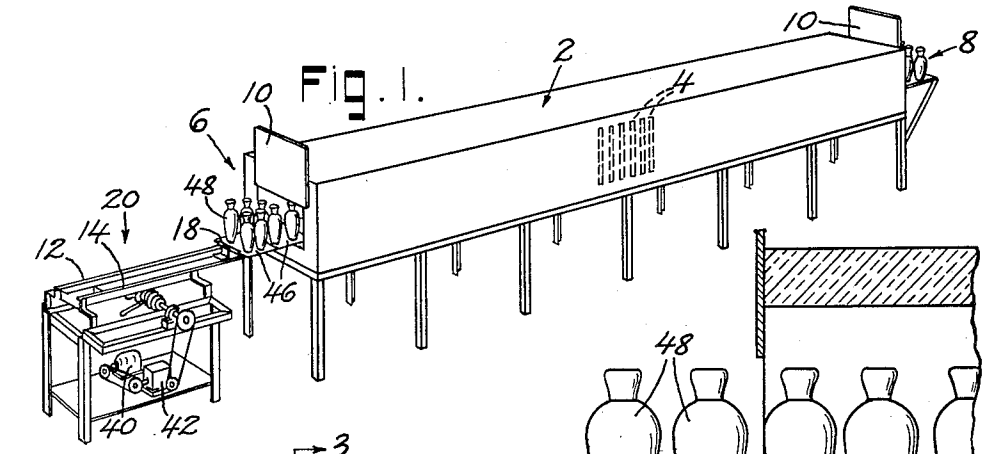
May 9, 1950 G. F. WILDE 2,507,076

TUNNEL KILN

Filed Dec. 10, 1946

Fig. 1.



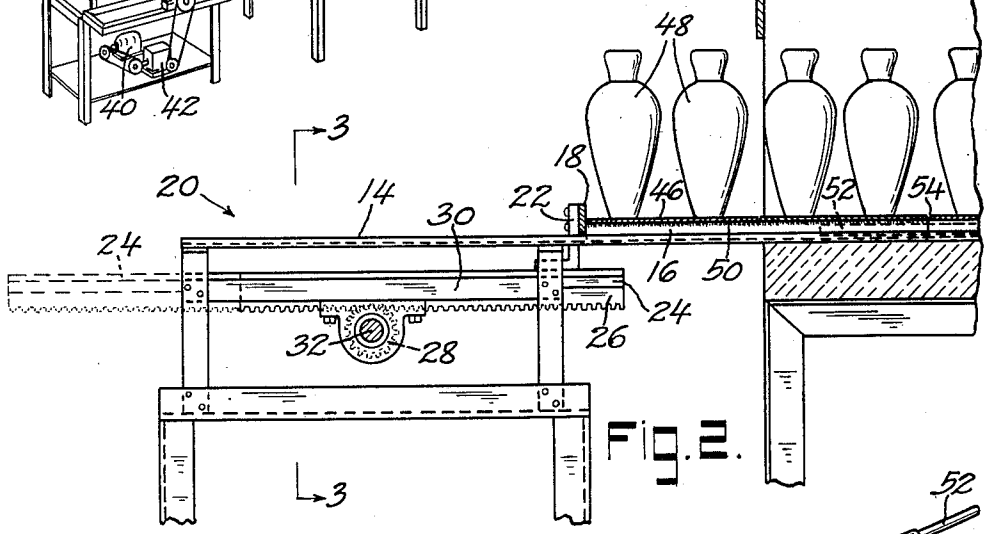


Fig. 2.

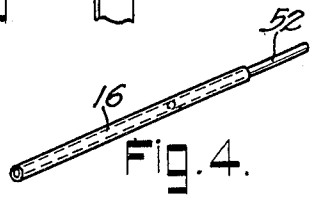


Fig. 4.

