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PREPARATION AND BURNING OF PEAT AS A DOMESTIC FUEL

by

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PREPARATION AND BURNING OF PEAT AS A DOMESTIC FUEL IN RURAL AREAS

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INTRODUCTION

This paper describes the designing and testing of a simple peat burner for domestic use in rural areas near the sources of peat supply. It also contains recommendations for the most effective preparation of peat for such a burner.

Peat has long been a source of heat which has not been fully exploited. It occurs extensively in Central and Eastern Canada in large bogs. Despite these large deposits and its reasonable accessibility, peat has not been an important fuel because of certain qualities which prevent its handling and burning in a conventional manner. An important obstacle is its extremely high moisture content which is up to ninety per cent in the bog. A protective gelatinous skin on the peat fibres further complicates matters by obstructing the removal of moisture. Furthermore, when dried to thirty or forty per cent moisture content for use as a fuel, the bulk density (weight per cubic foot) is so low that the cost of handling, transportation and storage soars out of proportion to its heat-

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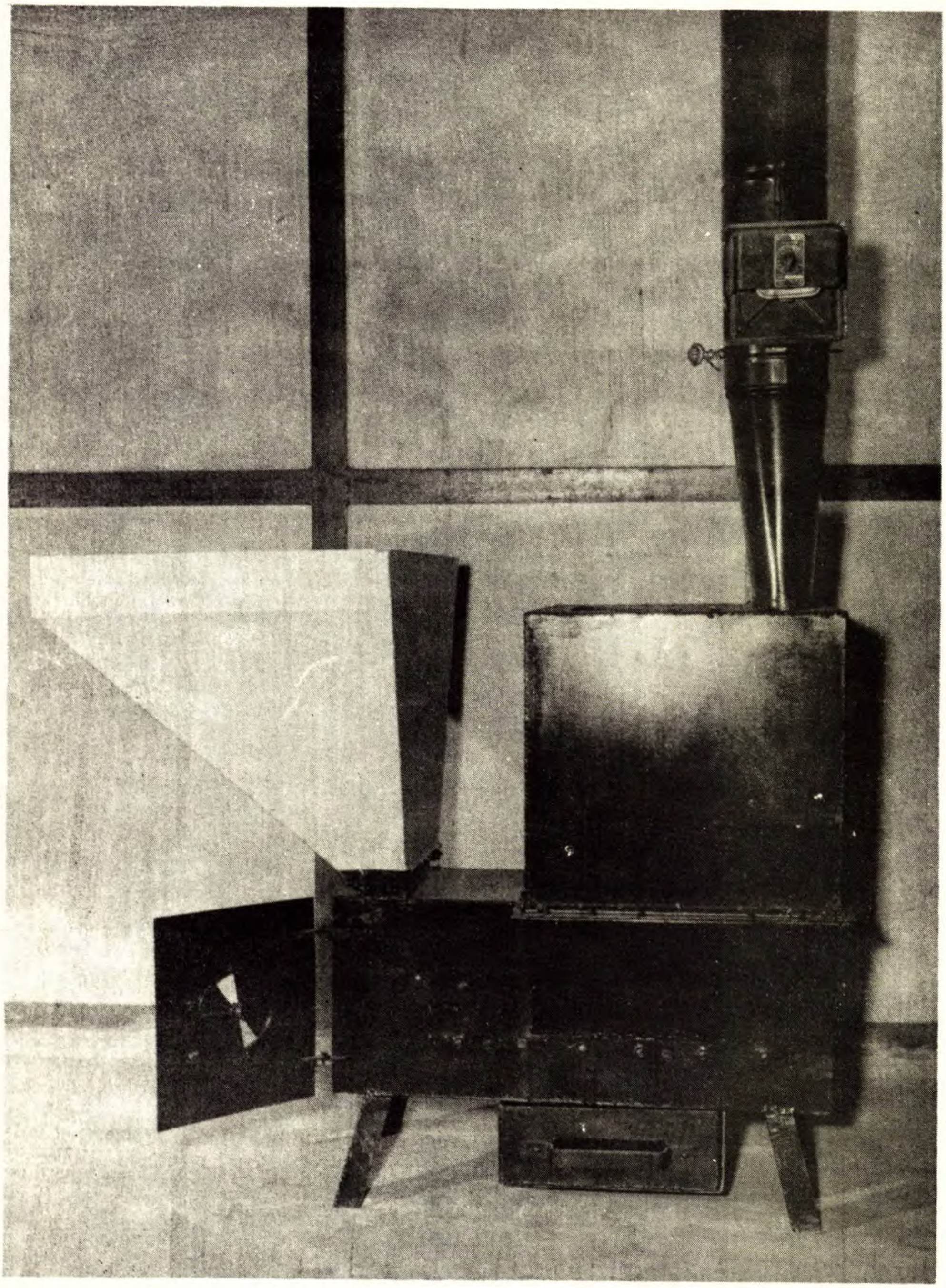


