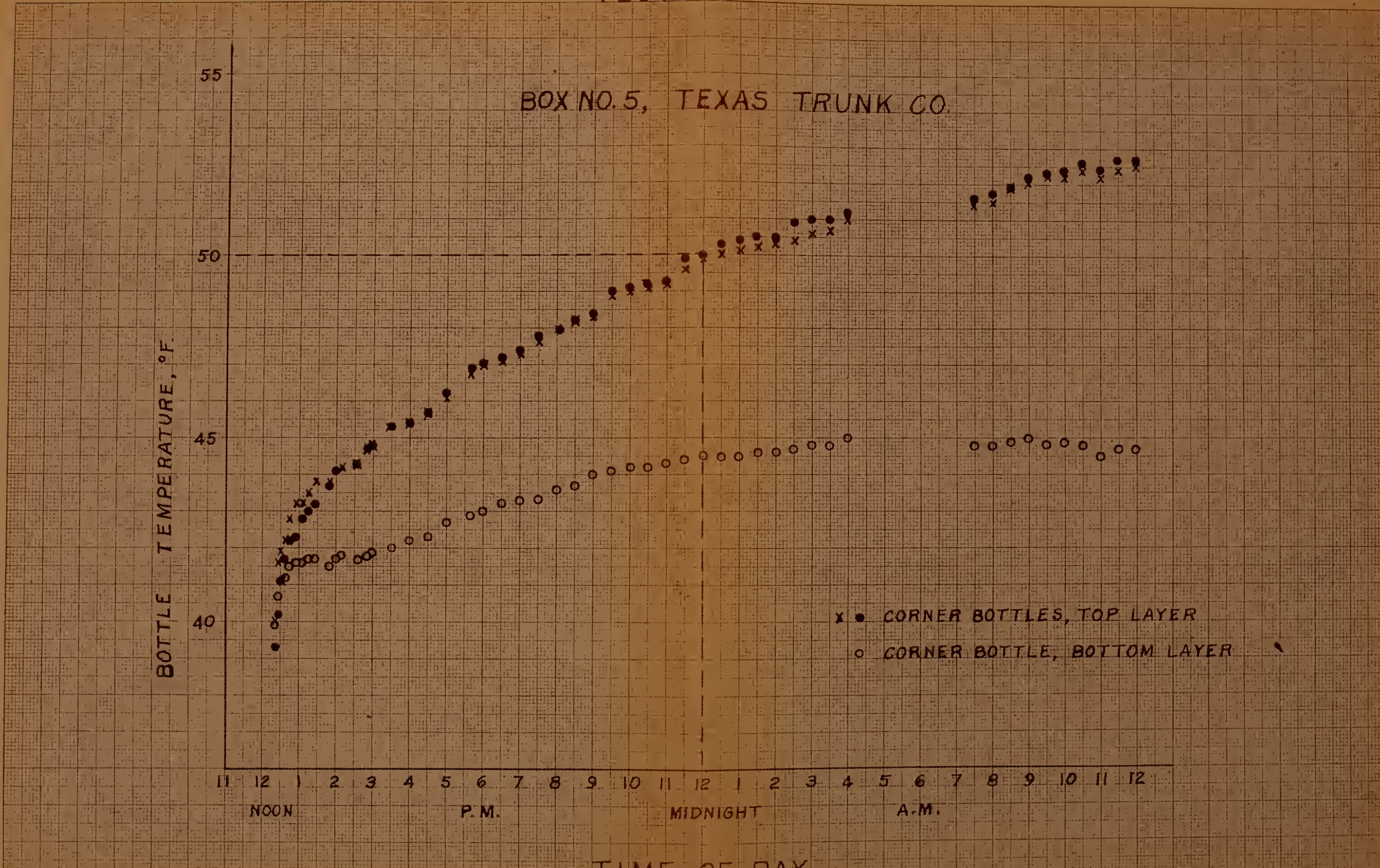

BOX NO. 4, TEXAS TRUNK CO.
55
50
45
40
BOTTLE TEMPERATURE, °F.
11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
NOON
P.M.
MIDNIGHT
A.M.
TIME OF DAY
• × CORNER BOTTLES, TOP LAYER
○ CORNER BOTTLE, BOTTOM LAYER

FIG. 7

TEST 4



BOX NO. 5, TEXAS TRUNK CO.
BOTTLE TEMPERATURE, °F.
55
50
45
40
11
12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
P. M.
MIDNIGHT
A. M.
TIME OF DAY
x ● CORNER BOTTLES, TOP LAYER
o CORNER BOTTLE, BOTTOM LAYER

