

A NEW TYPE OF GAS-FIRED VITREOUS ENAMELING FURNACE

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ABSTRACT

The furnace described in this article has a working chamber 4 feet wide by 3 feet high by 10 feet long, and is heated by ten gas burners, five on each side. Other proportions are made to suit the nature of the work to be enameled. City gas is most desirable, although any gas above the grade of producer gas may be used.

A furnace of this type can be brought to a working temperature in less than an hour, and will turn out from 12 to 24 loads of work an hour, depending on the kind of work being enameled.

The average gas consumption is about 1800 cubic feet of 500 B.t.u. gas per hour when firing about 600 square feet of flat ware totaling 690 pounds, representing 240 pieces, at an average temperature of 1700°F. The furnace runs without attention other than that given by the men who load and unload the fork.

Furnaces of the intermittent type have various features which are covered by patents issued and applied for. In addition to fuel economy, this type of furnace has the added advantage of producing ware of a very high gloss.

The first cost is low and no foundations other than the ordinary cement floor are necessary, as the entire furnace is above the floor level. Maintenance is practically nothing, as there is no muffle or combustion chamber.

If the following charts and photographs could be presented without further comment, leaving the rest to imagination, the author would be pleased, because to give all the details of a furnace such as this is very much of a problem.

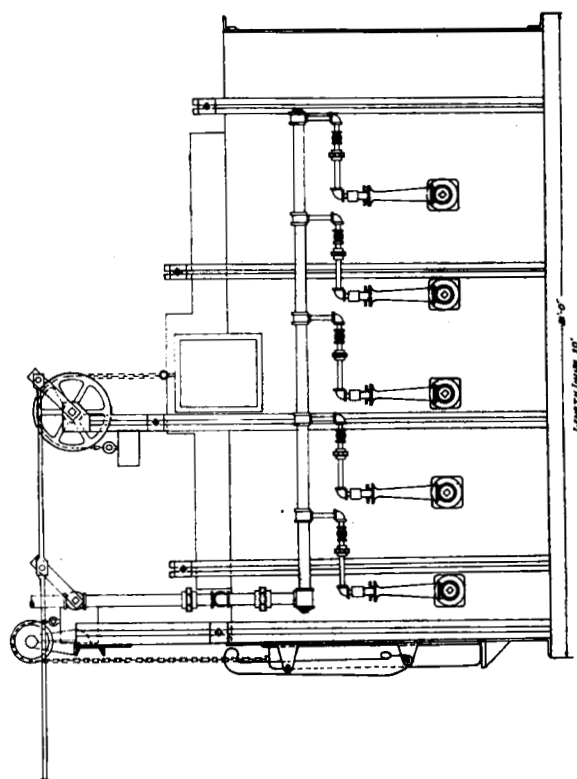
On one hand the users of the furnaces hesitate about letting their competitors know about the improvements made in methods of burning on enamel that result in improved product and reduction of cost.

On the other hand the manufacturer objects to a detailed description of the furnace and of the method of operation for fear of losing a sale of his knowledge of such things. Ordinarily you cannot sell to a person that which you have already given to him. Then, too, a failure with a certain type of furnace because of faulty construction or incorrect operation makes difficult the promotion of such a furnace even under guarantee of correct construction and successful operation.

In this instance the writer is a third party who has represented both sides in the selection and operation of furnaces of this type, hence will endeavor to be fair with all parties concerned.

The general design of the furnace is shown in Fig. 1. Photograph of a furnace of this type, but without steel casing, is shown in Fig. 2. Figure 3 is an interior view of one of these furnaces after 20 months full operation, except for occasional shut-downs over Sunday. No repairs of any kind have been made, and indications are that none will be required for many more months.