F.R.L. Model "B" Peat Burner.

ing value.

Many schemes for mechanical harvesting and preparation have been devised in modern times but none have been completely successful. The only method which has survived, a long established procedure in Europe, is to dig the peat from the walls of a trench, macerate it, pile it in cribs to air dry for one season and then burn it like wood in stoves or open fireplaces.

It seems logical to conclude, therefore, that peat can only be economically attractive as a fuel in the immediate vicinity of the bog, and that the method of harvesting, preparation and consumption of the fuel must be within the means of the ultimate consumer. With this in mind, the authors undertook to develop a method of harvesting and preparing the peat that did not involve expensive equipment, and to design a burner that would have a high heat release rate for extended periods without constant attention by the operator. The following sections describe the results of these studies.

HARVESTING AND PREPARATION

The type of burner considered for this project requires a loose, free flowing fuel. To produce such a material from peat, its natural structure must be broken down and this can be done by freezing and subsequent thawing. Such a procedure facilitates screening and drying which is necessary in the preparation of a free flowing material. For this reason the following procedure is recommended for harvesting and preparing the fuel:-

(1) Dig the peat in the early fall when the water-level in the bog is at its lowest point and the surface of the bog is firm enough to support a vehicle.

(2) Store the peat in the open for the winter in beds not more than two feet thick, preferably less. This is to ensure that frost penetrates to the bottom of the beds.

(3) After the peat has thawed out in the spring, screen it through a 1/2" round hole screen.

(4) Place in covered storage to dry all summer. The ideal method is to store in narrow bins of wire mesh or wooden slats, two feet wide and not more than four feet high.

Withdraw from covered storage and use as required.

DESIGN OF THE MODEL B PEAT BURNER

The heater used for burning the peat is fundamentally the same as certain incinerators and also the domestic sawdust burner used in British Columbia, with the addition of a small dumping bar grate at the foot of the step grates as shown in Figure 1. In the standard sawdust burner, the ash from the sawdust is very light and fluffy and is easily blown off the steps of the grates by a slight draft. The ash from peat, however, is much heavier and remains on the grates, even at full chimney draft. The dumping bar grate at the foot of the steps was the best means tried for maintaining a clean fire.

The step grates are so positioned that there is a uniform thickness of peat on the grates at all times. The thickness of the peat bed is governed by two factors. The first is the distance the foot plate projects beyond the bottom step, and the second is the angle of the step grate line. The angle of repose of a pile of peat is approximately 40 degrees from the horizontal. It necessarily follows, then, that the angle of the step grate line must be slightly more than 40 degrees from the horizontal for the peat to flow from the hopper over the steps. If the angle of the step grate line is too great, the bed of peat on the steps will become too thick at the bottom for the draft to penetrate and all the combustion will take place on the top step where the bed is thinner. The angle found by experiment to be most suitable was 43 degrees from the horizontal.

In designing the hopper for the burner, the angle of repose of 40 degrees from the horizontal should be exceeded by a good margin in order to avoid bridging of peat in the hopper.

The capacity of the burner is controlled by the number of steps in the step grate and by the length of the step plates.