FIG 8

TEST NO. 4

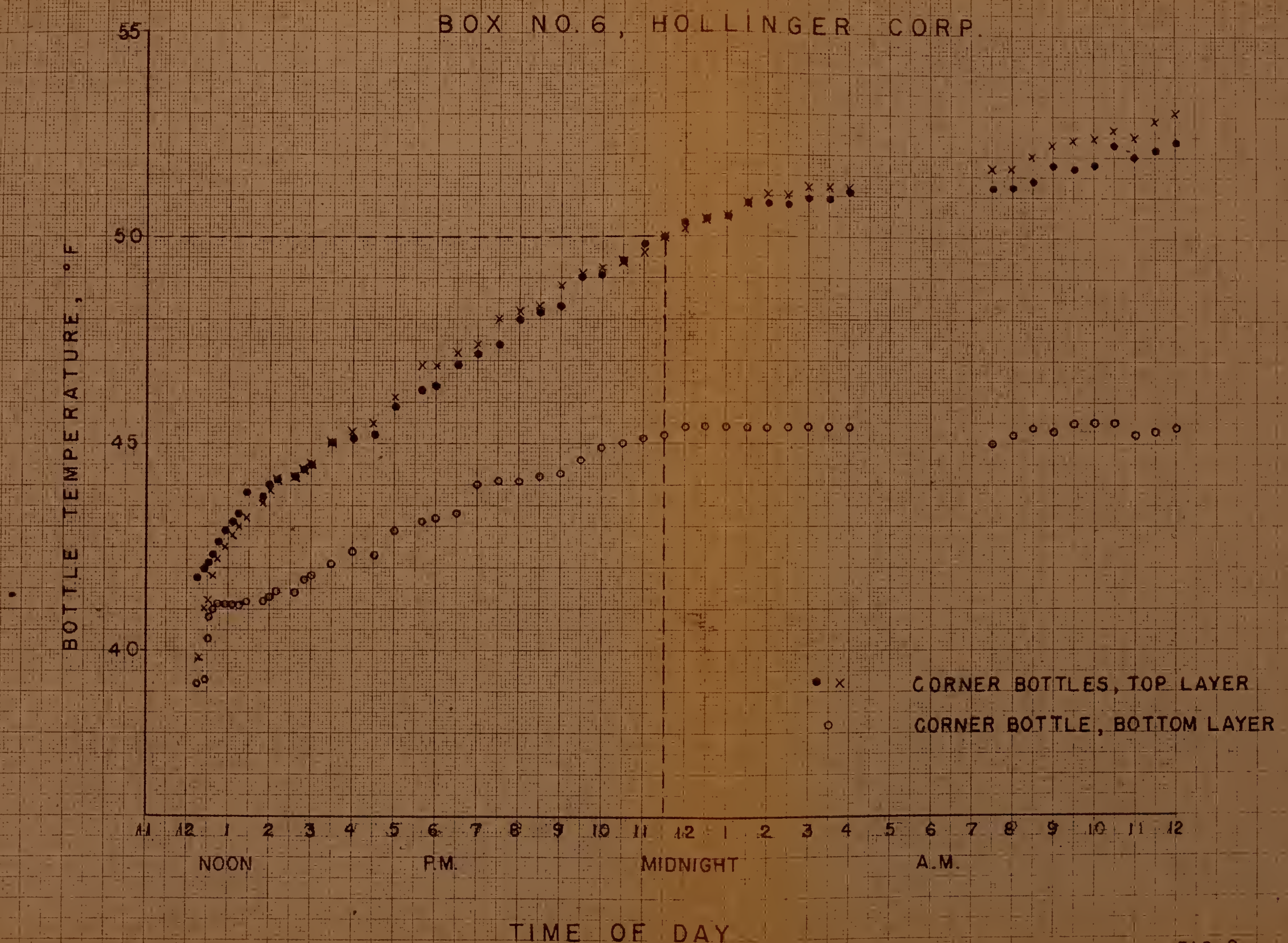


FIG. 9

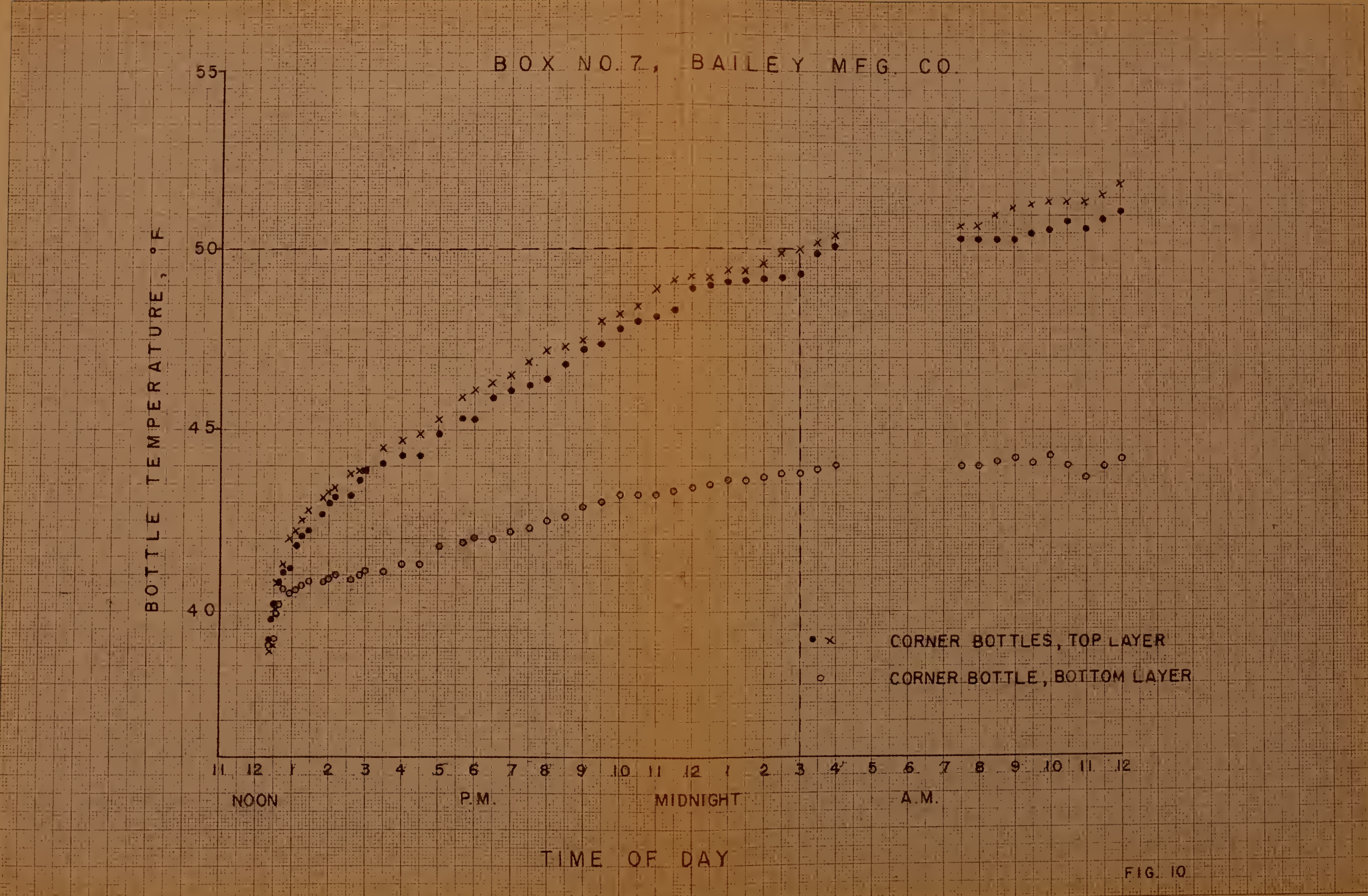

BOX NO. 7, BAILEY MFG. CO.
BOTTLE TEMPERATURE, °F
55
50
45
40
11
12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
NOON
P.M.
MIDNIGHT
A.M.
TIME OF DAY
CORNER BOTTLES, TOP LAYER
CORNER BOTTLE, BOTTOM LAYER