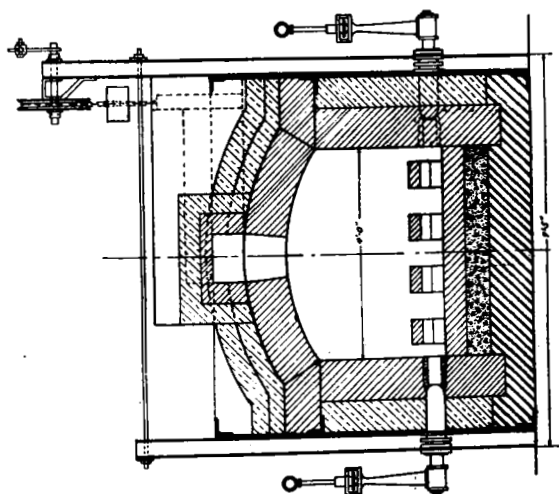
Figure 4 is a photographic copy of pyrometer chart, showing how this type of furnace comes up to working heat after a 72-hour shut-down.



Figured
Part of Furnace

#1.

FIG. 1.



Fire Brick
Refractory Brick
Insulating Brick
Heating Elements

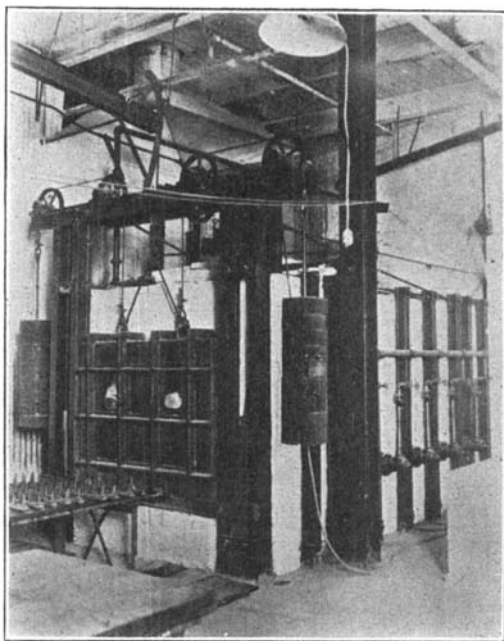


FIG. 2.

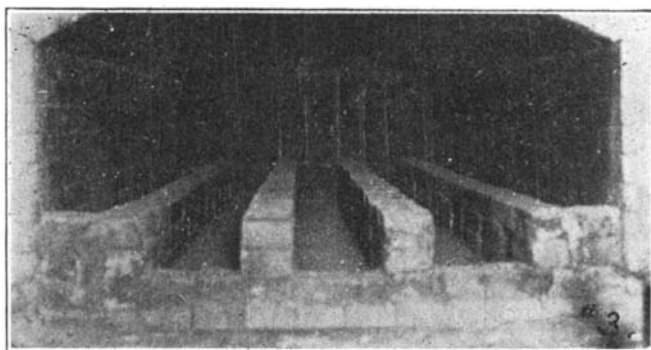


FIG. 3.

It also shows the variety of work done on that particular morning and an analysis of the chart runs about as follows:

- 4:10 Gas turned on. (Furnace at 750° after 72-hour shut-down)
- 4:53 Gas off. (Furnace at 1850° after 43 minutes firing)
- 4:55 First charge in
- 5:00 First charge out

From 5:00 o'clock until 7:35, a period of 2 hours and 35 minutes, a total of 36 loads was taken out of the furnace at a finishing temperature of 1600°F, consisting of 1003 square feet of first and second white coats on assortments of 22 and 24 gauge steel, consisting of splasher sides, panel tops, and broiler pans for gas ranges. Total net weight of material, 1140 pounds. Total number of pieces, 403. In addition to this, it required 220 pounds of supporting pins for each load, in order to give the proper support to this gauge of flat steel.

From 7:35 to 8:00 o'clock, 5 loads of ground coat, white, were taken out at a finishing temperature of 1700°F. Total square feet, 135. Net weight, 150 pounds. Total number of pieces, 50.

From 8:00 o'clock to 8:30, the furnace stood with the gas off while the workmen ate their meal.

At 8:30 the gas was turned on again and was ready for ground coat firing in 5 minutes, and from 8:35 to 9:20 a total of 10 charges of ground coat, white, were taken out at a finishing temperature of 1700°F. Total square feet, 270. Total net weight, 300 pounds. Total number of pieces, 100.

