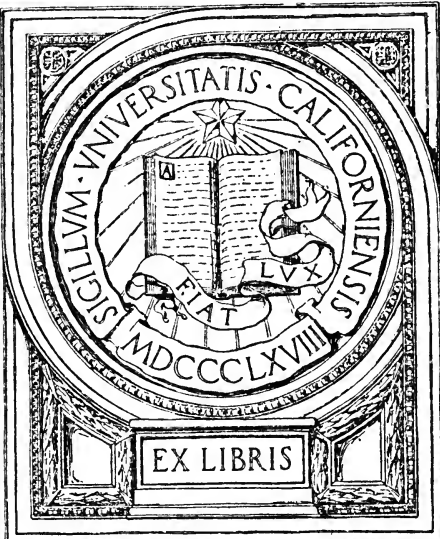


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THE FIRELESS COOKER

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BY

ELLEN ALDEN HUNTINGTON, A. B.

Instructor in the University of Wisconsin

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THE FIRELESS COOKER

In 1867 there was exhibited at the Paris Exhibition a "Norwegian Cook Box" which was lined with felt and contained tin cooking utensils. The food in the tin utensils was to be placed boiling hot in the box and kept there for some time, the heat in the food being retained by the felt lining, thereby thoroughly cooking the food. A somewhat similar method of cooking seems to have been used by the peasants in Germany when they placed kettles of boiling soup in feather beds to cook over night. The consular report from Germany in 1905 by G. H. Murphy states that Mrs. Bach, wife of the director of the Industrial School at Frankfort, developed and used the Norwegian method of cooking.

"Mrs. Bach stated that she has now (1905) been using the hay box for thirteen years, and that it has greatly reduced for her the cares and annoyances of housekeeping. At first she used the box merely for the purpose of keeping finished food warm, but it was not long before she discovered that the process of cooking continued in the box. She soon found that she could finish in the box all boiled and roasted meats, sauces, fish, soup, vegetables, fruits, puddings, etc. Of course the box cannot be used for beef steaks, cutlets, pancakes and the like, articles whose chief attraction lies in the crispness resulting from rapid cooking on a hot fire, but when food of this kind is being prepared it is a great comfort to the housewife to know that the rest of the meal is ready and hot in the box."

USED FOR ARMY PURPOSES

The attention of the United States War Department was drawn to the method of cooking given in this report and in 1905 experiments were made to test the practicability of its use in.

the commissary department of its various stations. The experiments which the department performed at one of its stations in the following year demonstrated that food could be cooked in a "hay box" with good results, with a saving of labor and fuel, and that it could be served hot at the end of a long march. An extract from a letter (Feb., 1906) states the advantages of the cooker in field operations. "The breakfast for the detachment of bakers was prepared over the same open fire and during the same time that the articles for the Fireless Cooker were prepared. . . . By the time breakfast was over the cooker was ready to be placed on wagon and ready to move with a command. No extra utensils had to be gathered, but everything (was) intact. Eleven sticks of cord wood, all small pieces, were used in the preparation of both the breakfast and articles for the cooker. At 5 P. M. the cooker was opened (packed at 7:18 A. M.) and everything was perfectly done. . . . The temperatures were higher in this test than others, owing to the fact that all of the utensils were full of material.

"I can unhesitatingly state that the Fireless Cooker has proven to be a success. . . . The use of the cooker will eliminate the necessity of securing large quantities of wood for cooking purposes. . . . The work of preparing dinner on the arrival in camp under present system, which is, to say the least, a very trying ordeal for the cooks, especially during inclement weather, will be eliminated. After a long day's march a hot meal is furnished at once from the cooker to a tired and hungry organization, by simply opening the box and serving. Should it occur that the cooker is not required for use during the day for any meal and that prospects of making a dry camp at night are evident, the boilers of the cooker could be utilized for holding water and it will be kept much cooler in the cooker than in any other way. . . . The utensils of enameled ware should be retained as they are easily cleaned, durable, and with ordinary care will last for a long time as they are not exposed to intense heat in the cooker as they would be on a cooking range."

As a natural outgrowth of this experimental work by the government came the adaptation of this method of cooking to the household use. There seemed to be no literature or information

on the subject, further than that given above, which states that the method seemed practicable for army use; and that many fireless cookers for household use were on the market. Therefore, in the year 1906-07 experiments were undertaken at the University of Wisconsin in order to test its practicability for household use.

The principles involved are: first, the conservation of heat; i. e., the retention in foods of heat developed by contact with fire without further application of heat; second, the cooking of foods with the temperature below the boiling point.

THE REAL "HAY BOX"

Hay has been generally used as a material in which to pack the cooking utensils, therefore, the name "hay box" came into vogue and is still frequently used. Some preliminary experiments were made with a box filled with hay, since it was inferred that this was the method which had been used at the army station.

This first "hay box" was made of an ordinary box with hay tightly packed around the agate pails used as cooking utensils.

After a few experiments the box was lined with asbestos and soon placed in a larger box also lined with asbestos. The space between the boxes was filled with sawdust. Not only was the hay troublesome to use as a packing material but the food was inclined to taste of it, so that asbestos was tried, and finally mineral wool was used, which proved to give more satisfactory temperature results. The results of these experiments are given in Table I.¹

¹ These experiments were made by Miss Elsa Castendyck, a student in the Home Economics Department.

TABLE I.

MATERIAL COOKED.	Box and material used.	Utensils used.	Minutes cooked on stove.	Time in box; hours.	TEMPERATURE IN CENTIGRADE.				Results.
					8 hrs.	10 hrs.	15 hrs.	Final.	
1. Oatmeal....	Single wooden, with hay.	Agate pail.	5	8½				24°	Not well cooked. Tasted of hay.
2. Oatmeal. ...	Single wooden, with different hay (timothy hay).	Agate pail.	5					24°	Same as Experiment 1 except that there was no flavor of the hay.
3. (a) Oatmeal (b) Oatmeal	Lined with asbestos, with timothy hay.	Agate pail.	5	18 10		29	28	28° 29°	Well cooked. In using fine cereals instead of oatmeal, the temperature and results were same as those of oatmeal.
4. Rice	Lined with asbestos, with timothy hay.	Agate pail.	3	8	21			21°	Underdone and rather cold.
5. (a) Carrots, (b) Potatoes	Box placed in larger one and space between filled with sawdust.	Agate pail.	3 3	14 14	19 19			19°	Cold. Carrots well cooked. Potatoes had absorbed water.
6. Oatmeal. ..	Single box filled with shredded asbestos.	Agate pail.	5		22			22°	
7 Hominy. ...	Double box with mineral wool.	Agate pail.	10	16			22	22°	Cold, but well done.
8. (a) Oatmeal (b) (c)	Double box with mineral wool.	Agate pail.	5					29° 30 30	Well done.
9. Oatmeal. ...	Double box with mineral wool.	Agate pail.	5	16			31	31°	
10. Beans	Double box with mineral wool.	Agate pail.	20	18				26°	Cold. When boiled on stove and then put in oven to start baking and left in hay box 14 hrs.; excellent flavor and was 33°C.

LINES OF INVESTIGATION

The conclusions drawn from these experiments led to three lines of investigation for the purpose of determining, if possible:

- I. The best materials to be used in the construction of the fireless cooker.
- II. The effect upon the conservation of heat of
 - (a) The mass or quantity of the food cooked.
 - (b) The density of the solution in which the food is cooked, i. e., the effect of different amounts of water on a given amount of given food giving solutions of different strengths.
- III. (a) The details of the satisfactory use of the cooker.
 (b) The advantages of cooking by this method, i. e., the economy in fuel, labor, time, and wear of utensils.

These points were taken up in turn, and the experiments which were undertaken in working this one were performed in the laboratory of the Home Economics Department.² Therefore, laboratory apparatus was used with the intention of ultimately adapting it to household use. By using such apparatus, results could be obtained more quickly and accurately.

The Centigrade thermometer was used in determining the temperatures.

C	F
0°	equals 32° Freezing point.
20°	equals 68° Room temperature.
60°	equals 140°
80°	equals 176°
100°	equals 212° Boiling point.