FIG. 10

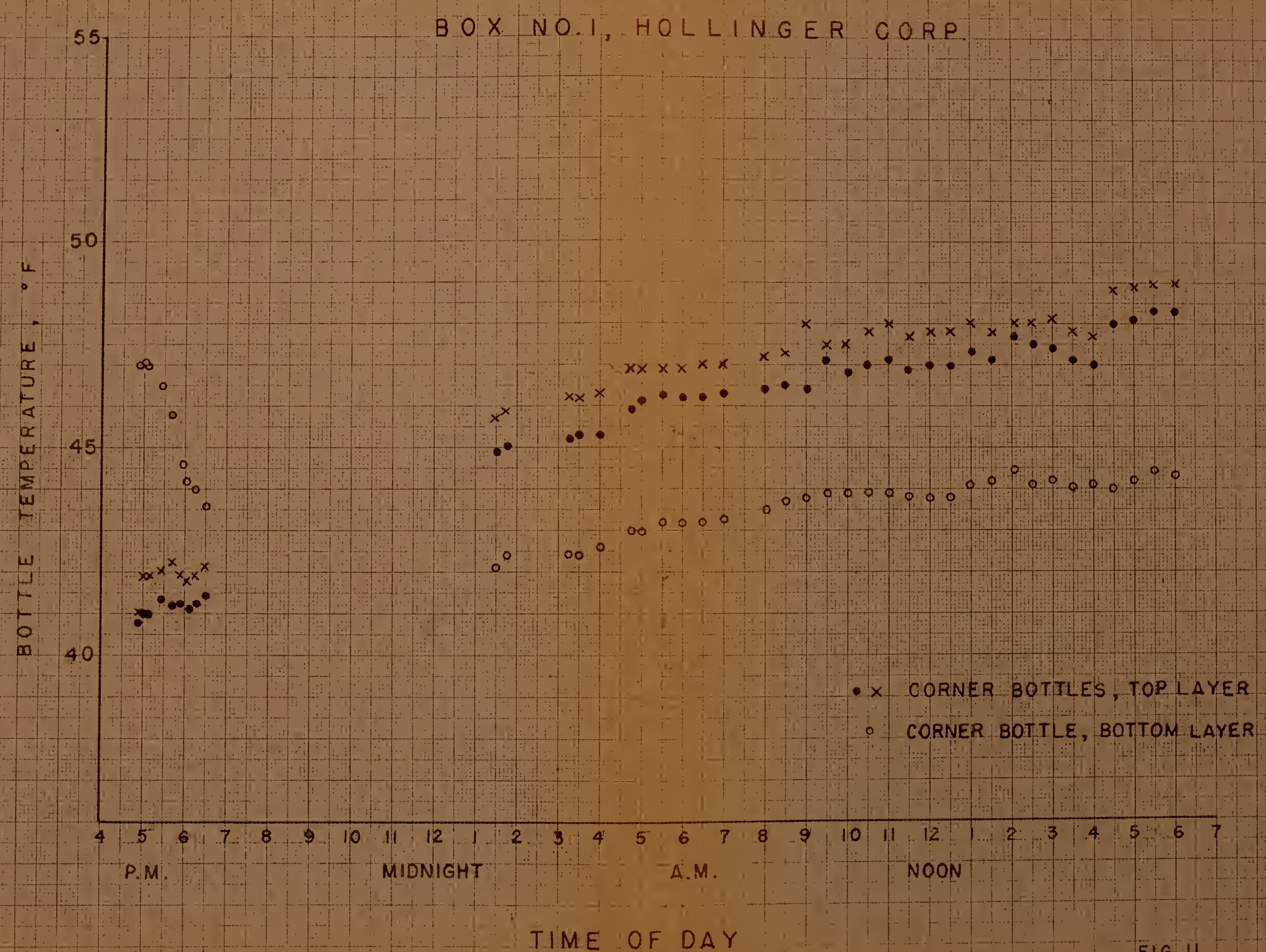

BOX NO.1, HOLLINGER CORP.
BOTTLE TEMPERATURE, °F
55
50
45
40
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
P.M.
MIDNIGHT
A.M.
NOON
• x CORNER BOTTLES, TOP LAYER
o CORNER BOTTLE, BOTTOM LAYER
TIME OF DAY

