The present invention relates broadly to kilns, and more particularly to a continuous compartment kiln for the firing of ceramic products, and to a method of operating the same.

There are in use at the present time two distinct types of continuous kiln for the firing of ceramic products. In one type the ware is placed in a continuous tunnel or in a series of contiguous connected chambers with permanent bottoms. Fires are maintained within these spaces, and are made to progress either along the continuous tunnel or from chamber to chamber. As soon as a section of the tunnel or a chamber has reached the desired temperature, the fires are stopped in this part of the kiln but are readied to be ignited in the next adjacent tunnel section or chamber which has been preheated by the heat of the waste gases from the section or chamber just fired off.

There are certain difficulties which are met with in this type of continuous kiln. For example, the cooling, owing to the large mass of masonry often takes place too slowly, particularly when the temperature falls below 500 degrees Fahrenheit. In hot weather this delays the operation of the kiln, and with many kinds of ware, such as pottery, the rate of cooling is too slow for the best results. Moreover, the large heat retention of the masonry either causes the operation of placing or setting the ware to take place at uncomfortable temperatures, or causes unnecessary loss of heat if the kiln is allowed to cool down to a point at which the working temperature is comfortable for the workmen. In the latter case, it is apparent that the whole operation is slowed down, and the capacity of the kiln thereby considerably reduced.

In the other type of kiln, the ware to be fired is placed on movable cars which are propelled slowly through a long tunnel in a train. Furnaces near the center of the tunnel maintain the heat at practically a constant temperature. As the cars enter the tunnel they are heated by a counter current of the waste gases coming from the furnaces. After they have passed the hot zone in front of the furnaces, the ware they are carrying is cooled by the air coming from the discharge end, which in part is utilized for completing the combustion of the furnace gases.

In distinction from the first type of continuous kiln, the setting of the ware on the cars takes place in the open and without subjecting the workmen to oppressive temperature conditions. Furthermore, the cars of cooling ware may be removed from the kiln at the temperature at which cooling proceeds most slowly in the first type of continuous kiln and brought down to atmospheric temperature comparatively quickly. Also, while in the first type of kiln the placing and discharging of the ware proceeds along the entire length of the kiln and the crew is compelled to transport the ware to the different sections or chambers which are to be filled, in the tunnel car kiln the setting operations are centralized, and they take place within a given space. This arrangement makes it possible to make use of permanent conveyors which transport the fired ware to the proper department of the factory.

The car tunnel kiln is, however, subject to two conditions which are unsatisfactory. In the continuous kiln having a moving fire zone, the ware is stationary and may be fired to exactly the desired maturing temperature, whereas such positive control is not possible in the car tunnel kiln, since the cars are in constant motion, and since the heat effect is a function of both the heat of the high fire zone through which the cars pass and the rate of travel of the cars. Any variation in the temperature cannot be so quickly regulated but that part of or a whole car or several cars may pass along without having received proper heat treatment.

The other and still more important point of objection to the tunnel car kiln is the constant danger of wreckage. If at any time part of the setting collapses and causes an obstruction, it is possible that a number of cars, or even the whole train, may become jammed. Such a condition makes necessary the shutting down of the kiln, which involves a heavy financial loss. This danger is ever present, and the most exacting precautions must be taken to place the charge securely and conform it strictly to the outlines of the tunnel. Any carelessness on the part of the workmen or accidental collapse of saggers, tiles or of the ware itself will invariably lead to disaster.

By the present invention I have provided
a kiln and method of operating the same embodying the advantageous features of both types of kiln above referred to without their attendant objectionable features.

In the accompanying drawings there is shown, for purposes of illustration only, one embodiment of the present invention, it being understood that the drawings do not define the limits of the invention, as changes may be made in the construction and operation therein disclosed without departing from the spirit of the invention or scope of my broader claims.

In the drawings:

Figure 1 is a longitudinal vertical sectional view of the left-hand half of a continuous compartment kiln embodying my invention.

Figure 1 is a view corresponding to Figure 1 of the right-hand half of the kiln.

Figure 2 is a front elevation of a portion of the kiln illustrating the construction and operation of the doors for the several compartments thereof.

Figure 3 is a horizontal sectional view on the line III—III of Figure 2, and

Figure 4 is a vertical sectional view, on an enlarged scale, of a portion of the kiln.