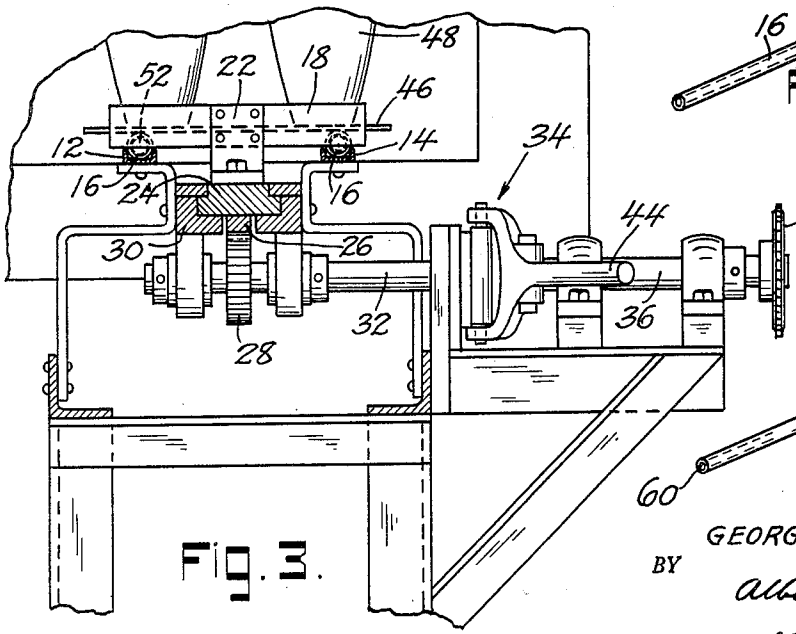


Fig. 3.

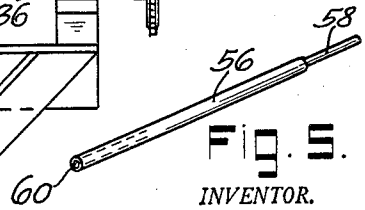


Fig. 5.

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TUNNEL KILN

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Application December 10, 1946, Serial No. 715,274

7 Claims. (Cl. 25—142)

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My invention relates to tunnel kilns for use in the ceramic industry, and particularly to methods and means for moving articles to be fired through such kilns.

It has been usual heretofore to provide tunnel kilns with tracks along which cars are moved to carry the articles to be fired through the kiln. Such cars are generally heavy in construction, and are provided with relatively thick slabs of ceramic material for supporting the ware so as to prevent distortion or sagging of the support under the high temperature to which the cars and ware are subjected. However, even with such constructions, the cars often jerk or tilt as they are moved through the kilns and the supports for the ware sometimes break or sag sufficiently to cause the ware to topple over and produce a jam within the kiln. Moreover, if the cars are pushed through the kiln one after another any obstruction to movement of the cars tends to cause the cars to buckle up or to be derailed. It is then necessary to allow the whole kiln to cool down before the fallen or broken ware or the displaced cars can be removed safely and the kiln prepared for renewed operation.

The use of such heavy constructions also is objectionable because the car and the support usually weigh much more than the ware itself, and therefore a greater amount of the heat is required to raise the car and support to the firing temperature than is used productively in firing the ware. This not only renders the process expensive, but also makes it necessary to employ a relatively long kiln or to move the ware through the kiln very slowly in order to allow time for the car and support as well as the ware to be brought up to the firing temperature and to permit them to cool down sufficiently after firing to prevent "crazing" of the ware when it is removed from the kiln. Such slow operation is particularly objectionable when the kiln is used for decorating ceramic ware since the pigments or colors used for decorating purposes are sometimes volatile and therefore are evaporated or partially destroyed before they are fused and fired onto the ware. Under these conditions the decorations tend to become dull or flat in appearance and to lose much of their attractiveness.

In accordance with my invention, these objections to constructions of the prior art are overcome, and means are provided for moving ware through a tunnel kiln whereby the loss of heat in raising the temperature of the car and support is reduced materially, and the temperature of the ware may be raised and reduced comparatively quickly so as to permit the use of a

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shorter kiln and avoid deterioration of the colors used in decorating ceramic ware. Moreover, the economies effected in the use of heat in the kiln render it economically feasible to employ electric heating elements which are capable of the most accurate control and are economical to use in the construction of the kiln.

These results are preferably attained by providing a novel type of car and support which may be made of light-weight and highly conducting materials such as stainless steel or other high melting point metals or alloys, or light weight and strong ceramic materials, and by employing means for supporting and connecting the cars to each other in a manner which prevents buckling or jamming of the car or jerky or irregular movement thereof as the ware is passed through the kiln.