FIG. 11

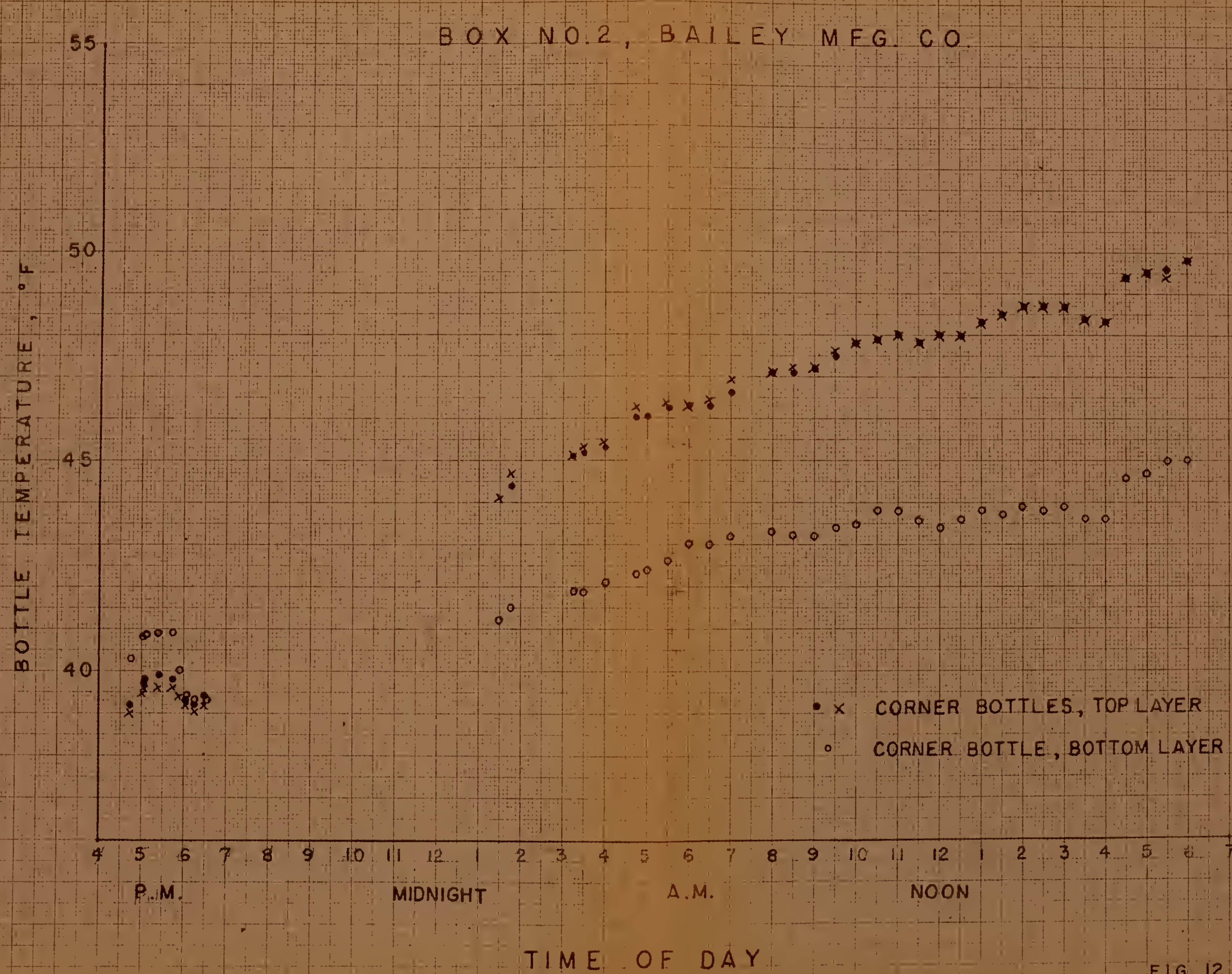
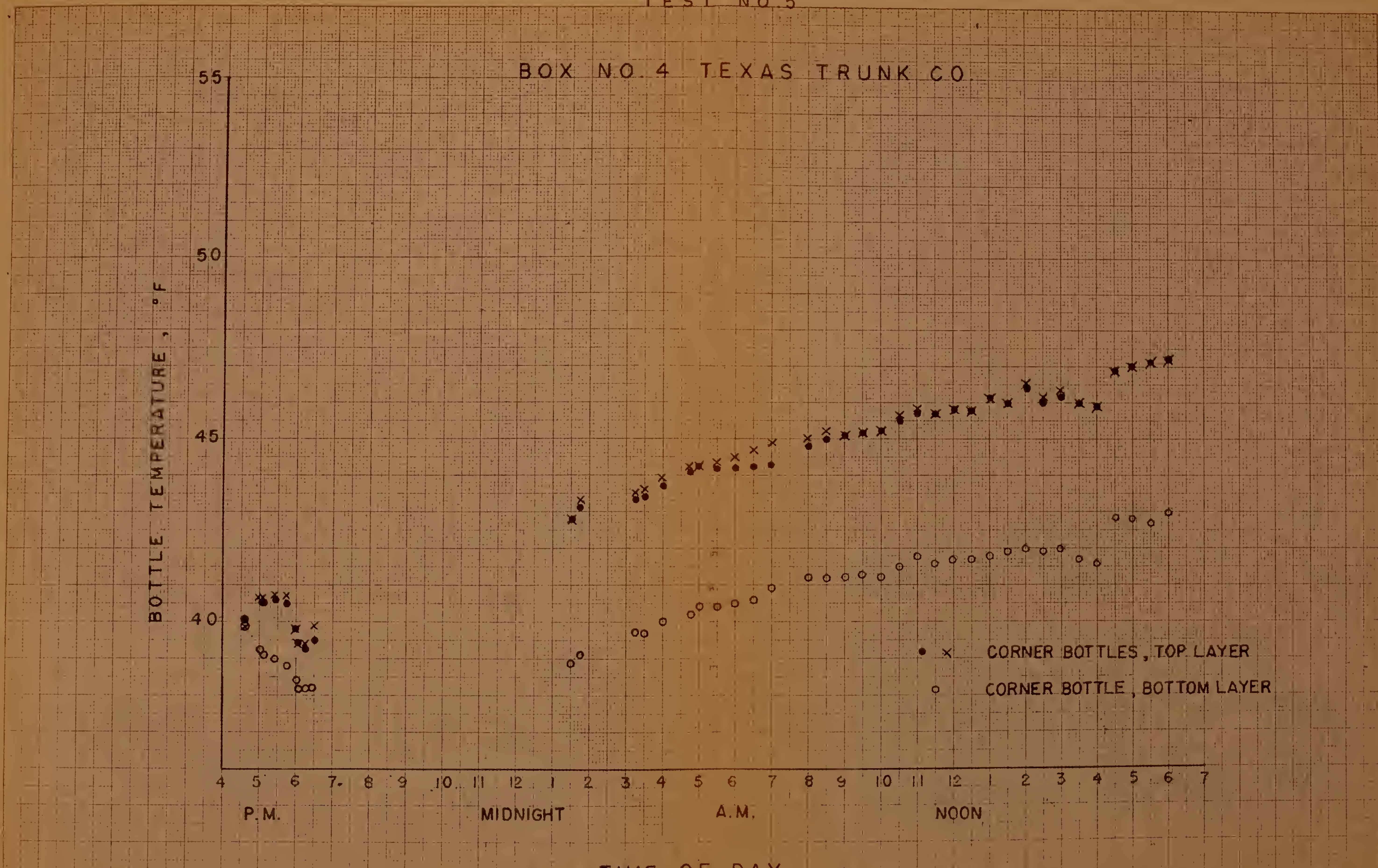