A kiln constructed in accordance with my invention may comprise any suitable number of compartments. In Figures 1 and 1 existing kiln having twelve compartments. These compartments are similar to the chambers of the continuous kiln with traveling fire and fixed ware charge.

Instead of having bottoms which are fixed and an integral part of the kiln, however, these compartments are provided with bottoms in the form of movable platforms adapted to be set with ware outside of the kiln at some convenient centralized point, and then moved into position in the various compartments of the kiln.

The construction of the movable platforms is illustrated most clearly in Figure 4.

Each platform may consist of a cast iron or steel frame 13 covered with a layer of insulating material 14. On top of the insulating material is a relatively thick layer 15 of refractory material, such as fire clay, and on this layer are placed the setting blocks 16 properly spaced to provide channels for the passage of the hot gases beneath and between the stacks of ware 17 placed in spaced relation upon said blocks. For moving these platforms, it is apparent that each of them might be provided with its own running gear, but I have illustrated a more economical method of moving them. For this purpose, a suitable lift truck 18 is provided operating on rails 19. As already pointed out, the platforms will be set with ware outside of the kiln at some convenient centralized point. When loaded with ware, a platform will be run into its particular compartment of the kiln by means of the lift truck and lowered into position so that it is supported by ledges 20 at opposite sides of the compartment, the usual sand seal 21 being provided. After the platform has been lowered into position, the same lift truck may be used to move another platform. It will therefore be apparent that all of the platforms may be operated by means of a comparatively small number of lift trucks, which is much more economical than providing each platform with a running gear.

A door is provided at least one end of each compartment of the kiln, these doors being sufficiently large to permit of the passage of the loaded platforms and the trucks into and out of the compartments. Where the compartments are arranged in two rows, but one door to each compartment is required, but where the compartments are arranged in a single row, two doors may be found desirable for each compartment, one at each end thereof. The construction and operation of the doors is illustrated in Figures 2 and 3.

Each door is preferably constructed of fire brick 22, encased in a cast iron or steel frame 23, and guided for vertical movement by steel channel guides 24. Each door may be counterbalanced by means of counterweights 25 connected to the door by cables 26 running over pulleys 27 at the upper end of the channel guides.

I have described the construction of the kiln, I will now proceed to first describe the operation of a single compartment, and then the general operation of the entire kiln.

Again referring to Figure 4, the heated air from a preceding compartment flows through the opening 28 in the partition wall between adjacent compartments into the combustion chamber 29, where it meets the producer gas issuing from the flues 30. Combustion is complete as may be desired takes place in the chamber 29, and the hot gases of combustion pass over into the compartment space 31, and thence through the channels between the setting blocks 16 and through the spaces between the stacks 17 resting on said setting blocks, and exit through the opening 32 leading to the combustion chamber 33 of the next adjacent compartment, and then pass into the compartment space 34 of each compartment to preheat the ware in each compartment.

The general operation of the entire kiln will be apparent by reference to Figures 1 and 1. Assuming that the properly fired material has just been removed from compartment No. 1, and that the material in compartments 2, 3, 4 and 5 is cooling, and that the fire in the combustion chamber of compartment 6 has just been ignited, it will be seen that the heated air flowing through compartments 1 to 5, inclusive, meets the producer gas issuing from the flues of the combustion chamber of compartment 6. The
hot products of combustion serve to fire the ware in compartment 6, and these products of combustion pass through compartments 7, 8, 9, 10 and 11, preheating the material in these compartments. The waste gases, having given up their heat, then pass out through a vertical flue 35 into a flue 36 leading to a collecting flue (not shown) outside the kiln. Such collecting flue may communicate either directly with a stack or with a fan chamber from which the gases are exhausted. The several vertical flues 35 are provided with dampers 37 whereby the waste gases may be conducted out through any desired flue 36 by opening the damper of that particular flue. After the ware in compartment 6 has been properly fired, the fire in the combustion chamber of that particular compartment may be stopped, and the fire ignited in the combustion chamber of compartment 7, and so on. It will be noted that compartment 12 has been indicated as ready for placing. As soon as a loaded platform has been placed in position in this compartment, the damper 37 in the flue 35 between compartments 11 and 12 may be closed, and the damper in the end flue 35 opened, thereby causing the products of combustion to pass into compartment 12 and preheat the ware in that compartment. When compartment 12 is being fired its waste gases are drawn by means of fan draft through compartment 1 and others adjoining the latter. When the cooling of the ware in any particular compartment has progressed sufficiently far, the lift truck 18 may be run into position beneath the platform in that compartment, and said platform raised enough for clearance, and then removed outside the kiln for complete cooling, unloading and resetting. These operations may hence be performed outside of the heated kiln without discomfort to the workmen at centralized unloading and loading stations. A freshly loaded platform may then be placed in position in the compartment just discharged, and in which the temperature is still high enough to permit the charge to absorb considerable heat from the kiln walls. The latter need never be cooled to the point required in the old type of compartment kiln, thus effecting an appreciable saving of heat, and permitting of preheating of the ware in an atmosphere of pure air, a fact of considerable importance in certain classes of products. By means of suitable mechanical devices, it is possible to manipulate the lift truck so that the operator need not enter the kiln compartment, and hence will not be uncomfortably exposed to the heat of such compartment.