To find the corresponding degree in the Fahrenheit scale multiply the degrees Centigrade by $\frac{9}{5}$ and add 32. Holes were cut in the covers of the apparatus to permit inserting a cork through which a thermometer was passed.

² Mrs. E. C. Compton, a student in the Home Economics department, assisted in many of these experiments.

I. (1) *The best materials to use in the construction of the fireless cooker.* The most important point of all seemed to be the determination of the best material to use in packing around the cooking utensils to retain the heat. Hence this was considered first.

Apparatus used:

Outside retainers: tin pails; each 3,500 cc. capacity.

Inside retainers: tin cans; each 1,250 cc. capacity.

Packing material: (1) hay. (2) excelsior. (3) sawdust. (4) newspaper. (5) mineral wool. (6) hair (such as is used in plaster).

Solution placed in inside retainer: 1,000 cc. of 1 per cent. salt solution. When the solution in each can was boiling hot, it was covered, the thermometer inserted, and quickly packed in the outside retainer using the different packing materials.

The temperatures taken are given in the following table:

TABLE II.

Time.	Hay.	Excelsior	Paper.	Sawdust.	Mineral wool.	Hair.
Initial	98	99	98	99	93	96
15 min.	92	92	94	90	94	89
30 min.	87	88	89	87	91	.....
45 min.	81	85	85	83	89	85
1 hr.	79	81	82	80	86	82
1 hr., 15 min.	76	78	78	77	84	79
1 hr., 30 min.	74	76	76	74	82	77
1 hr., 45 min.	72	73	73	72	80	75
2 hrs.	70	71	69	70	78	.....
2 hrs., 15 min.	69	69	67	68	76	.....
2 hrs., 30 min.	68	66	65	66	74	.....

The results show that of these six materials mineral wool is the best one to be used. Curves of these temperatures are shown in Plate I.

15 30 45 1:00 1:15 1:30 1:45 2:00 2:15 2:30 2:45 3:00

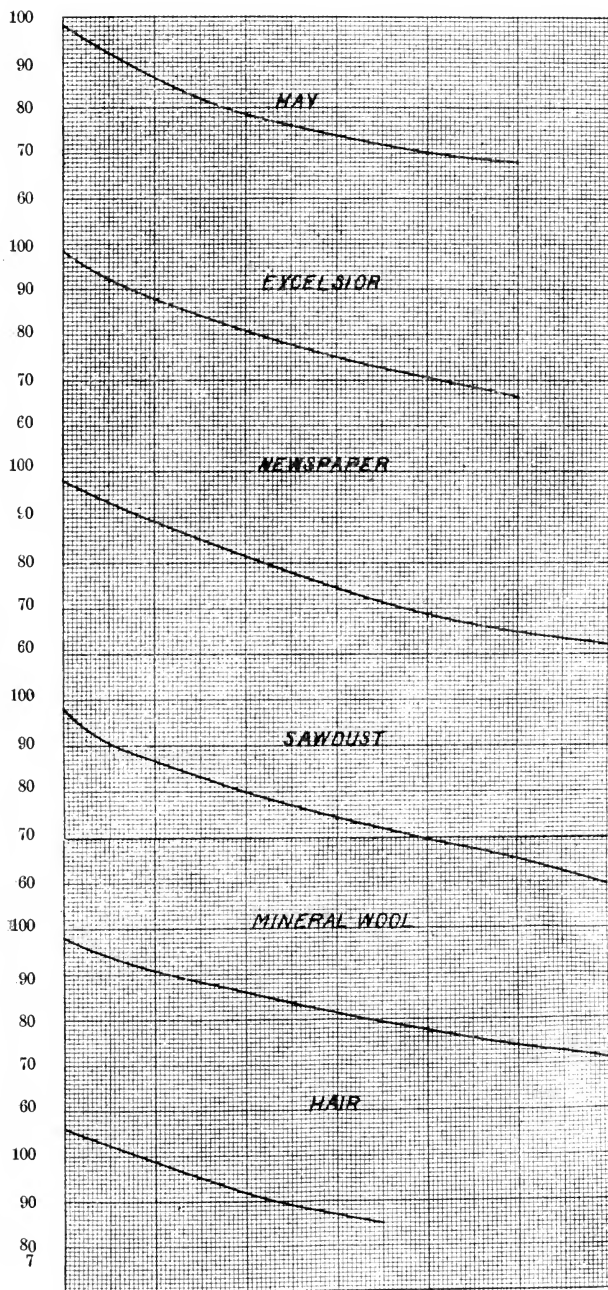


PLATE I.—CURVES SHOWING TEMPERATURES MAINTAINED BY DIFFERENT PACKING MATERIALS.

“Mineral wool is the thread-like filaments which have the appearance of wool or cotton when massed together; produced by the action of steam or air under pressure upon vitreous or scoriaceous substances when in the molten state. As an article of commercial value the article first came into use in 1871, it having been produced in that year in Germany. The production of it in the United States came about four years later. In the various processes of smelting ores of metals the compressed air necessary to accelerate combustion sometimes escapes from the furnaces through the tapping hole in such a way as to separate the cinder into sheet-like particles, which in tearing themselves from the fluid steam draw out threads of various lengths and fineness.

“The slag of the blast furnaces is the cheapest and most abundant substance which can be utilized for the manufacture of the article. This, however, is only a coincidence, and furnace slags in every case cannot be utilized, for some of them contain too large a proportion of silica to make fine and pliable fibres, while others are so basic, owing to the high percentage of lime, that they will not draw out satisfactorily. Besides, when there is an excess of lime, the tendency is for the fibres to become caked or solidified, there not being sufficient acid present to give stability and permanence to them. By mixing together four parts of orthoclase feldspar and six parts of dolomitic limestone, a cinder is obtained which runs fluid and is susceptible of conversion almost entirely into fibres of a stable nature. As a general thing the color of mineral wool is white. The fibres of mineral wool act as a medium to prevent the circulation of the air; which being accomplished, the passage of heat is retarded. By reason of its porosity the material also forms a most effective barrier to the transmission of sound. The indestructible character of the fibres makes mineral wool available for all purposes of insulation.”³

There are several qualities of mineral wool sold; the best quality, as its name indicates, seems like wool. The poorer qualities contain more or less slag and dust. This dust is very irritating to the nose and throat and it comes from even the best.

³ Johnson's *Encyclopedia*.



PLATE II. APPARATUS IN EXPERIMENT I (1).

quality if it is frequently handled. If the wool "wears out" in this way it can be renewed at but little expense.

I. (2) The effect upon the conservation of heat of the material of which the outside retainer is made.

Apparatus used:

Outside retainers: (a) galvanized iron box; 15,000 cc. capacity. (b) wood box (white pine) 15,000 cc. capacity.

Inside retainers: tin pails used for outside retainers in Exp. I (1), 1,250 cc. capacity.

Packing material: Exp. A. 5 lbs., 10 oz. mineral wool in each box. Exp. B. iron box, 6 lbs., 12 oz., mineral wool; wood box 6 lbs. 10 oz. mineral wool.

Solution: Exp. A. 3,000 cc. of 10 per cent. starch solution.

Exp. B. 3,000 cc. of 10 per cent. salt solution.

TABLE III.

Time.	EXPERIMENT A.		EXPERIMENT B.	
	IRON.	Wood.	Iron.	Wood.
Initial.....	93	90	94	95
15 minutes.....			91	92.5
45 minutes.....			89	89
1 hour and 15 minutes.....			86.5	87
2 hours.....	91	81		
2 hours and 15 minutes....	90	80	83	82.5
2 hours and 30 minutes....	89	79		
3 hours and 15 minutes....			80	79.5
5 hours and 30 minutes....			73	73
6 hours and 30 minutes....			70	70
9 hours.....			65	65
23 hours.....	46	47		
23 hours and 15 minutes...			45	46
24 hours and 15 minutes....			44	45
25 hours and 15 minutes....			43	44
26 hours and 15 minutes....			42	43
28 hours and 45 minutes...	41	42		
44 hours and 45 minutes...	33	32		

The results obtained in Experiment A indicate that the wooden box was slightly better than the iron. The results obtained in Experiment B showed that the material of the outside retainer had no appreciable effect on the temperature of the material in the inside retainer. Curves of these temperatures are shown in Plate III.