BOX NO. 2, BAILEY MFG. CO.
BOTTLE TEMPERATURE, °F
55
50
45
40
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
P.M.
MIDNIGHT
A.M.
NOON
TIME OF DAY
• × CORNER BOTTLES, TOP LAYER
○ CORNER BOTTLE, BOTTOM LAYER

FIG. 12


TEST NO. 5
BOX NO. 4 TEXAS TRUNK CO.
55
50
45
40
BOTTLE TEMPERATURE, °F
CORNER BOTTLES, TOP LAYER
CORNER BOTTLE, BOTTOM LAYER
4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7
P.M.
MIDNIGHT
A.M.
NOON
TIME OF DAY
FIG. 13

TEST NO. 5

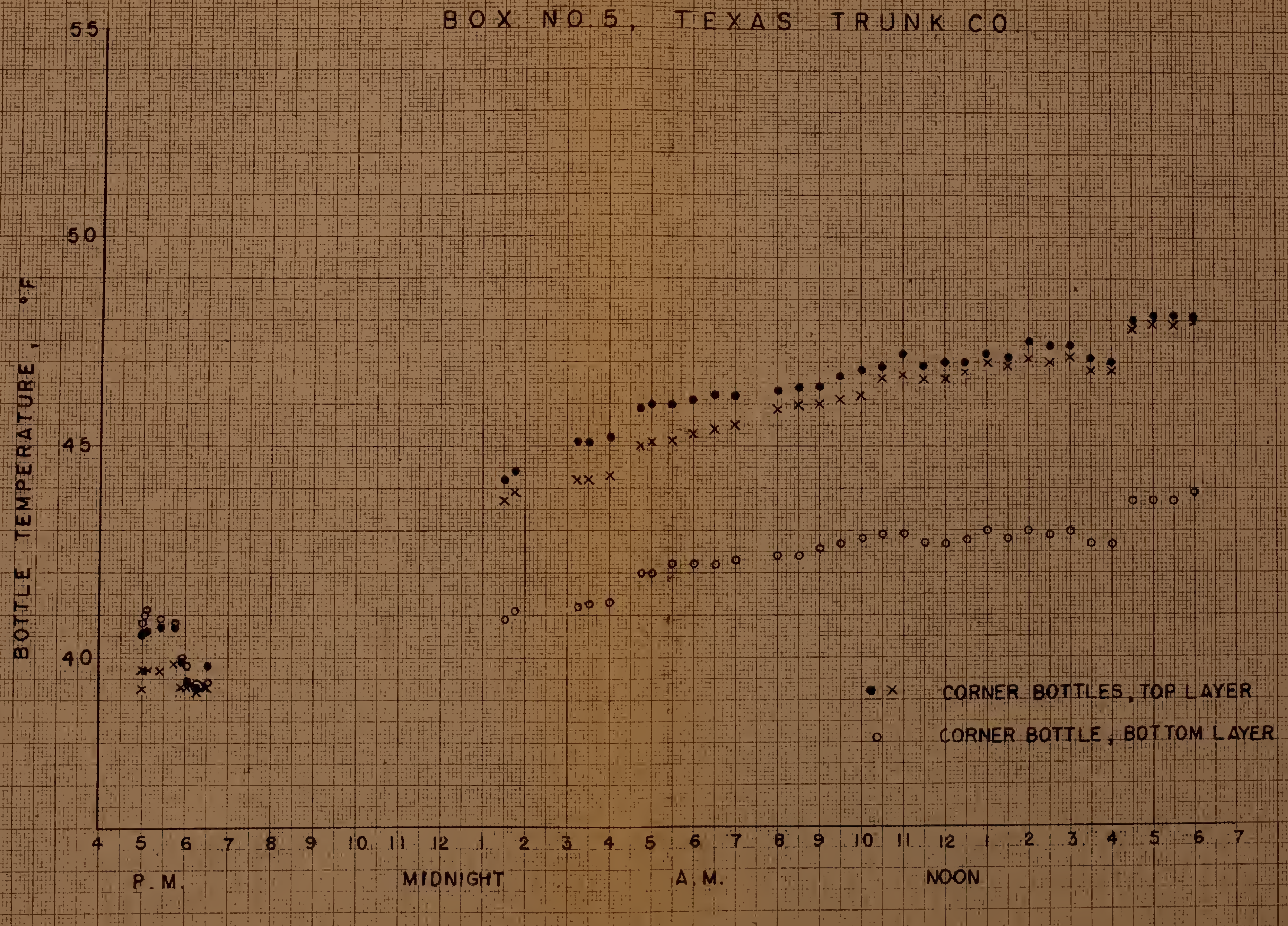


FIG. 14

TEST NO 5

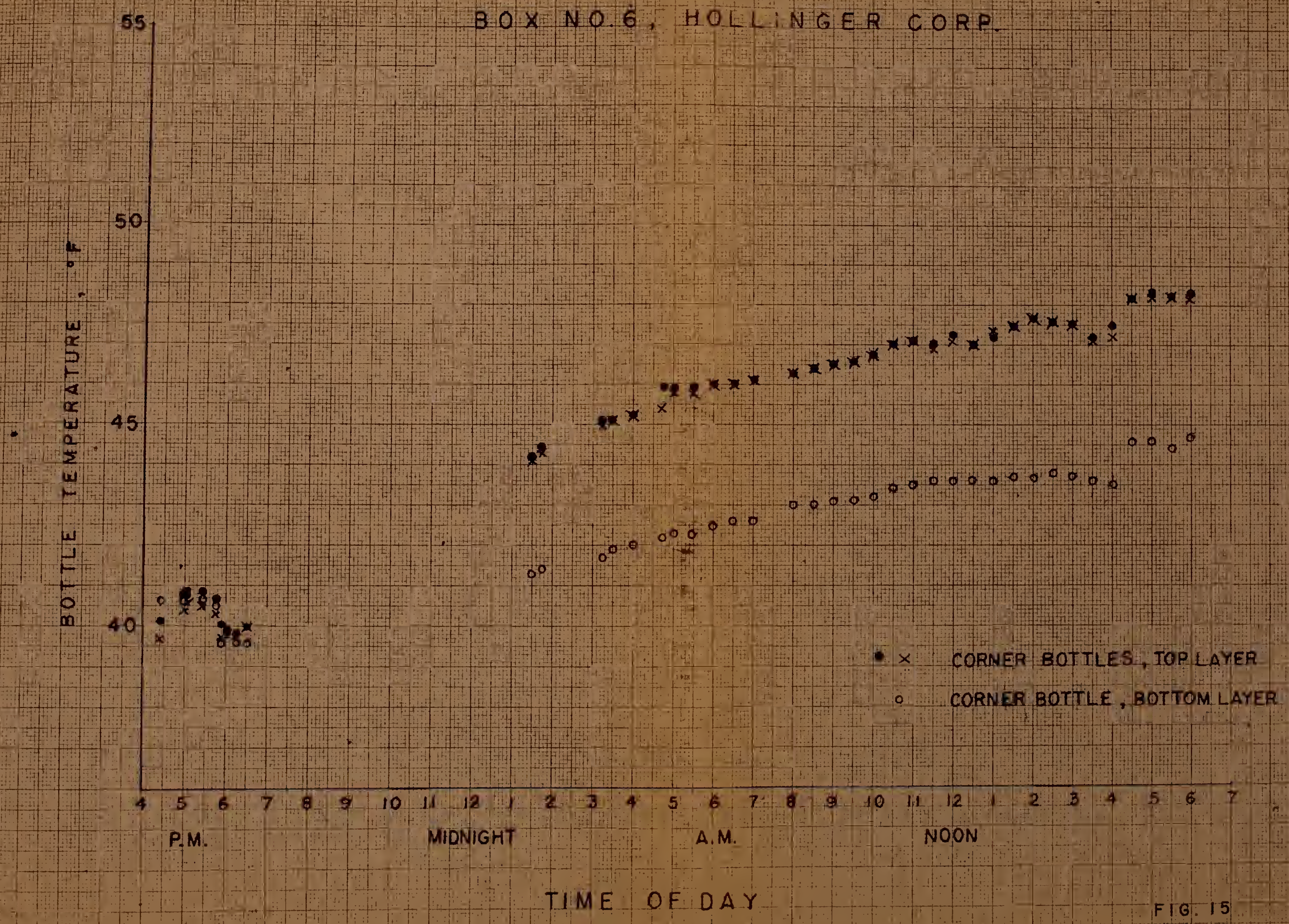


FIG. 15

TEST NO. 5

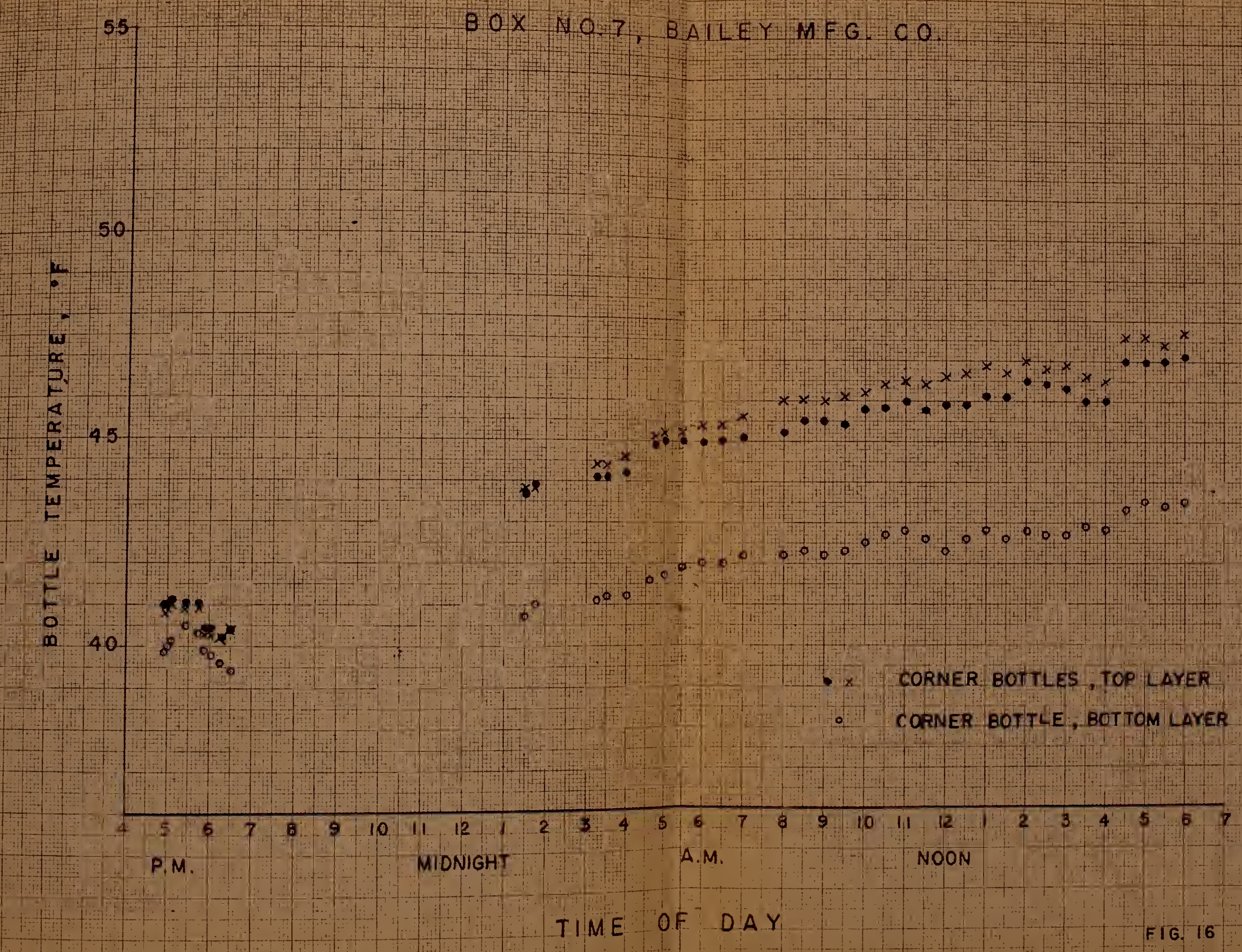


FIG. 16

THE NATIONAL BUREAU OF STANDARDS

Functions and Activities

The functions of the National Bureau of Standards are set forth in the Act of Congress, March 3, 1901, as amended by Congress in Public Law 619, 1950. These include the development and maintenance of the national standards of measurement and the provision of means and methods for making measurements consistent with these standards; the determination of physical constants and properties of materials; the development