Draft Control

During preliminary tests with this peat burner, a soft clinker was produced which obstructed the flow of fresh fuel. The need for controlling the maximum burning rate was obvious and this was accomplished by regulating the draft by means of a wafer temperature-actuated damper control in the flue pipe. The maximum temperature in the heater can be controlled with this device by the simple adjustment of a control knob on the damper. The draft opening in the front of the heater was left open at all times.

TESTING OF THE BURNER

Procedure

Since the purpose of the tests on this particular heater was primarily to determine when a satisfactory design had been achieved, the initial tests were often of short duration, because, after a change in the design had been made, it was frequently evident that the change was not satisfactory. However, after the preliminary testing had produced a design which appeared to fill the necessary requirements, the unit was operated around the clock, following the cycle which would normally apply in a domestic application. The ash was removed in the morning and the heater brought up to and maintained at a high rating until late evening. Then the draft was checked and the heater banked until the following morning. The temperature in the dome of the heater was continuously recorded by instrument and notes were kept of the weight of fuel placed in the hopper, and of any changes made to draft settings, etc.

Before entering on a discussion of test results it is again emphasized that the purpose of this investigation was to develop a method of harvesting and preparing peat for the domestic consumer and to design a suitable burner for this fuel. No attempt was made therefore to obtain data on the efficiency of the heater, or stack losses, etc, but, attention was focused on combustion efficiency and losses to the ash pit.

Results

Table I gives the analysis of the peat used for these tests. This peat was obtained from a bog two miles west of Springhill Cemetery, near Vernon, Ontario, and twenty miles from Ottawa, in the late fall, 1952. It was harvested and prepared as described earlier. It should be noted in passing that the moisture content of the peat as used for these tests is higher than it would be if the fuel were allowed to dry for the period recommended. The peat was harvested in the late fall and the tests on the burner were completed by the following March. A moisture content of about twenty per cent can be expected if the peat is allowed to dry in covered storage for a full summer.

TABLE 1

nalysis of Bulk Sample & Moisture Content of Peat used for Each of Six Runs

roximate	Bulk Sample	Run 1	Run 2	Run 3	Run 4	Run 5	Run 6
sture......... %	46.2	34.4	34.0	31.2	32.2	30.6	29.8
l.............. %	2.7	--	--	--	--	--	--
atile Matter.. %	33.6	--	--	--	--	--	--
ed Carbon..... %	17.5	--	--	--	--	--	--
imate							
bon........... %	30.7	--	--	--	--	--	--
rogen......... %	8.3	--	--	--	--	--	--
l.............. %	2.8	--	--	--	--	--	--
phur.......... %	0.1	--	--	--	--	--	--
rogen......... %	1.3	--	--	--	--	--	--
gen........... %	56.8	--	--	--	--	--	--
lorific Value J/lb. gross....	5160	--	--	--	--	--	--
Softening mp. °F.	2360	--	--	--	--	--	--

The temperature curves shown in Figures 2 to 6 inclusive illustrate the results of the steps taken in the improvement of the design. These temperatures were obtained inside the burner, about one inch below the dome. Temperatures in the fuel bed were considerably higher.

Figure 2 indicates the extreme temperatures in the dome of the stove with full draft on a clean fire. The maximum temperature of 1900°F. in the dome of the stove was accompanied by a temperature of 2300°F. or better in the fuel bed because a clinker was formed on the foot plate and it extended up over the first step of the grates. This solid formation stopped the even flow of peat down over the steps and it was not possible to get another peak temperature until the clinker had been removed. Not only was this extreme peak temperature undesirable because of the clinker formation, but, the metal of the stove became a dull red with two bright red spots showing on the sides of the grate box just ahead of the step line.

An inexpensive, wafer-actuated damper with an adjustable setting was installed in the flue pipe to limit the maximum temperatures and to control the burning rate. Figure 3 illustrates the effect of this control. The maximum temperature in the dome of the stove was lowered 400°F. with a corresponding lower temperature in the fuel bed. The duration of this high-rating period was extended and there were no clinkers formed. However, there was a build up of ash on the foot-plate at the base of the steps which finally reached a point when it interfered with the flow of fresh fuel to the fire. The result was of course that the lower steps of the grate became inactive and greatly reduced the maximum output.