From 9:20 until 11:05 they resumed work on first and second white coat and put through 30 charges in this period at a finishing temperature of 1600°F, consisting of 1122 square feet. Net weight, 1295 pounds. Total of 438 pieces.

From 11:05 to 11:50 they were back on ground coat white, and in this period turned out 11 charges. Total square feet, 297. Net weight, 330 pounds. Total pieces, 110.

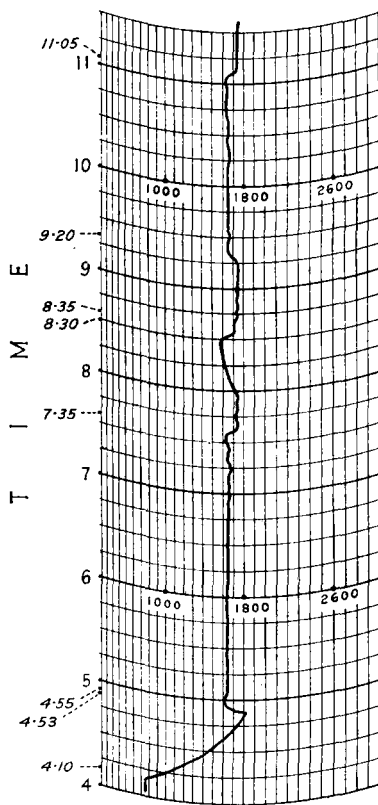


FIG. 4.

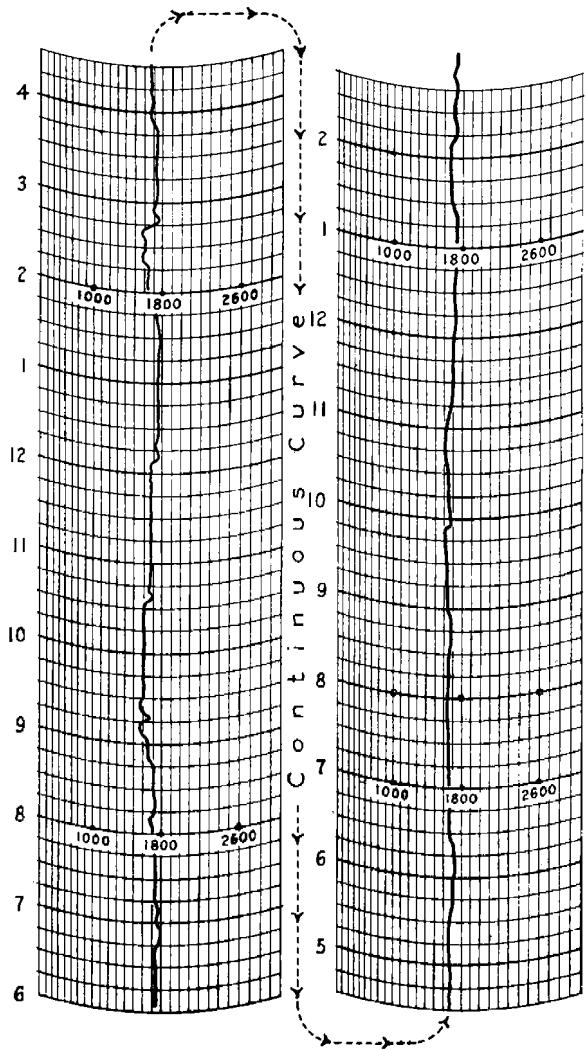


FIG. 5.

These figures, while taken from actual practice, are not the best obtainable, but are given to represent what can be expected under conditions as you find them the first few hours after starting the furnace after a shut-down of several days.

Figure 5 is a photographic copy of pyrometer chart for 21 hours' running, showing various temperatures for ground coat, first white coat, and second white coat on steel; also you will note 5 loads of cast iron were fired, 2 shortly after 9:00 and 3 more about 2:00 P. M. These were cast iron stove legs weighing approximately 3 pounds a piece, and 52 legs constituted a load.