of methods and instruments for testing materials, devices, and structures; advisory services to Government Agencies on scientific and technical problems; invention and development of devices to serve special needs of the Government; and the development of standard practices, codes, and specifications. The work includes basic and applied research, development, engineering, instrumentation, testing, evaluation, calibration services, and various consultation and information services. A major portion of the Bureau's work is performed for other Government Agencies, particularly the Department of Defense and the Atomic Energy Commission. The scope of activities is suggested by the listing of divisions and sections on the inside of the front cover.

Reports and Publications

The results of the Bureau's work take the form of either actual equipment and devices or published papers and reports. Reports are issued to the sponsoring agency of a particular project or program. Published papers appear either in the Bureau's own series of publications or in the journals of professional and scientific societies. The Bureau itself publishes three monthly periodicals, available from the Government Printing Office: The Journal of Research, which presents complete papers reporting technical investigations; the Technical News Bulletin, which presents summary and preliminary reports on work in progress; and Basic Radio Propagation Predictions, which provides data for determining the best frequencies to use for radio communications throughout the world. There are also five series of nonperiodical publications: The Applied Mathematics Series, Circulars, Handbooks, Building Materials and Structures Reports, and Miscellaneous Publications.

Information on the Bureau's publications can be found in NBS Circular 460, Publications of the National Bureau of Standards ($1.00). Information on calibration services and fees can be found in NBS Circular 483, Testing by the National Bureau of Standards (25 cents). Both are available from the Government Printing Office. Inquiries regarding the Bureau's reports and publications should be addressed to the Office of Scientific Publications, National Bureau of Standards, Washington 25, D. C.

NBS