THE DRESSLER TUNNEL KILN FOR FIRING SANITARY WARE¹

By GEORGE BRAIN

Owing to the erratic results that were being obtained at the plant of the Universal Sanitary Manufacturing Company at New Castle, Pa., during the year 1915, particularly with their glost firing, the management decided to take what might be called a very grave departure from the methods then in use for the production of the finishing gloss on sanitary ware and to build a continuously operated tunnel kiln, of the muffle type, known as the Dressler tunnel kiln, which incidentally was the first in America, and the first in the world for firing sanitary ware.

It seemed foolish to them to continue to place ware in saggers, and gradually bring the heat to the goods, and then cool, wasting time and enormous quantities of fuel. They were convinced that the right method was to maintain the temperature desired near the middle of the tunnel, bring their goods up to the heat, and then past to the cooling zone, using the heat from the goods, to help conserve the precious fuel, which they had been wasting for years in their intermittent kilns.

The potters would have argued, "we know we are getting fairly good results by our present methods. Well, anyway, as good as may be obtained with our present equipment which we know something about while we do not know what the results will be if we take such a step as putting in a continuous kiln as part of our equipment, which is all theory and remains to be proven."

I was not connected with the company when the decision was made. It is just possible, however, that had I been consulted as a potter, I would probably have advised against such a step. Therefore, I am not speaking as one taking pride in having made the proposition, but as an enthusiast after the event.

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FIG. 1.—Side view of loaded truck. *B, B* are fire-clay slabs. *A, A* are supports on outside of slabs *B* used for supporting upper deck. Behind these supports and between the bowls small articles can be fired as described in the paper. It will readily be seen that by enclosing the bowls in saggars the space would be divided and thus ruined for use for extra pieces. The sketch shows one side of the truck holding 8 closet bowls and 6 jars, or a total for the truck of 16 closet bowls and 12 jars. When tanks are placed the total number of tanks that can be fired vary from 10 to 12 according to the size of the tanks.

The kiln is approximately 250 feet long and holds 44 trucks, each measuring 5 feet 8 inches long and 3 feet 6 inches wide. Each truck is capable of holding 18 large pieces of sanitary ware (8 tanks, 10 closet bowls). At 22 trucks per day (7 days per week) the production would be 396 pieces of sanitary ware per day, or figuring on a six-day basis for shop production, 462 pieces per day from the shops. We have never been able to produce this amount. Our total production per day from the clay shop has never exceeded 360, so that the tunnel kiln has never been pushed to its capacity. Incidentally we are hoping to make the 450 mark this summer when we get our new casting shop in operation. The distance from the entrance to the maximum temperature zone, speaking in trucks, is 28 and from there on to the end of the kiln is 16 trucks. Based on a maximum production

of 44 trucks per day, or one per hour, the time occupied by the ware from placing in kiln to time of coming out is only 44 hours. Adding to this the extra six hours given for cooling, in an antechamber provided on our return truck, the time occupied is 50 hours, from placing to packing shed. Compared with the intermittent kilns there is a saving of the difference between six days (144 hours) and 50 hours, which equals 94 hours, which means that the time occupied by the process of glazing is cut down by about 60 per cent. Compare the amount of fuel used in each case.

An intermittent glost kiln will use about 250,000 cubic feet of gas per kiln, or if coal is used, about 15-16 tons. The Dressler kiln uses 50,000 cubic feet of gas per day or intermittent kiln equivalent. If using coal in a gas producer 3 tons per day or intermittent kiln equivalent will suffice—an actual saving of four-fifths, or 80 per cent, of the fuel, which in itself is not to be taken lightly during this period of high cost of living.

It is interesting here to note that when on a few occasions we used saggars on several trucks our production per truck was cut down from 18 to 10, or 44 per cent. In addition to this, when using saggars we were not able to fire smaller articles without providing extra space for them. The reason for this you will readily see. On each side of the truck (lower deck) we fire 4 closets, or 8 in all, which leaves 6 spaces to be filled. All kinds of articles fairly large in size, can be fired in these spaces, such as paper boxes, water coolers, etc., equal to a production of about 850 pieces per week.

On one occasion we took an order for a certain type of white jar for which we had to provide special saggars in the bisque. Had we continued to do this our profit on the jars would have been small. Instead we raised our heat in the tunnel kiln to cone 9, hardened our glaze a little and dipped the jars green, firing them but once through the tunnel kiln. We saved considerably on this, because in raising our heat from cone 7 to 9 we only used an extra 5000 cubic feet of natural gas per day, costing \$1.75—about one and one-half cents per jar.