One of the objects of my invention is to provide a novel type of means for supporting and moving ceramic ware through a tunnel kiln.

Another object of my invention is to reduce the amount of heat and the length of time required for firing or decorating ceramic articles.

A particular object of my invention is to provide a tunnel kiln with means for supporting and moving articles therethrough in a manner to substantially eliminate interruptions in the operation of the kiln.

These and other objects and features of my invention will appear in the following description thereof in which reference is made to the figures of the accompanying drawing.

In the drawing:

Fig. 1 is a perspective of a typical form of tunnel kiln embodying my invention;

Fig. 2 is an enlarged longitudinal sectional view through a portion of the tunnel kiln illustrated in Fig. 1;

Fig. 3 is a vertical sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a perspective of an alternative form of guide member embodying my invention, and

Fig. 5 is a perspective of a further alternative form of guide member embodying my invention.

In that form of my invention chosen for purposes of illustration, the tunnel kiln is indicated generally at 2, and is provided with heating means such as the electrical resistors indicated diagrammatically at 4. The ware to be fired is passed into the kiln through the inlet end 6 and is discharged from the kiln at the outlet end 8. Doors 10 are provided for closing the inlet and outlet ends of the kiln but are movable to the raised positions shown to allow the ware to pass into and out of the kiln.

The means provided for moving the ware through the kiln in accordance with my invention includes the tracks 12 and 14 which are preferably in the form of stainless steel channel members and are located in parallel relation on the floor of the kiln and extend longitudinally through and beyond the opposite ends of the kiln. The tracks present continuous parallel upwardly facing channels along which guide members 16 such as cylindrical or tubular rods are movable. Any desired number of tracks may be used to provide an adequate support for the ware but as shown two tracks are generally sufficient for use in a kiln employed for decorating ceramic ware.

The guide members shown in Figs. 2, 3 and 4 are made in short lengths, say from 18 inches to 3 feet in length, and preferably are formed of a metal such as stainless steel or other alloy capable of withstanding extremely high temperatures without undergoing distortion or rapid deterioration on long exposure to high temperatures. The guide members are employed in pairs or groups, one being positioned in each track, and the ends of the tubes are aligned so that they may be engaged by the pusher member 18 of the pusher mechanism 20.

Any suitable form of pusher mechanism may be employed, but as shown in Figs. 1, 2 and 3 the pusher mechanism is located adjacent the inlet 6 of the kiln and the member 18 extends transversely of the tracks 12 and 14 above the same in position to engage the outer ends of the guide members 16 located in the channels of the tracks. The pusher member 18 is mounted upon a bracket 22 carried by a bar 24 which is provided on its lower face with a rack 26 engageable with the pinion 28. The bar 24 is mounted on the slide bearings 30 and is advanced by the pinion 28 from the dotted line position of Fig. 2 to the full line position shown in successive cycles of operation. The pinion 28 is mounted on the shaft 32 and is connected by means of a clutch 34 to a shaft 36 driven by the pulley 38 from a motor 40 and reduction gear 42. The clutch 34 is provided with a handle 44 which is movable to connect and disconnect the pinion carrying shaft 32 to the motor driven shaft 36. When the clutch is disconnected, the bar 24 and pusher member 18 may be moved freely away from the ends of the guide members and to the right as seen in Fig. 2. The projecting ends of the tracks 12 and 14 are thus cleared to receive another pair or group of guide members in abutting relation with the ends of the preceding guide members. Successive pairs of guide members are thus arranged on the tracks and pushed through the kiln one after another and are removed from the tracks at the outlet end of the kiln and returned to the inlet end for another passage through the kiln.

The guide members described serve as cars or carriages for moving the supporting means 46 on which is carried the ware 48 to be fired or decorated. The supporting means shown are in the form of plates formed of stainless steel or other thin, light material capable of supporting the ware without undergoing distortion at the high temperatures to which the ware and support are subjected. The sheets 46 may be secured rigidly to the guide members 16 as by welding or otherwise as indicated at 50 in Fig. 2. However, the supporting means preferably are separable from the guide members as shown in Fig. 4 so that the supporting sheets may be placed on and removed from the guide members after the guide members have been placed in the channels of the tracks

12 and 14. Furthermore, by forming the supporting means separate from the guide members, the guide members and sheets are capable of limited relative movement as they travel along the tracks. The guide members therefore can move so as to follow any lateral irregularities in the tracks or they may shift in position relative to the supporting means to pass over rough spots or other irregularities in the track without jerking or otherwise disturbing the supporting means and ware.