From the foregoing, the advantages arising from my invention will be apparent to those skilled in the art. They may be briefly summarized as follows: The movable kiln floor platforms permit of the rapid setting of the ware to be fired at one point most convenient for plant operation. This makes for plant economy. The work of setting the ware takes place under the most favorable conditions for the workmen, and does not expose them to the high temperatures common in compartment kilns as heretofore constructed and operated, especially in summer. The placing of the platforms in the kiln compartments is done rapidly. The freshly set ware may be placed in compartments in which temperatures unfavorable for the workmen still prevail. In this manner, heat otherwise wasted is utilized, and the turn-over of the kiln decidedly increased. The discharging of the fired ware from a compartment may take place while such compartment is still too hot for the workmen, and such compartment may be emptied rapidly and made ready to receive a fresh charge. The unloading of the ware can take place at a central unloading station, which increases plant economy. The work of unloading the platforms takes place under favorable conditions, and hence can be carried on with maximum expedition. The platforms with their loads of green or fired ware are moved only at comparatively low temperatures, and remain in a fixed position during the process of firing. They are hence not subject to vibration as in the car tunnel kiln, and the danger of wreckage is completely eliminated. The total turnover and capacity of a continuous compartment kiln with removable floor platforms constructed in accordance with my invention is decidedly greater than is the case with the old type compartment kiln, and the rapidity of the firing process may be greatly increased as conditions demand.

I claim:

1. In the method of operating a continuous compartment kiln having a plurality of compartments arranged side by side, each compartment whereof is provided with a removable platform for supporting the ware and with means for firing such compartment, the steps consisting in loading a plurality of such platforms exteriorly of the kiln, moving the loaded platforms into position in said kiln, firing one of the compartments having a loaded platform in position therein, passing the hot products of combustion therefrom into an adjacent compartment having a loaded platform therein to thereby preheat the ware in said compartment, stopping the fire in the first compartment and permitting it to cool to a predetermined point, removing the platform with its fired ware therefrom, firing the adjacent compartment, and moving a freshening loaded platform into the first compartment.

2. In the method of operating a continuous compartment kiln having a plurality
of compartments arranged side by side, each compartment whereof is provided with a removable platform for supporting the ware and with means for firing such compartment, the steps consisting in loading a plurality of such platforms exteriorly of the kiln, moving the loaded platforms into position in said kiln, firing one of the compartments having a loaded platform in position therein, passing the hot products of combustion therefrom into a plurality of adjacent compartments each having a loaded platform therein to thereby preheat the ware in said compartments, stopping the fire in the first compartment and permitting it to cool to a predetermined point, removing the platform with its fired ware therefrom, firing the next adjacent compartment and placing a freshly loaded platform in position in said first compartment while the latter is still hot.

3. In the method of operating a continuous compartment kiln having a plurality of compartments arranged side by side, each compartment whereof is provided with a removable platform for supporting the ware and with means for firing such compartment, the steps consisting in loading a plurality of such platforms exteriorly of the kiln, moving the loaded platforms into position in said kiln, firing one of the compartments having a loaded platform in position therein, passing the hot products of combustion therefrom into an adjacent compartment having a loaded platform therein to thereby preheat the ware in said compartment, stopping the fire in the first compartment and permitting air to flow therethrough to cool the ware in said compartment, firing the adjacent compartment and passing the heated air from the first compartment into said adjacent compartment as a combustion supporting element.