In order to reduce the build-up of ash in front of the step grates, the foot-plate projecting beyond the steps was shortened. Figure 4 shows the result of this change. It was not beneficial as far as a sustained high output was concerned but did give a much longer unattended period at a lower rating. There was an increase of unburned combustible in the ash in the pit, and the fuel bed on the grates was thinner. Most of the spill-over into the ash-pit burned out before it was smothered by ash and the reduced maximum rating can be traced to holes which developed in the thinner fuel bed. When the pile of ash in the ash-pit built up to the point when it formed a retaining barrier at the foot of the step grates, the rate dropped off sharply.

The ash-pit, which was quite shallow, was deepened at this point to increase the unattended period. Figure 5 shows the effect of the alteration. Contrary to expectations, the rating rather than the unattended period was increased. The reason for this is not clear. It is believed that the additional amount of unburned fuel in the ash-pit took longer to burn away than in the previous run and that a slightly thicker bed was maintained on the step-grates for a longer period, making a higher rating possible. More fuel was burned per hour so the amount of ash deposited in the pit was greater. This heavier deposit of ash smothered out the unburned peat in the ash-pit faster and the condition where there was a restraining pile of ash in the pit was reached sooner. This theory is supported by the fact that the percentage of unburned combustible in the ash-pit was higher for this run than for the previous run.

The result of the final modification to the grates is shown in Figure 6. This change consists of the addition of a bar grate extending out $5\frac{1}{2}$ inches over the ash-pit from the edge of the foot-plate. The grate was built up of 1/4" round steel rods spaced 1/4" apart and welded at both ends to cross-rods. One of these cross rods extends through the sides of the ash-pit and is fitted with an arm and counterweight which holds the free end of the grate tight up under the foot-plates. When this grate is dumped, it deposits any accumulation of ash into the pit and also spreads the pile of ash underneath so that it does not form a cone. The addition of this grate prevents a spill-over of the larger sizes of unburned peat into the ash-pit but allows the burned out fine ash to drop through. It was possible to operate the burner for extended periods, maintaining a relatively even heat output with a minimum amount of attention on the part of the operator. At a medium to low rating, as shown in Figure 6, the normal procedure was to dump the bar grate twice a day, once in the morning and once in the evening, rake the accumulated ash off the back of the steps at the same time, and empty the ash-pit container once a day, the output of the heater being controlled by setting the control knob on the flue damper for the required maximum temperature. There was a marked drop in the unburned combustible in the ash-pit for this run, the reason being of course that the spill-over of the larger sizes of fuel into the ash-pit was stopped and the smaller sizes which dropped through the bar grate had a much better chance to burn out before being smothered.

The temperature curve for a short duration, high rating run is shown in Figure 7. The only attention the heater required for this period after light off was to dump the bar grate and rake the back edge of the steps after 3 hours and 45 minutes of operation. The fuel in the hopper was allowed to run out at the end of 5 hours and 15 minutes to see what the effect would be. No smoke or sparks backed up into the hopper because a sufficient draft was maintained until the heater was cold. The amount of peat burned for this run was 103½ lbs. or approximately 20 lbs. per hour. It's moisture content was 29.8 per cent as shown in Table 1.

General Observations

One objection to the burning of peat is the disagreeable odour which accompanies combustion. The possibility of the products of combustion escaping to the heated space does not exist if a heater is installed properly and connected to an adequate chimney. However, because of the high percentage of inherent oxygen present in peat, it will smoulder for hours even when covered with inert ash, giving off the odour so typical of burning peat. The first precaution to be observed, then is, to quickly remove and quench the ash outdoors.

Before starting a fresh fire, it is always advisable to make sure that the chimney is drawing well. This is particularly so with a peat burner, and the easiest method of making sure that the chimney is warm and drawing well is to burn some paper and a few bits of kindling wood in the ash pan before attempting to light the peat. The peat fire can then be started easily by opening the front door of the heater and holding a burning piece of paper close to the back of the step grates. The draft will draw the flame from the paper through the peat bed starting a fire on all steps. All that remains to be done is to close the front door, leaving the draft slot open, and set the knob on the damper control for the desired temperature.