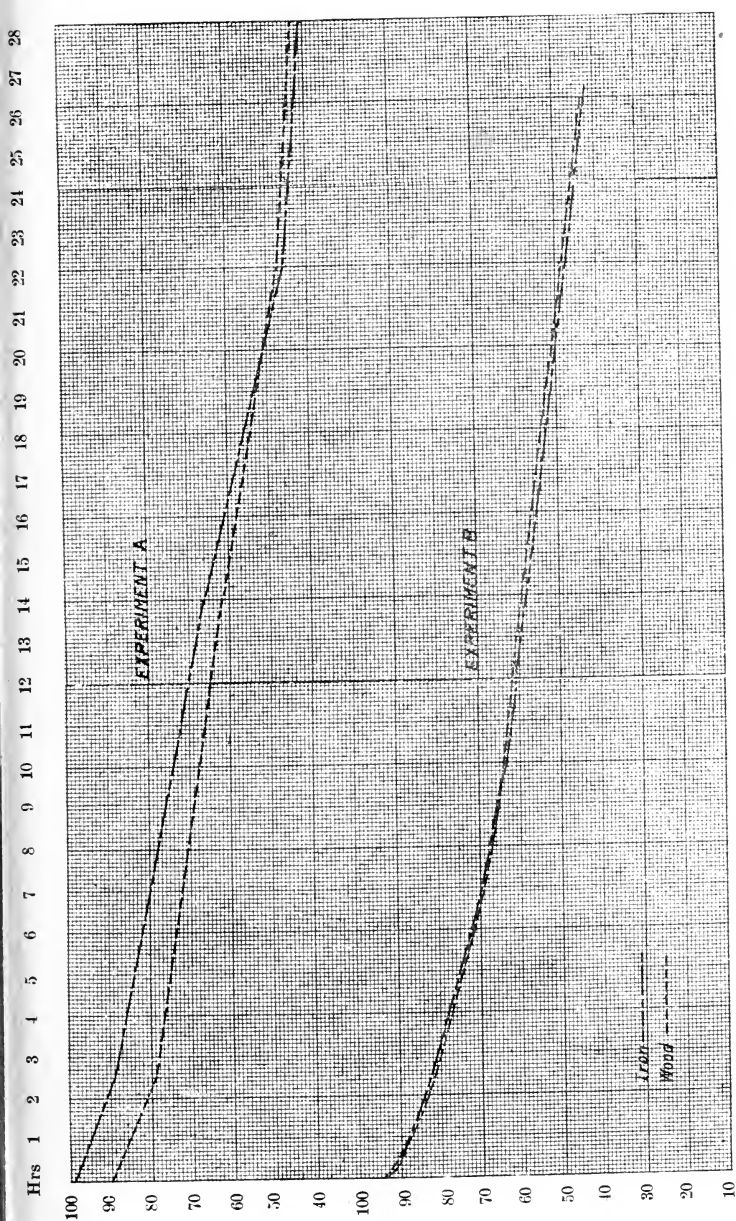


PLATE III.—CURVES SHOWING EFFECT OF IRON AND OF WOOD RETAINERS UPON CONSERVATION OF HEAT.

The conclusion, therefore, was drawn that the *material* of which the outside retainer was made had no appreciable effect on the conservation of heat.

I. (3) The effect upon conservation of heat of an air space about the inside retainer.

Outside retainers: wooden boxes of the same size and shape as in Exp. I (2).

Inside retainers: cans used in Exp. I (1).

Packing materials: 5 lbs. mineral wool.

Solutions: 1,000 cc. of 10 per cent. starch solution.

Wooden box No. 1 had an air space of about 1 inch on all sides.

Wooden box No. 2 was packed closely about the can with wool.

The temperatures taken are given in Table IV.

TABLE IV.

Time.	Box No. 1 (air space)	Box No. 2 (no air space).
Initial	96	97
15 minutes.....	93	95
30 minutes.....	90	94
45 minutes.....	88	90
1 hour.....	85	
18 hours, 30 minutes	31	42
19 hours	30	40
20 hours	29	39
21 hours	29	38

The results show that an air space about the inside retainer causes a loss of heat. Curves of these temperatures are shown in Plate IV.

Before the construction of the cooker could be definitely decided upon it was necessary to work out the second line of investigation since the size of the cooker depended largely upon the results obtained on this point.

II. The effect upon the conservation of heat of

(a) the mass or quantity of the food cooked.

(b) the density of the solution in which the food is cooked; i. e., the effect of different amounts of water on a given amount of given food which would give solutions of different strengths.

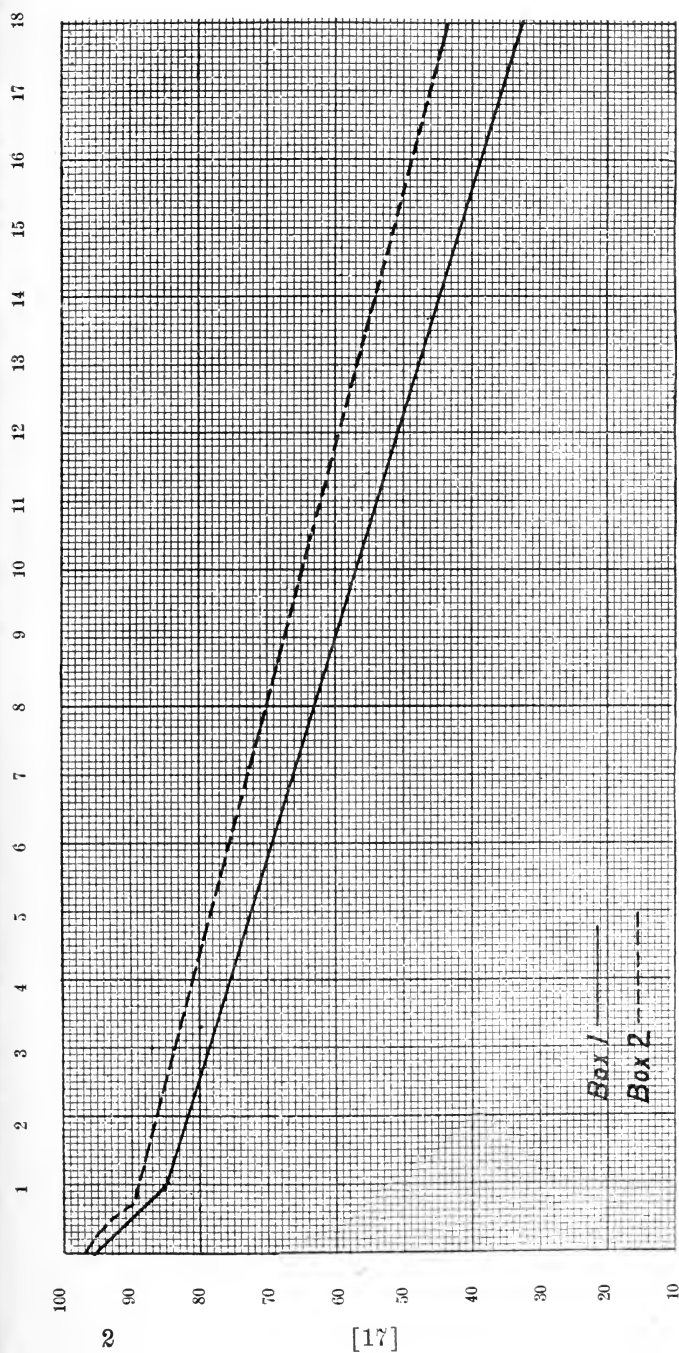


PLATE IV.—CURVES SHOWING EFFECT OF AIR SPACE UPON CONSERVATION OF HEAT.

II. (1) The effect upon the conservation of heat of the mass or quantity of food to be cooked.

Apparatus used:

Outside retainers: for (1), (2), and (3): pails used in Exp. I (1); 3,500 cc. capacity; (4) galvanized pail; 15,000 cc. capacity.