Figure 6 is a photograph of a typical gas meter installation which is used for metering the gas to this type of furnace. The installation illus-

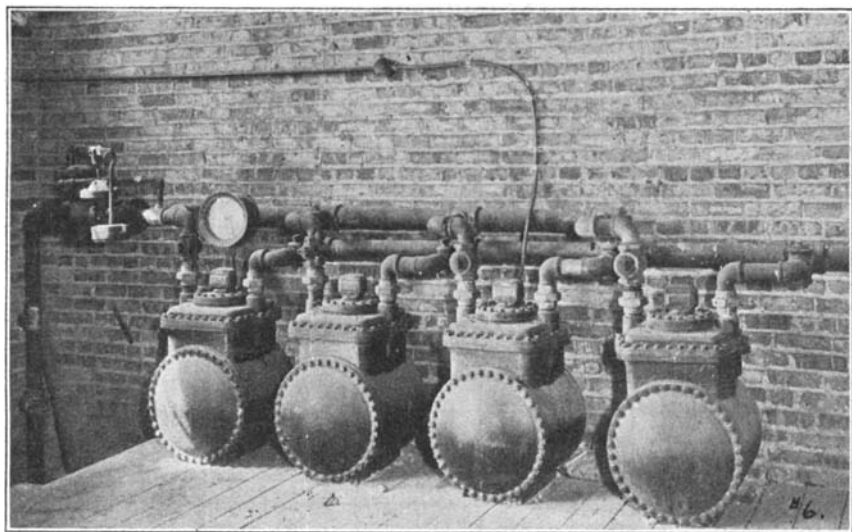


FIG. 6.

trated handles city gas of approximately 500 B.t.u.'s per cubic foot, and has a capacity of 24,000 cubic feet of gas per hour. The burning rate of each furnace is about 7200 cubic feet per hour, but for the short interval that the gas burns between loads, the gas consumed is less than 100 cubic feet per minute, and the total consumed is about 1800 cubic feet per hour. This installation will handle nicely, four of the furnaces described in this article, and this brings us to the item of cost.

The average gas consumption for the 21-hour period shown on Chart 5 was 1800 cubic feet of 500 B.t.u. gas per hour, and at 50 cents per thousand this would represent a total fuel cost of 90 cents per hour per furnace. There was no other expense in connection with the fuel because the air

for combustion is drawn in at the gas mixers by an automatic device known as an inspirator. The average production of material in this 21-hour period was 600 square feet per hour; average weight of material per hour, 690 pounds; average number of pieces per hour, 240; average finishing temperature, 1700°F. Two men did all of the work on this furnace, including loading and unloading fork, loading and unloading furnace, opening and closing the door, regulating the fuel, and so forth. The total labor