When pushing such light weight guide members and supporting means through the kiln the tracks 12 and 14 hold the guide members in position against lateral displacemnt from their aligned positions. However, there is always a possibility that such separable elements may buckle upward if there is any material resistance to longitudinal movement thereof, such as that due to an obstruction or rough place in the track along which the guide members are moved. When the ware itself is not very heavy such upward buckling of the guide members and supports may take place quite readily. In accordance with my invention this danger is overcome by providing the guide members with interengaging elements which serve to hold the guide members in longitudinal alignment. In the construction illustrated in Figs. 2, 3 and 4 the guide members are in the form of tubes and connecting rods 52 are inserted into the tubular guide members and into positions in which they project beyond the ends of the guide members and from one tube into another. The rods thus extend beyond the abutting ends 54 of adjacent tubes as seen in Fig. 2 and positively prevent relative vertical movement of the tubes and of the supporting means carried thereby. By similarly connecting all of the longitudinally aligned guide members throughout the length of the kiln the members are in effect interconnected so as to form a single assembly which prevents buckling of the relatively movable elements.

As shown in Fig. 5 the guide members may be in the form of solid rods or bars 56 each of which is provided on one end with a reduced portion 58 and provided on the opposite end with a complementary recess 60 designed to receive the reduced portion of a succeeding guide member.

In using the construction described for firing or decorating ceramic ware, the kiln is raised to the desired temperature by the heating elements 4. The pusher member 18 is then drawn back to its dotted line position as seen in Fig. 2 and the tubular guide members 16 are placed in the upwardly facing channels of the tracks 12 and 14. The clutch handle 44 of the clutch 34 is then operated to connect the pinion carrying shaft 32 to the motor driven shaft 36. The pinion 28 then rotates to move the rack 26 and bar 24 along the slide bearings 30 to carry the pusher member 18 to the right as seen in Fig. 2 and to push the guide means along the tracks and into the end 6 of the kiln.

When the supporting means 46 are fixedly secured to the guide members, the placing of the guide members on the tracks serves to position the supporting means horizontally to receive the ware 48. In the alternative, if the supporting means is separable from the guide members, the supporting means are placed on the guide members and the ware is arranged so as to be carried therewith into the kiln.

In either case the guide members, supporting

means and ware are advanced by the pusher member 18 until the parts are substantially in the position shown in full lines in Fig. 2. The clutch 34 is then operated to disconnect shaft 32 from shaft 36 and the bar 24 and pusher member are drawn back to the dotted line position. Connecting rods 52 are then inserted approximately half way into the ends of the preceding tubular guide members so that the remaining half of the connecting rods project from the rear ends of the guide members. Another pair of guide members is then slipped over the projecting ends of the connecting rods and positioned in the channels of the tracks 12 and 14. The supporting means and additional ware are then placed in position to be advanced by the new pair of guide members and the clutch 34 is operated to cause the assembly to be pushed into the kiln. In this way successive guide members and supporting means are passed one after another through the kiln and a substantially continuous supply of ware is advanced from the inlet 6 through centrally heated zone of the kiln to the outlet end 8 thereof.

When the fired ware reaches the discharge end of the kiln the door 10 is opened and the ware is removed. The supporting means by which the ware was carried are then removed and the guide members are drawn from the projecting ends of the connecting rods 52 and removed from the tracks. The rods 52 also may be withdrawn from the following guide members and the door 10 again can be closed. The guide member and supporting means and connecting rods may then be returned to the inlet end of the kiln and reassembled to receive additional ware to be fired.

With this construction and operation, the weight of the guide members, connecting members and supporting means is relatively insignificant as compared to the weight of the ware being fired. The heat employed in firing the kiln therefore is utilized almost exclusively in raising the temperature of the ware and in firing the glaze or decorative material. The low heat capacity of the elements employed for moving the ware through the kiln thus assures high thermal efficiency of the kiln, and as a result it is economically feasible to heat the kiln by the use of electrical resistors or other relatively high cost forms of heating means.