Inside retainers: for (1), (2), and (3), inside cans of Exp. I (1); for (4), pail same size as outside retainers of (1), (2), and (3).

Packing material: mineral wool.

Solutions: 10 per cent. starch.

Quantity used: (1) 250 cc.

(2) 500 cc.

(3) 1000 cc.

(4) 3000 cc.

The temperatures taken are given in Table V.

TABLE V.

Time.	(1)	(2)	(3)	(4)
15 minutes.....	83	83	83	92
30 minutes.....	79	81	82	92
45 minutes.....	76	79	81	90
1 hour	72	77	80	89
1 hour and 15 minutes.....	69	75	78	88
1 hour and 30 minutes	66	73	77	87
1 hour and 45 minutes	61	71	76	6
2 hours	59	69	75	85
2 hours and 15 minutes.....	57	68	74	84
Loss	26	25	9	8

The most significant results are obtained from (1), (2), (3) where the conditions are practically alike. Curves of the temperature are shown in Plate V. The results from this experiment show that the greater the mass the higher the temperature maintained. Exp. III, (a) (3) with oatmeal, illustrates this again, and this point was brought out in the report from the army station previously quoted.

But there arises the question, then, as to whether there are

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maximum and minimum quantities so far as results are concerned.

An experiment was made in cooking oatmeal in a pint can placed in one of the small pails of Exp. I (1) packed with mineral wool. The oatmeal was cooked five minutes on the

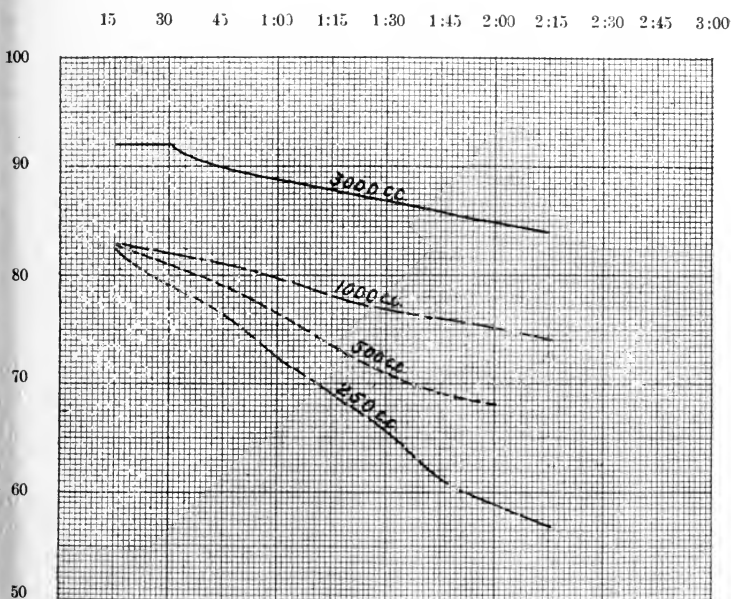


PLATE V.—CURVES SHOWING THE EFFECT OF MASS UPON THE TEMPERATURE MAINTAINED.

stove and then left in this small cooker over night. In the morning it was cold and not well done. It is evident that this quantity (about 250 cc.) is below the minimum amount which can be well cooked in the cooker.

The minimum amount must lie between this quantity and that given in Exp. III (a) (3).

II. (b) (1) The effect upon the conservation of heat of the density of the solution.

Apparatus used:

Outside retainers: pails, same as in Exp. I (1).

Inside retainers: cans, same as in Exp. I (1).

Packing material: mineral wool.

Solutions: 1000 cc. 1 per cent., 5 per cent., 10 per cent. and 20 per cent. corn starch.

The temperatures taken are given in Table VI.

TABLE VI.

Time.	1 per cent.	5 per cent.	10 per cent. ⁴	20 per cent. ⁴
Initial.....	98	99	90	78
15 minutes.....	88	92	84	75
30 minutes.....	80	85	77	70
45 minutes.....	71	77	72	65
Total loss	27	22	18	13

The results show that the higher the percentage of starch in the solution, i. e., the greater the density of the solution, the less rapidly the temperature falls. Compare with Experiment I. (1) Here the retainer packed with mineral wool contained a 1 per cent. salt solution which fell 9° in the same length of time, therefore, the above experiment was repeated with salt solution.

II. (b) (1a) Experiment II. (b) (1) repeated using salt solutions.

Apparatus used:

Outside retainers: pails, same as in Exp. I (1).

Inside retainers: cans, same as in Exp. I (1).

Packing material: mineral wool: 1 lb., 3 oz. in each retainer.

Solutions: 1000 cc. 1 per cent., 3 per cent., 5 per cent., 10 per cent. and 20 per cent. salt.

The temperatures taken are given in Table VII.

⁴These could not be raised to a higher temperature because it was necessary to stir continually and they burned on rapidly.

TABLE VII.

Time.	1 per cent.	3 per cent.	5 per cent.	10 per cent.	20 per cent.
Initial	95	94.5	97.5	98	98
15 minutes.....	91	89.5	95	93	95.5
30 minutes.....	89	87	93	92	93.5
45 minutes.....	87	85	92	89	91.5
1 hour	85	83	90	87	89.5
1 hour, 15 minutes..	83.5	80	86.5	85.5	87.5
3 hours.....	71.5	69	72	73	76
3 hours, 15 minutes..	70	68	71	71	74.5
3 hours, 30 minutes..	69	67	69.5	70	73
3 hours, 45 minutes..	67.5	65	68	69	72
4 hours.....	66	64	63	68	71
4 hours, 15 minutes..	65	63	64	67	69
4 hours, 30 minutes..	63	62	63	65.5	68
4 hours, 45 minutes..	62	61	61	64.5	67
5 hours.....	61	59	60	63	66
Total loss	34	35.5	37.5	35	32

15 min.

30 min.

45 min.

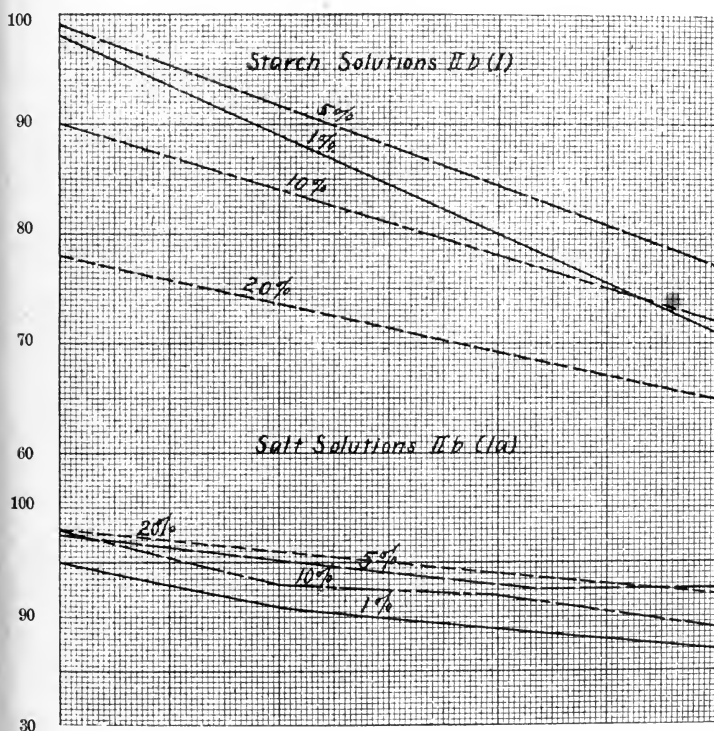


PLATE VI.—CURVES SHOWING EFFECT OF DENSITY UPON CONSERVATION OF HEAT.

The results show that the greater the density of the solution, the less rapidly the temperature falls. Curves of the temperatures given in Tables VI and VII are shown in Plate VI.

II. (b) (2) To determine the effect of convection currents on temperature.

Apparatus used:

Outside retainer: wooden box.

Inside retainers: agate pail.

Packing material: mineral wool.