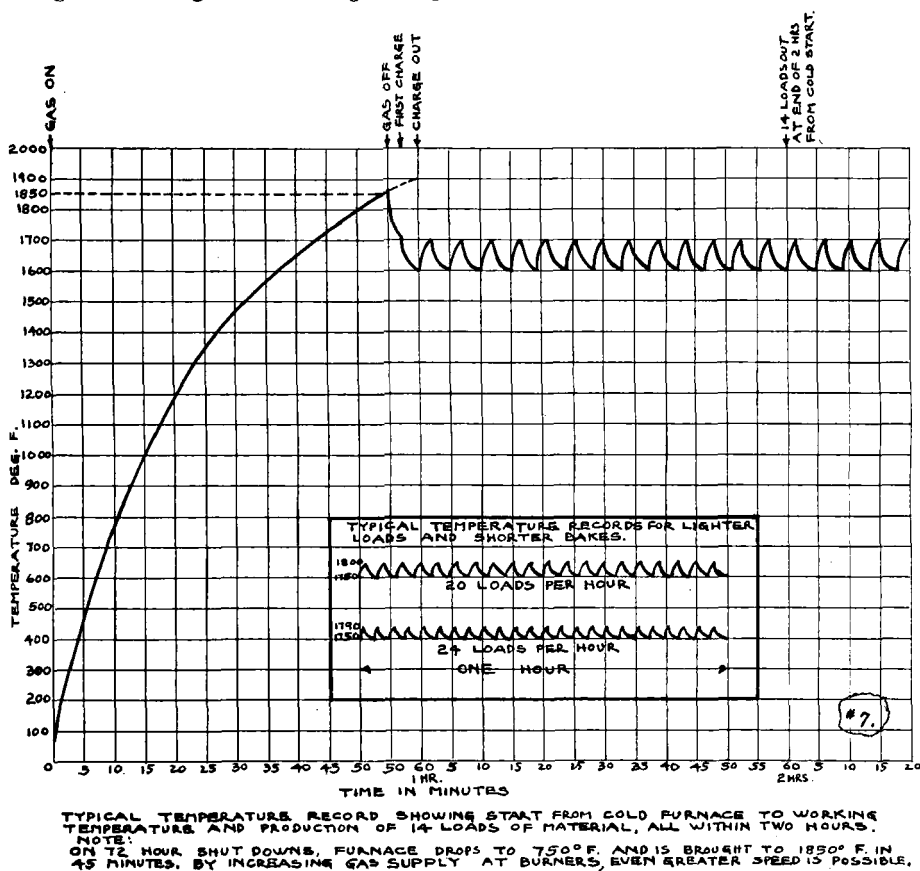


FIG. 7.

expense per hour was therefore two men at 50 cents each. This makes a dollar an hour for labor and 90 cents an hour for fuel, a total of \$1.90 per hour, which, divided by the production per hour on the class of goods previously mentioned, is, labor and fuel, 32 cents a hundred square feet or 27 cents per hundred pounds. These costs can be further reduced by leaving supporting pins in the oven, for certain classes of ware, also by use of flue gases in waste heat boilers and dry rooms. No exact figures

have been obtained as yet, but indications are that leaving pins in the oven reduces fuel cost about 18 cents per hour per furnace, and heat recovered from the gases by boiler and dry-rooms represent a further saving of about 18 cents per hour per furnace.

Chart 7 is a typical temperature record showing the start from cold furnace to working temperature and production of 14 loads of material all within 2 hours. Inserted in this chart are some typical temperature