Experience with this heater has been that it will burn any peat that will feed evenly from the hopper. The moisture content of the peat, therefore, is an important factor. If the moisture content is above 45%, the fuel has a marked tendency to hang up in the hopper and to feed in spurts which produces an unsatisfactory fire. If the procedure recommended for the harvesting and preparation of the fuel is followed, the moisture content will be well below the point where bridging in the hopper will occur.

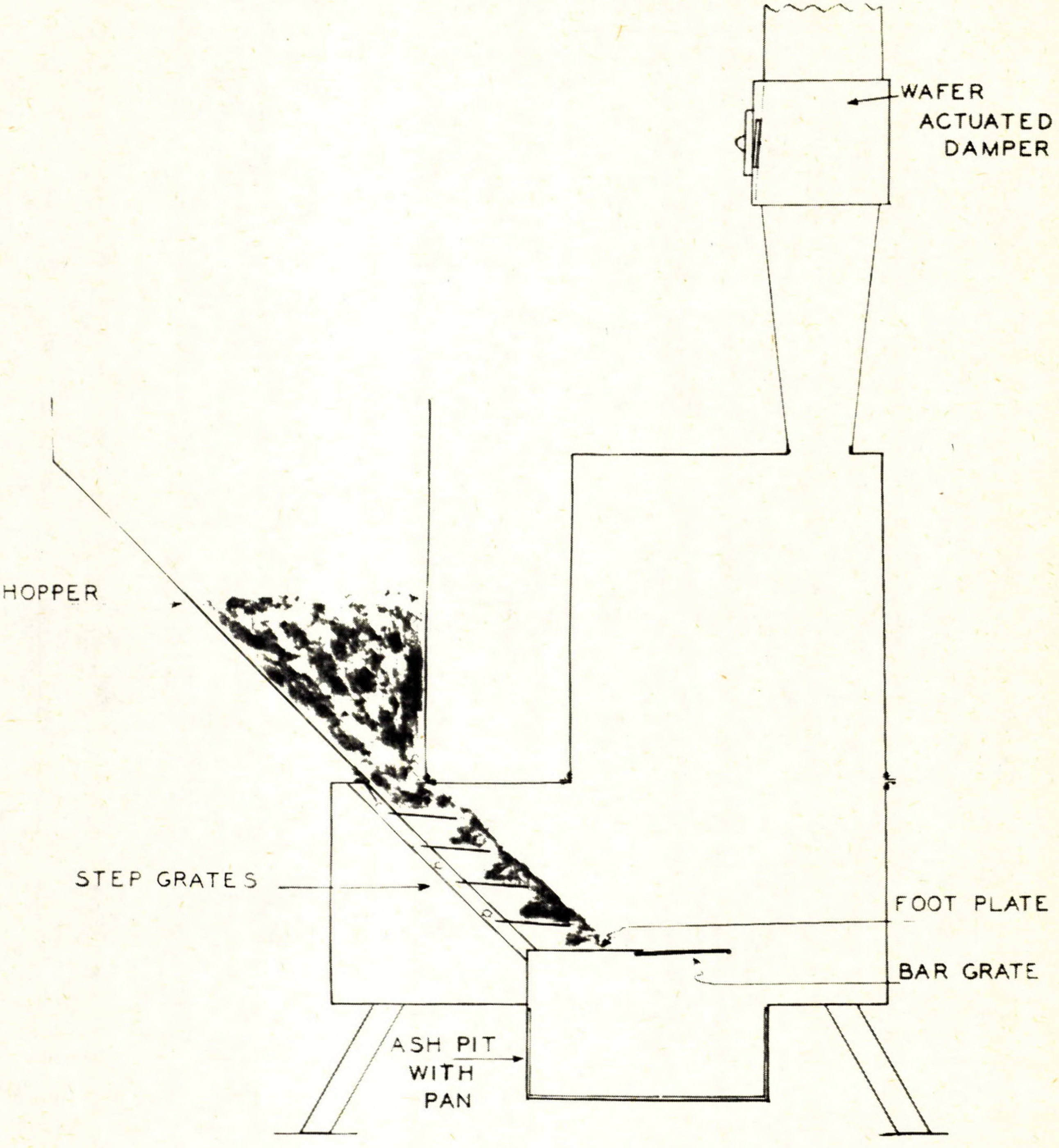
The capacity of the heater is a function of the number and length of the step grates and the area of radiating surface and it is possible to adapt the principle to either stoves or furnaces. On a furnace, the damper control might well be the conventional thermostat and motorized damper with a limit control in the furnace dome.