Solution: 2000 cc. of 10 per cent. starch. Cover of pail with holes as follows: 1, center. 2, between center and edge. 3, edge.

The temperatures taken are given in Table VIII.

TABLE VIII.

Time.	Hole 1.	Hole 2.	Hole 3.
Initial	81	79	82
15 minutes	78	77	75
30 minutes	77	76	74
45 minutes	77	75	73
1 hour	76	74	72
3 hours, 30 minutes	68	66	64
5 hours	65	63	62
19 hours, 30 minutes	42	41	40
25 hours, 30 minutes	38	37	36
27 hours, 30 minutes	36	35	35
Total loss	45	44	47

The results show that the highest temperature seems to be maintained nearest the center; the lowest nearest the outside. Curves of these temperatures are shown in Plate VII.

Summarizing the conclusions reached in the foregoing experiments it was found that so far as the retention of heat was involved, (1) the outside retainer might be round or square, made of galvanized iron or wood; (2) the packing material should be mineral wool; (3) the larger the mass and the greater the density of the food cooked, the better the conservation of heat.

CONSTRUCTION OF COOKER

The construction of the fireless cooker was based on these conclusions taking into consideration, also, the ease with which

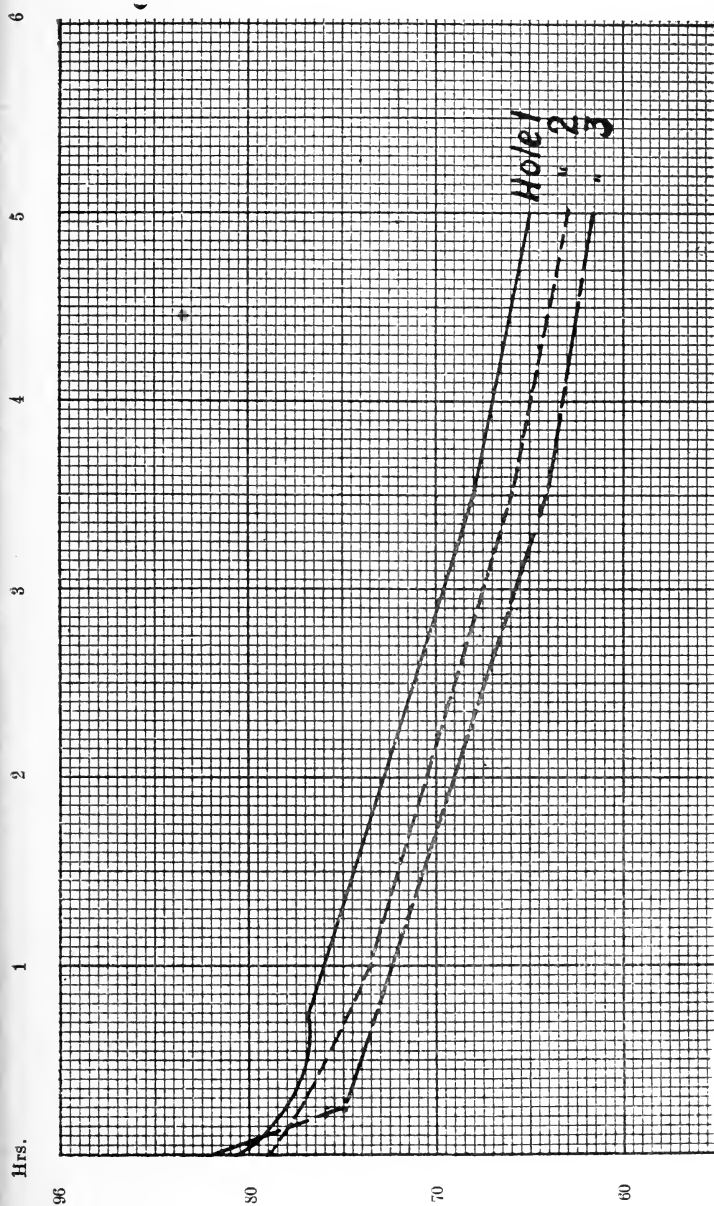


PLATE VII.—CURVES SHOWING EFFECT OF CONVECTION CURRENTS ON TEMPERATURE.

such materials would be obtained by the housekeeper and their facility for use.

A four gallon galvanized iron pail, (15,500 cc. capacity; $10\frac{1}{2}$ inches in diameter by $11\frac{1}{2}$ inches high), was used for the outside retainer and lined one inch thick on the sides and the bottom with mineral wool. This required from four to five pounds of mineral wool and as this packed very easily there was no trouble in making it remain in place. The mineral wool was covered with cheese cloth and an asbestos plate put in the bottom to hold the cloth down, while the top was held up by a galvanized iron hoop cut at one point permitting it to snap inside the pail. The cheese cloth held the mineral wool in place and prevented its falling down when the cooker was used. The cover was treated in a similar way; i. e., filled with mineral wool, covered with cheese cloth which was held in place by an iron hoop. Agate pails were used for the inside retainers as they are easily obtained and convenient for use; one two-quart pail and one three-quart pail were used. The covers must be flat; i. e., without a knob, so that the pails will pack closely together and fit in the outside retainer. The covers should have a bail to make them fit as tight as possible, and to prevent slipping. One pail holding a large mass could be used as well as two, but pails of different sizes are convenient in household use. The pails used in the following experiment had tin covers, since these were flat and the tin cover permitted the insertion of the thermometer. There should be a small pad of mineral wool to fit around the smaller pail, since an air space causes a loss of heat.

Other materials may be substituted for these in the construction of the cooker, such as candy pails or ordinary wooden boxes for the outside retainer, or larger sized pails, but this size is easily moved, a convenient one for use in the average household, and the materials are easily obtained. The cooker should be completely constructed since this lends ease to the use of the cooker. The cost of the cooker which has been described is from \$1.50 to \$2.00. The mineral wool costs from four to five cents per pound.

In the preliminary experiments which led to the three lines of investigation it had seemed to be most practicable for those

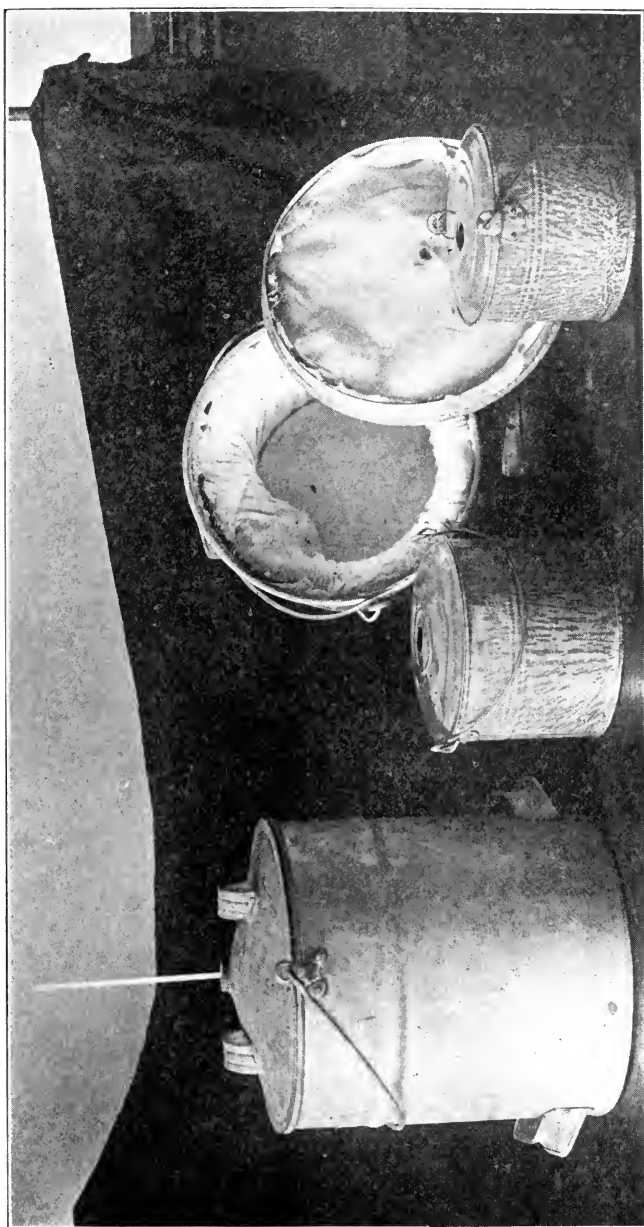


PLATE VIII.—LABORATORY COOKER.

foods which require long, slow cooking. Therefore, after the cooker had been constructed, the third line of investigation was pursued, taking this into consideration.