4. In the method of operating a continuous compartment kiln, each compartment whereof is provided with a removable platform for supporting the ware, the steps consisting in loading a plurality of such platforms exteriorly of the kiln, moving the loaded platforms into position in said kiln, firing one of the compartments having a loaded platform in position therein, passing the hot products of combustion therefrom into a plurality of other compartments each having a loaded platform wherein to thereby preheat the ware in said compartments, stopping the fire in the first compartment, after the ware in said compartment has been sufficiently fired, and igniting it in the next compartment, and repeating the last mentioned step for each of said compartments.

5. In the method of operating a continuous compartment kiln, each compartment whereof is provided with a removable platform for supporting the ware, the steps consisting in loading a plurality of such platforms exteriorly of the kiln, moving the loaded platforms into position in said kiln, burning a mixture of air and gaseous fuel in one of the compartments having a loaded platform therein, passing the hot products of combustion from said compartment into another compartment having a loaded platform therein to thereby preheat the ware in said compartment, stopping the combustion in the first compartment and permitting air to flow therethrough to cool the same, and passing the heated air from said first compartment into the second compartment and burning a mixture of said air and a gaseous fuel in said second compartment.

6. In a kiln, a plurality of contiguous compartments each having a removable platform for supporting the ware, means whereby said platforms may be moved into and out of said compartments, and a combustion chamber in each of said compartments communicating with the interior thereof, each of said combustion chambers communicating with the interior of an adjacent compartment whereby the hot products of combustion may be passed from one compartment into an adjacent compartment and whereby air flowing through one compartment can be supplied to the combustion chamber of the next adjacent compartment as a combustion supporting element, substantially as described.

7. In a kiln, a plurality of contiguous compartments each having a removable platform for supporting the ware, means whereby said platforms may be moved into and out of said compartments, a combustion chamber in each of said compartments communicating with the interior thereof, and means for supplying gaseous fuel separately to each of said combustion chambers, each of said combustion chambers communicating with the interior of an adjacent compartment whereby the hot products of combustion may be passed from one compartment into an adjacent compartment and whereby air flowing through one compartment can be supplied to the combustion chamber of the next adjacent compartment as a combustion supporting element, substantially as described.

8. In a kiln, a plurality of contiguous intercommunicating compartments each having a removable platform for supporting the ware, means whereby said platforms may be moved into and out of said compartments, means for supplying gaseous fuel separately to each of said compartments, and means associated with each of said compartments for exhausting the products of combustion directly therefrom, substantially as described.

9. In a kiln, a plurality of compartments each having a removable bottom for sup-
In the method of operating a continuous compartment kiln having a plurality of compartments arranged side by side, each compartment whereof is provided with a removable platform for supporting the ware and with means for firing such compartment, the steps consisting in loading the removable platform of each compartment exteriorly of the kiln and then placing the platform in its compartment, firing the compartments one after the other and passing the hot products of combustion from each compartment during its firing through one or more of the other compartments, the hot products of combustion from the last compartment of the series being passed through the first compartment of the series, permitting each compartment after the fire therein has been stopped to cool to a predetermined point and then removing the platform with its fired ware therefrom and placing a loaded platform in position therein while such compartment is still hot.

In a kiln, a plurality of compartments each having a removable platform for supporting the ware, each of said compartments having a combustion chamber at one side thereof communicating with the interior of said compartment and also with the interior of the adjacent compartment and having at the other side thereof a damper-controlled flue for the oftake of the products of combustion from such compartment, substantially as described.

In a kiln, a plurality of compartments each having a removable platform for supporting the ware, each of said compartments having a combustion chamber at one side thereof communicating with the interior of said compartment and also with the interior of the adjacent compartment and having at the other side thereof a damper-controlled flue for the oftake of the products of combustion from such compartment, and means associated with each of said combustion chambers for supplying fuel thereto, substantially as described.

In a kiln, a plurality of compartments each having a removable platform for supporting the ware, each of said compartments having a combustion chamber at one side thereof communicating with the interior of said compartment and also with the interior of the adjacent compartment and having at the other side thereof a damper-controlled flue for the oftake of the products of combustion from such compartment, and a flue associated with each of said combustion chambers for supplying gaseous fuel thereto, substantially as described.

In the method of operating a continuous compartment kiln having a plurality of compartments arranged side by side, each.