CONCLUSIONS

Results of tests on the Model B Peat Burner indicate that peat may be considered to be a serviceable fuel in rural areas. The burner has the necessary features required for everyday use in that it is simple to operate, requires a minimum of attention to produce a steady heat, and is sufficiently flexible to meet a wide temperature variation. The equipment required for obtaining an adequate supply of fuel is simple and within the means of the consumer.

The use of the burner is naturally restricted to areas in the immediate vicinity of peat bogs. At the present time, the majority of these bogs are waste land surrounded by prosperous farm areas in which the woodlots no longer supply sufficient fuel to fill the local requirements. The peat burner could be of use in these areas.

In order to give the consumer some guidance on the quantity of peat that will be needed to meet the heating requirements for a season, it is only necessary to compare the heating value of peat with coal. If the consumer uses five tons of coal per season, he will need eight tons of peat with a twenty per cent moisture content and it will be necessary to dig thirty-five tons of wet peat from the bog. In other words, it will be necessary to dig seven tons of wet peat from the bog, freeze it, thaw and screen it and allow it to air-dry for one season to equal the heating value of one ton of coal.


WAFER
ACTUATED
DAMPER
HOPPER
STEP GRATES
FOOT PLATE
BAR GRATE
ASH PIT
WITH
PAN

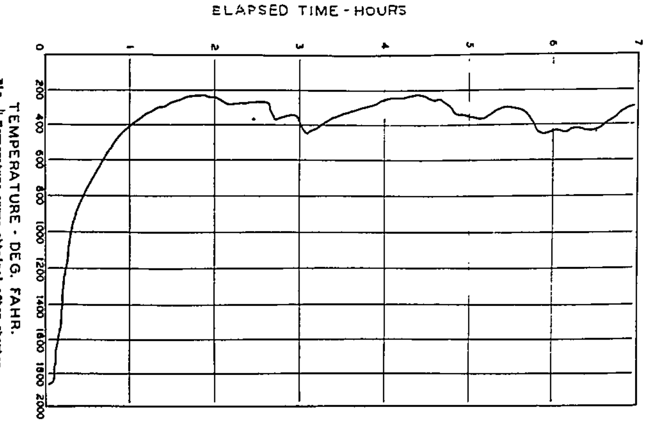


Fig. 4-Temperature curve obtained after shortening foot-plate.

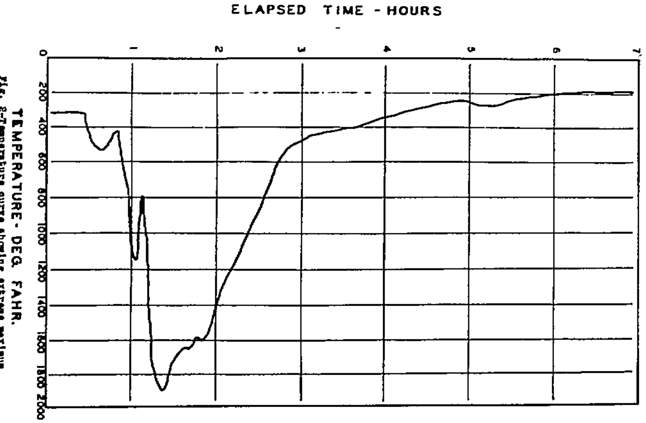


Fig. 2-Temperature curve showing extreme maximum temperatures before installation of automatic damper.