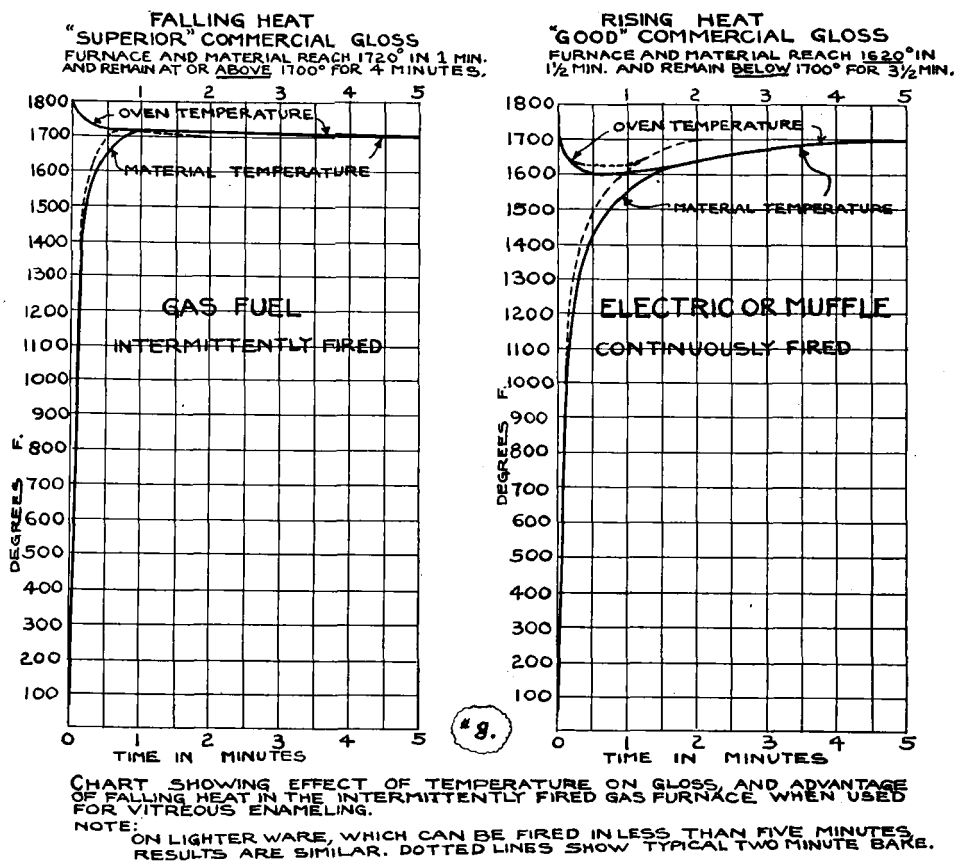


FIG. 8.

records for lighter loads and shorter heats. These charts are taken from actual pyrometer records, but on account of the frequent charges and short intervals of firing, the pyrometer record shows almost a straight line, due to the slight lag in the thermocouple.

Chart 8 shows a very important point in favor of the intermittently fired gas furnace, because the finished goods have a very high gloss. This has been attributed to the fact that the fusing of the enamel takes place

at a falling heat. For example, when the door is opened to receive the goods, the furnace is at a temperature of 1800°F , although the desired finishing temperature is 1700°F . Careful observation with optical pyrometer and calculating the lag of our recording instruments indicate that it takes about a minute for the goods and the oven to come to the same temperature, and in doing this the furnace temperature drops about 80°F . Therefore, from that time on, whether the goods are in the oven 2 minutes or 3 minutes or more, they are under a slightly falling temperature which is approximately 3°F per minute.

Making similar observations on a muffle furnace, in which the finishing temperature of the goods was the same, namely 1700°F , we found that, not having the thermal head of 100° to start with, the temperature in the vicinity of the goods dropped to 1600° , and it took about a minute and a half for the oven temperature and the goods to equalize. After that period there was a slowly rising temperature, and if left in the oven approximately 5 minutes, the normal temperature of 1700° was restored; but if under these conditions the enamel was fused at 1600°F , it would evidently be still more liquid at the end of the bake, which would tend to thin the surface and diminish the gloss. On the other hand, if the enamel is compounded to be thoroughly melted at 1700°F , it only reaches this temperature for a fraction of the time, when compared with the intermittently fired furnace, which starts off with a thermal head of about 100° on heavy work and at least 40° on light work.

The big advantage of the gas fired furnace seems to be that, by distributing the fuel over a large number of small burners and designing them in such a way that combustion is self-starting and practically complete before the products enter the furnace chamber, rapid and economical combustion takes place, and the heat absorbed by the goods can be restored to the furnace in from 30 seconds to a minute and a half, depending on the class of work being enameled, or in any event within the time that it takes the 2 men to take the finished work off the fork and reload with work to be enameled. The opening in the main gas valve regulates the flow of fuel, and this determines the length of time to restore the furnace to proper heat.

In calculating the heat balance of the furnace on which these results were obtained, it is found that the average fuel consumption is about 900,000 B.t.u.'s per hour, of which about 15% goes into the enameled ware and about 20% into the loading pins. Here is where room for economy is possible, because on some classes of work the pins can be left in the oven. The other losses are radiation losses, flue losses, and heat lost each time door is opened.

In a furnace which is now under construction, the fuel consumption, it is thought, will be less than 700,000 B.t.u.'s per hour, because while no

change is contemplated in the method of loading with pins, it is planned to use automatic temperature control which will shorten the period in which the furnace is under fire, and compressed air operated doors will shorten the time that the door is open. Furthermore, this latest furnace is being built with 9" of insulating brick inside of the steel casing, so that radiation losses will be reduced to a minimum.