III. (a) *The details of the satisfactory use of the cooker.*

(b) *The advantages of cooking by this method; i. e., the economy in fuel, labor, time, and wear of utensils.*

III. (a) (1) It has been shown that there must be a certain mass or quantity of food cooked. (II a.) Therefore, when a small amount of food is being cooked in but one of the inside retainers, boiling water should be put in the other in order to give a larger mass. (Note the temperatures in Exp. III a (3).) If a large quantity of food is cooked the mass will be sufficiently great without it.

EVAPORATION AND FLAVORING MATTER

It is self-evident that there will be no loss of water from evaporation as there is in cooking over a flame, and allowance should be made for this. It is also evident that salt or flavoring matter must be added to the foods before they are placed in the cooker.

METHOD OF PROCEDURE

Since the object in using the cooker is to retain heat, the nearer boiling the food can go into the cooker, the longer will the process of cooking continue before the temperature falls too low. If two foods are to be put into the cooker, the cooking on the stove should be so planned that the cooking of both is finished at the same time.

A description of the method of cooking oatmeal in the cooker may give, perhaps, the best idea of the manner of using it. In the smaller pail boil one quart of water to which has been added two teaspoonfuls salt, add two cups oatmeal. Boil five minutes over a low free flame. At the same time boil two quarts of water in the larger pail. When the oatmeal has cooked five minutes and the water is boiling, cover both pails, rapidly place the larger one in the bottom of the cooker and the smaller one

on top. Put the pad around the smaller pail and cover. Allow it to remain in the cooker from eight to twelve hours. If necessary reheat the oatmeal before serving.

REHEATING TO SERVE NECESSARY

In the experiments which have been made in the department it has been found that usually the food needs reheating before serving.

TIME OF COOKING ON STOVE AND IN THE COOKER

III. (a) (2) The length of time which the foods should be cooked on the stove and in the cooker is important from the standpoint of economy as well as satisfactorily cooked foods. To a great extent experiment only will determine it. For example, fowl must be cooked for an hour on the stove and eight hours in the cooker, while chicken requires but thirty minutes on the stove and five hours in the cooker. The larger the piece of meat the longer it must be cooked in the oven in order to have the heat penetrate to the center before putting it into the cooker. Otherwise, after being placed in the cooker, the temperature will drop rapidly as heat is utilized in heating the inside of the meat.

If the meat is tough it will be necessary to cook it longer in the cooker. Since tough meats should cook for a long time at a low temperature the cooker is a most excellent medium for this purpose.⁵

The results of the experiments which have been made upon this point are given for convenience in a table below.

⁵ See *A method of roasting meat* in *Bulletin of the University of Illinois*, May, 1907.

TABLE IX.

Foods.	Time over fire.	Time in cooker.	Remarks.
CEREALS:			
Oat and wheat.....	5 min.	All night.	
Corn cereals	10 min.	All night.	
MEATS:			
Corned beef.....	30 min.	10 hrs.	{ If necessary reheat and cook 4 to 6 hrs. longer.
Pot roast beef . . }			
Roast beef	30 min.	4-6 hrs.	{ The size of the pieces and its toughness determine the time.
Leg of lamb.....			
Leg of mutton.....			
Chicken.....			
Fowl	1 hr.	8-14 hrs.	{ If not done after 8 hrs., reheat and cook 4 to 6 hrs. longer.
BAKED BEANS.....	30 min.	8-12 hrs.	Brown in oven.
PRUNES	5 min.	8-12 hrs.	{ Use less water than when cooked on stove.

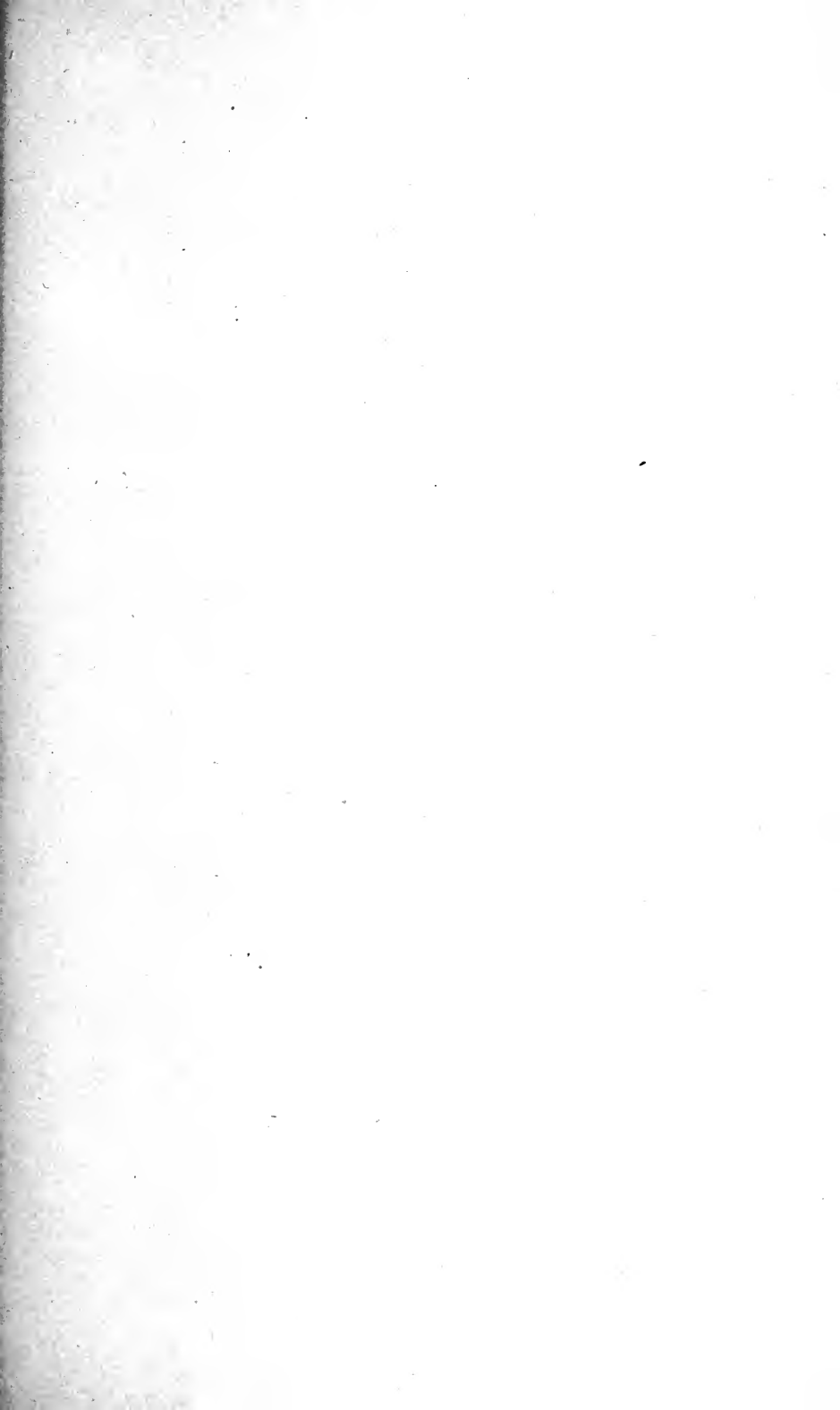
The cereals usually need reheating before serving and this can be done best by putting the pail in a pan of water. It can be reheated over the free flame if care is taken not to allow it to burn.