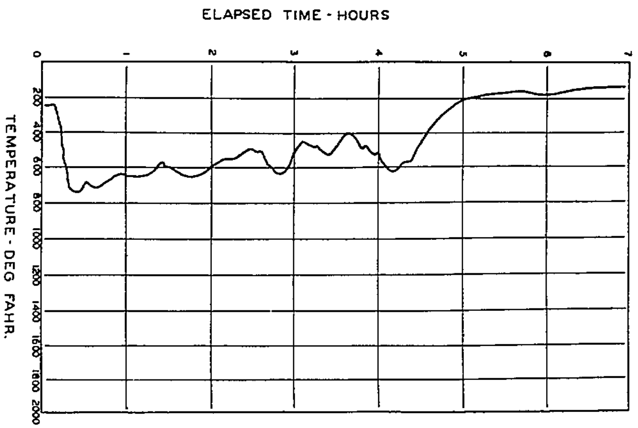


Fig. 5-Temperature curve showing effect of deepening the ash-pit.

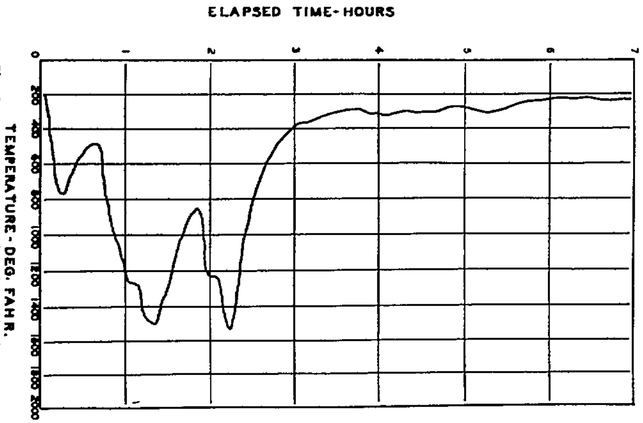


Fig. 3-Temperature curve showing effect of automatic damper.

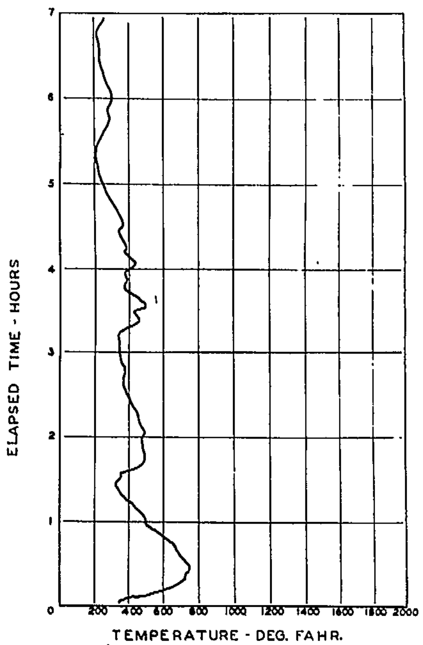


Fig. 6-Temperature curve obtained after addition of bar-grate.

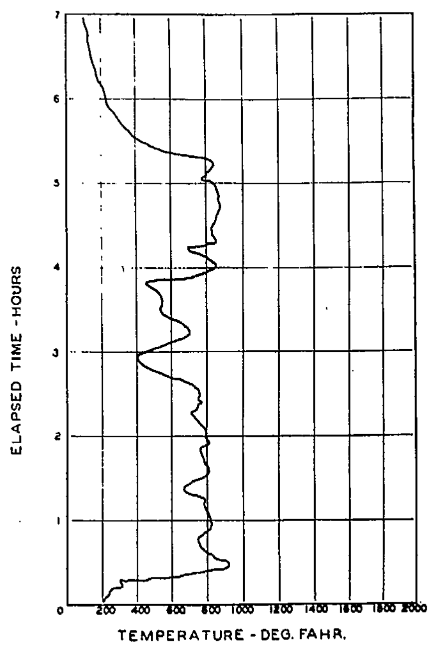


Fig. 7-Temperature curve obtained for a high-rating run on finalized design.