These savings are worth while and were not thought of when the kiln was first installed. Firing without saggars has tre-

mendous advantages. Each piece of ware can be seen and inspected from the time it is placed until it enters the kiln. Our kiln operators are thus able to check any slips that our kiln placers may have made.

The saving in equipment and labor is also enormous. (1) Our men place all our ware during an 8-hour day, while 2 men working day (12 hours) and 2 men at night (12 hours) put the trucks in the kiln and unload same as they come out. (2) As all our slabs and supports are cast they stand up well. We use an average of two large slabs per day, and several small supports. You will readily see that the displacements of ware for firing these is very small indeed. This would not be the case with saggars.

Based on a production of 70 green saggars per day (35 rings and 35 bottoms) there would be a displacement of 35 pieces of ware, which, based on a profit of $12\frac{1}{2}$ per cent, would mean that the company would be the loser of \$12,000 each year, irrespective of what it cost to make the saggars and the space occupied by the saggars and sagger room. Wadding is entirely eliminated. This effects a direct saving of thousands of dollars per year, which any manufacturer will appreciate.

Six men, including kiln placers, operate our Dressler kiln, working a total number of 64 hours per day, or, based on a 7-day week or a 7 intermittent 16 feet 6 inches kiln equivalent, 448 hours per week.

Let us see how many men it takes to produce 7 intermittent kilns per week. Seven 16 feet 6 inch kilns will average 50 bungs, or 350 bungs per week. Each union kiln placer sets 7 bungs per day (8-hour day) or it takes an equivalent of 50 times 8 hours per week equals 400 hours for kiln placing. Drawing the same kilns finds work for 10 men each time a kiln is drawn, of 5 hours each kiln or 50 hours per kiln for whole gang, or 350 hours per week. It is fairly reasonable to say that 1 fireman and 4 helpers will fire 7 kilns per week. One fireman 8 hours per day for 6 days equals 48 hours per week. Four helpers 12 hours equals 48 hours per day or 7 days equals 336 hours per week. It is safe to assume that it will take an extra laborer for punching and cleaning up 8 hours per day for 6 days or 48 hours per week.

Unloading 105 tons of coal 10 hours per week. Just these alone will give the huge total of 1192 hours per week for the same product as one tunnel.

In using the number of hours per day as a comparison, I believe I am able to show you without giving you actual dollars and cents exactly what we save on labor alone. Let us compare—448 hours per week for Dressler and 1192 hours per week for seven 16½ ft. kilns, a saving of 6.14 hours per week or in percentage about 55 per cent.

Had it been necessary for us to use saggars in our Dressler kiln it will be readily seen that our labor saving would have been very small, besides which we would have cut down the production to an enormous extent. Had saggars been used one bottom and one ring would be used per piece of sanitary ware. Our kiln placers instead of handling 400 pieces of ware or thereabouts would have to handle 400 pieces plus 800 saggars with necessary wadding. That of course is assuming for sake of comparison that the same number of pieces could be fired with saggars; as a matter of fact the actual production would be cut in half and even at that would give the two kiln placers more work than they could handle. It is very easy to see that our kiln placers would be multiplied by 3, or instead of 2 we could need 6, and at least 4 extra men would be needed for the drawing irrespective of the extra cleaning up that would be necessary. The labor saving appeals very much to me indeed, especially with regard to kiln placers. Where could we possibly get 4 extra kiln placers, not to speak of kiln drawers? As matters stand in the skilled labor world, it is next to impossible. They would, however, be necessary, if we used saggars, which certainly would be the case if it were not for the fact that our kiln is of the muffle type. It is not that we save money on the labor so much as the fact that we are able to operate with so few laborers.

In regard to quality it may be said that we are able to steadily produce goods of first-class quality, with none of the glost defects so prone to crop up in saggered kilns of any description which are direct fired.

It will be interesting here to note what our repairs have cost us during 4 years of operation. Three years ago we decided to

repair the arch in the heat zone which had sunk about 3 inches owing to low-grade fire brick having been used. We made a number of arch bricks ourselves from what we considered after a series of tests would give us good results. Six hundred were used in all and they are in the kiln to-day in first-class shape. We have also used 20 to 25 sections of combustion chambers during four years, not a terrible expenditure by any means, either in labor or materials.

Since the first few trial trips in the fall of 1915, when we shut down the kiln to make any improvements the operating had suggested to us, we have had one run of fifteen months and two of twelve months each. Twelve months ago we voluntarily shut down when the sanitary business was at its lowest ebb. Had this not been the case I firmly believe we would have run for a full two years—not at all a bad record for a kiln operating at cone 7 and part of the time at cone 9.

UNIVERSAL SANITARY MANUFACTURING CO.
NEW CASTLE, PA.

NOTICE—Discussion of this paper will be published later as part of the Discussion of Tunnel Kilns.