The roast flavor must be given to meats either before inserting in the cooker or afterwards. If it is given beforehand the subsequent cooking in the steam gives it a flavor which is a combination of roasting and boiling with the roasting rather predominating. If it is given afterward the roasting unquestionably predominates. The water should not be added to the roast of beef until just before removing from the oven (allowing enough time to heat it to the boiling point).

The salt should be added to the simmering meat five minutes before removing it from the fire.

Stews and so-called boiled meats seem to have a better flavor when cooked in the cooker than when cooked on the stove.

Questions have been asked from time to time as to the advisability of cooking meat in a tightly covered vessel but there is no reason why it should not be done since ptomaine poisoning results only from the development of germs already present before the meat is cooked. The half hour of cooking on the stove would destroy any germs.





Prunes and other dried fruits (soaked) may be deliciously cooked in the cooker. The syrup does not evaporate as on the stove, however, and less water should be used. Because the evaporation does not take place the syrup is less thick.

EXPERIMENTS WITH OATMEAL

(Illustrating second line of investigation.)

As a mere matter of interest experiments were made with oatmeal to prove the point which has been already considered, namely, the greater the density and mass of the food to be cooked the more heat is retained.

These experiments were made with the cooker and the oatmeal was cooked in the proportion 1 qt. water, 1 pt. oatmeal, and 2 teaspoonfuls salt. It was cooked for five minutes on the stove before being put into the cooker.

TABLE XI.

Exp.	Min. wood.	Top pail, 2 qts.	Bottom pail, 3 qt.	TEMPERATURES.					
				Initial.	15	20	45	3:45	5:30
1	6½ lbs	1 pt. oatmeal ⁶	Not used	99	97	95	93	71	63
2	7½ lbs	1 pt. oatmeal.	1 pt oatmeal.	98	96	94	91	..	67
3	7½ lbs	1 pt. oatmeal.	1 qt. water...	98	95	.....	89	70	60
4	7½ lbs	1 pt. oatmeal.	Empty, but heated.	94	.....	90	.....	.....	53
5	6½ lbs	1 pt. oatmeal.	2 qts. water 20 gs. salt.	97	96	93	91	... ..	62

⁶1 qt. oatmeal=1 qt. water and 1 pt. oatmeal and 2 T. salt.

In working out these details of the satisfactory use of the cooker there is more or less involved the last point of investigation, namely: III (b) the advantages of cooking by this method, i. e., the economy in fuel, labor, time, and in wear of utensils.

ECONOMY OF FUEL

1. The economy in fuel is perhaps the most important and likewise rather more easily determined than the economy in

labor and time. Apparently there would be a certain economy in fuel in cooking with the cooker since the foods remain on the stove so much shorter a time. Oatmeal, for example, is cooked but five minutes on the stove and then put in the cooker instead of being cooked an hour or longer on the stove. In the laboratory the experiments were made with gas, the results of which are given in the following table (Table X). The results are somewhat surprising in that there is not a greater economy of fuel in using the cooker. But the amount of gas necessary to heat the food boiling hot or the oven and food hot, is greater in proportion to the time for this portion of the cooking than that necessary for continued cooking. This is very clearly shown in the experiment with corned beef (2). In each case two quarts of cold water was added to the meat three times and slowly brought to the boiling point. (This draws out the brine.) When it boiled the third time (b) the meat was put in the cooker. The gas used for this process was 9.5 ft. of the total 15.4 ft. In the morning 2.7 ft. were used to re-heat the beef and it was again placed in the cooker for four hours longer. At the end of that time it was cooked for an hour, using 3.2 ft. The intention in cooking it the hour was to be able to serve it hot and also to finish the cooking. If it had been left in the cooker six hours it would probably have been well done and less gas would have been used (2.7 ft.) to heat it for serving. The comparative experiment shows that by using the two quarts of cold water three times as in the other case and cooking for six hours on the simmerer there was used only 19.2 ft. of gas. In this experiment especial care was taken to economize the gas used in cooking, so that 19.2 ft. probably expresses the minimum amount necessary to cook that amount of beef by this method. Another experiment was therefore made to determine the amount generally used when cooking the same quantity of beef. In this case 25 ft. of gas was used. And it seemed done though not quite as tender, after four and a quarter hours cooking. Since it is much easier to be careless than to be careful this shows one point of our household waste.

If the fuel used is coal where the fire in all probability would be kept running there is little economy of fuel, if any,

in using the cooker. The cost of fuel, given in the table, in the use of the cooker could have been reduced in some cases if two foods had been cooked at the same time, since when a small quantity of food was cooked, 3 ft. of gas was required to heat two quarts of cold water to the boiling point which was inserted with the food in order to give sufficient mass. This was the case with the prunes, for example.

Again it is probable that a denser solution than water (salt or calcium chloride solution) could be put into the lower pail with a greater conservation of heat. But one experiment has been tried with a salt solution in the lower pail and the results show that the above premise would doubtless prove correct.

ECONOMY OF TIME

III. b (2) Besides the economy of fuel there is an economy of labor and time. The food in the cooker does not require as much attention as does the food on the stove. The housewife can complacently work in any part of the house without making excursions to the kitchen to see if the food is cooking properly or that it is not burning. Also it is possible to save the labor and time when it is most needed. If the housewife is obliged to be away all day she can return at night to find the food cooked, a great boon to a working woman. It could be used to good advantage on picnics where there is facility for carrying the cooker, and it is desired to have the food hot on arrival.

ECONOMY OF UTENSILS

III. b (3) There is an economy in the wear of utensils since there is less danger of food becoming burned and the direct application of heat to the utensil takes place for a shorter time.

The economy in fuel, labor and time, and utensils, was noticed at the army station and all of this economy favors the use of the cooker.

TABLE XII.

Experiments comparing the "laboratory cooker" with commercial cooker. A., commercial cooker.⁷ B., laboratory cooker.

MATERIAL COOKED.	Utensils used.	Minutes cooked on stove.	TEMPERATURE IN CENTIGRADE.				Time in box, hrs.	Results.
			Initial.	End of				
				2d hr.	4th hr.	Final.		
I. Chicken:								
A	2 agate pails, tin covers.	30	90	83	67	67	4	Good. Chicken good flavor and well done. Broth good.
B	2 agate pails, tin covers.	30	90	84	69	69	4	
II. Chicken:								
A } repeated.....	.....	30	90	64	58	78	4	Good, but not as satisfactory as I. Loss in temperature due to difficulties in putting pails in box.
B } Exp. 1 .....	.....	30	88	69	63	63	4	
III. Custard:								
Cooked in lower pail A--of exp. II. A.....	Tin mold.	1	.....	.....	.....	64	4	Water around A--65. Water around B--66. This exp. was to show that foods may be overcooked in the cooker--custard not well cooked; overdone.
B--of exp. II. B.	Tin mold.	1	.....	.....	.....	64	4	
IV. Oatmeal:				End 1st hr.				
A	Same as exp. I.	5	90	86	.....	.....	.....
B		5	86	89	.....	.....	.....

⁷Commercial cooker packed with excelsior and asbestos.

Some incidental experiments were made with the cooker to prove other possibilities in the cooker.

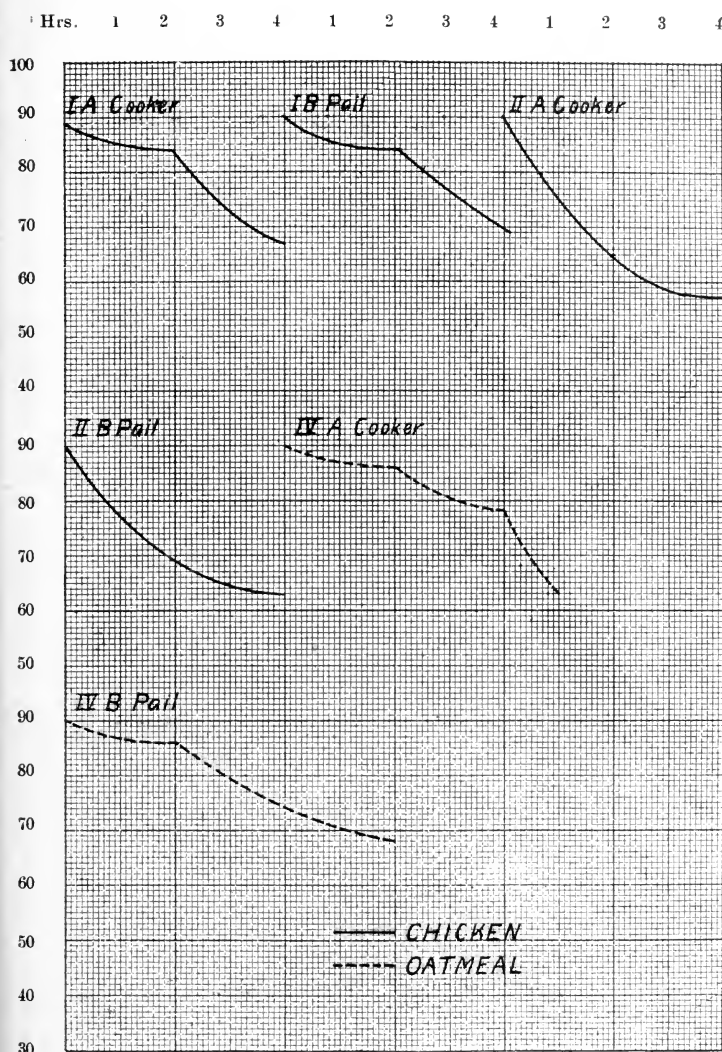


PLATE IX.—CURVES SHOWING COMPARATIVE RESULTS OF "COMMERCIAL" AND "LABORATORY" COOKERS UPON CHICKEN AND OATMEAL.

(See Table XII.)

OVERCOOKING IN COOKER

The first was to determine whether there was possibility of overcooking.

A custard cooked for one minute on the stove showed no signs of curdling. After four hours in the cooker it was badly curdled. One can draw from this the conclusion that other foods rich in proteids might be spoiled by long cooking in the cooker. It has, in fact, been found in cities where hot dinners are sent out in heat retainers, that the best results are secured with meats when they are put into the retainers almost raw.

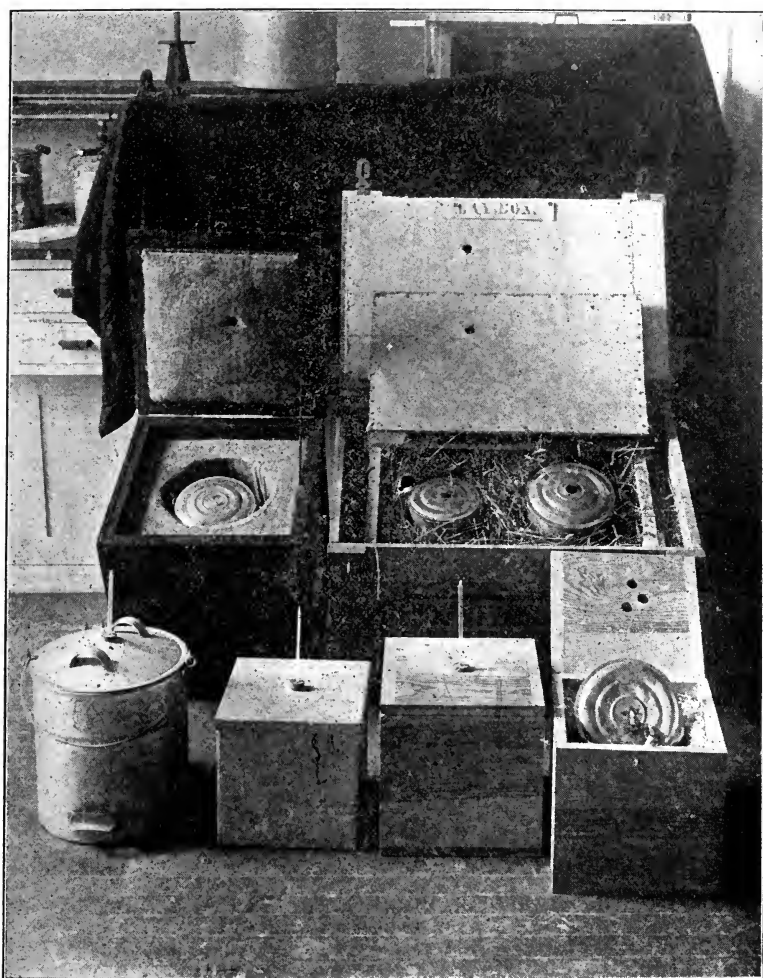
An experiment performed at the University showed that potatoes could be kept in the cooker long enough to absorb water and become unpalatable.

SOUP STOCK

Soup stock and meat stews have been cooked in the cooker with good results. The flavor seemed better than when cooked on the stove.

STEAMING

But one experiment in steaming in the cooker has been tried and that had unsatisfactory results. Upon consideration, steaming would seem impossible as well as any attempt to cook foods which require a high dry heat. The temperature rapidly falls below the boiling point so that the temperature would soon be too low to produce steam or carry on the cooking. The experiment was an attempt to so-called "steam" a suet pudding. The pudding was boiled on the stove for an hour before being placed in the cooker. At the end of three hours it was removed from the cooker. The water around the pail was 63°C and the pudding not at all well done. It required two hours boiling on the stove to finish cooking it. This was the same length of time that had been necessary to boil an equal weight (A) of the pudding on the stove. The fuel used in cooking (A) for three hours was



Commercial cooker. Original hay box.
Laboratory cooker. Galvanized iron box. Wood boxes.
PLATE X.—APPARATUS IN CONDUCTING EXPERIMENTS.

7.6 ft. While that necessary to cook (B) for one was 4.00 ft. and the total amount used (reheating after it was in the cooker required more gas) was 9.8 ft. It might be possible to cut off half an hour of the cooking by placing it in the cooker but the economy of fuel would not be very much in such a case. The report from the army station, however, states that satisfactory results were obtained in cooking such a pudding and also brown bread. It would seem as though such a method might be used if some substance were used to increase the density of the solution surrounding the steamed article, thereby raising the temperature.

COLD THINGS KEPT COLD

Since mineral wool acts as insulator, preventing heat from passing from the inside of the box to the air, it is reasonable to think of the possibility of its use for the purpose of keeping heat from passing from the air to the inside of the box—i. e. for the purpose of keeping cold things cold. In the summer time ice was placed in one of the pails and the temperature read 6°C , at the end of 15 to 18 hours the ice was melted but the temperature read only 12°C .

ICE CREAM KEPT IN THE COOKER

An experiment was made showing the possibilities of keeping ice cream in the cooker. A pint of ice cream (B) was placed in a pail which was packed in ice and salt in another pail and this in turn put in the cooker. At the end of seventeen hours the outside edge was melted but the inside (about half the cream) was still solid. The ice and salt had melted. An equal quantity (A) left in the can of the freezer packed in ice and salt in the ordinary fashion was entirely melted.

DEWAR BULB AND THERMO BOTTLES

The Dewar bulb which is used in physics laboratories involves the same principle. The construction of vacuum for insulation is much more expensive than the mineral wool. The

“Thermo Bottles” used so much in automobiling are constructed on the same principle, but vacuum is so expensive that it precludes the possibility of adapting it to household use at present. Experiments with hot water and with oatmeal in a Thermo bottle were made and the temperature results were not as satisfactory as with the cooker, probably because a smaller mass was used (one quart).

CONCLUSIONS

These experiments show the possibilities of the fireless cooker, which based on scientific principle proves itself practicable for household use.

Foods may be well cooked in it and it proves most desirable and economical of time and fuel for those foods which require long slow cooking, such as oatmeal, meats and dried fruits. Since the temperature is that of boiling water it is not practical for cooking those foods which require the high dry heat of an oven, or for steaming. It may be possible to overcome this difficulty by inserting a quantity of liquid which has a higher boiling point than water.

Also, there is a certain economy of fuel, labor, time, and utensils in using the fireless cooker.

Housekeeping has lagged far behind other industries. An evidence of this has been the disregard of small economies. There is, however, a growing tendency toward such economies and toward measuring them accurately and scientifically.

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