My invention is particularly useful in the decorating of previously fired ware in that it is possible to bring the ware up to the necessary temperature for firing the glaze or fixing the decorative material very rapidly, and but little heat is required for raising the temperature of the article moving means. For this reason the pigments or other decorative material are fired and fused before they undergo appreciable evaporation or decomposition. Bright, attractive colors are therefore obtainable, similarly the ware may be cooled relatively rapidly, and without awaiting prolonged cooling of the kiln or article moving means. As a result the length of the kiln may be materially reduced, and the time of the firing operation is considerably shortened. It will thus be seen that the cost of the kiln, and the cost of the firing operation may be considerably below those heretofore necessary either for firing or decorating ceramic ware whereas the quality of the product may be improved.

While I have described and shown my invention as used in combination with an electrically heated kiln other types of kiln may be employed.

Similarly, the type of pusher mechanism, clutch and drive employed may obviously be varied considerably, and numerous other forms of tracks, guide members, supporting means and connecting elements may be employed. In view thereof it should be understood that the embodiment of my invention herein shown and described is intended to be illustrative only and is not intended to limit the scope of my invention.

I claim:

1. A tunnel kiln having a pair of parallel tracks extending from an inlet end of the kiln to an outlet end thereof in the ware receiving portion of the kiln, a plurality of elongated guide members each formed to extend longitudinally of said tracks and separable one from another so that pairs of said guide members may be placed on the tracks at the inlet end of the kiln and removed from the tracks at the outlet end of the kiln, means located adjacent the inlet end of the kiln and engageable with the guide members for pushing said pairs of guide members one after another along said tracks and through said kiln from the inlet end to the outlet end thereof, a ware supporting member carried by each of said pairs of guide members and spanning said tracks, and means releasably interconnecting said guide members to hold said members in alignment during their movement through the kiln but separable to permit removal of said guide members from other guide members adjacent thereto when the supporting means and ware emerge from the outlet end of the kiln.

2. A tunnel kiln having a pair of parallel tracks extending longitudinally therethrough from an inlet end to an outlet end of the kiln and each presenting an upwardly facing channel in the ware receiving portion of the kiln, a plurality of pairs of elongated but relatively short guide members arranged in longitudinal alignment in said channels with the ends of each pair of guide members in alignment transversely of said tracks, a supporting means spanning said tracks and carried by each of said pairs of guide members for receiving ware to be fired, means for pushing said pairs of guide members along said tracks and through said kiln, and separable connecting means extending from one guide member of a pair to a longitudinally adjacent guide member for holding said guide members in alignment during their movement through the kiln said connecting means being separable to permit removal of said guide members from other guide members adjacent thereto when the supporting means and ware emerge from the outlet end of the kiln.

3. A tunnel kiln having a pair of parallel tracks extending longitudinally therethrough from an inlet end to an outlet end of the kiln and each presenting an upwardly facing channel in the ware receiving portion of the kiln, a plurality of pairs of elongated but relatively short guide members arranged in longitudinal alignment in said channels with the ends of each pair of guide members in alignment transversely of said tracks, a supporting means spanning said tracks and carried by each of said pairs of guide members for receiving ware to be fired, means for pushing said pairs of guide members along said tracks and through said kiln, said guide members each having complementary projecting and recessed means extending parallel to said tracks and arranged in separable interconnected relation for holding said guide members in longitudinal alignment said connecting means being separable to per-

mit removal of said guide members from other guide members adjacent thereto when the supporting means and ware emerge from the outlet end of the kiln.

4. A tunnel kiln having a pair of parallel tracks extending longitudinally therethrough and each presenting an upwardly facing channel, a plurality of pairs of relatively short tubular guide members arranged in longitudinal alignment in said channels with the ends of each pair of guide members in alignment transversely of said tracks, a supporting means carried by each of said pairs of guide members for receiving ware to be fired, means for pushing said pairs of guide members along said tracks and through said kiln, and rods positioned within said tubular guide members and extending from one tube to another to hold said guide members in alignment.

5. A tunnel kiln having a pair of parallel tracks extending longitudinally therethrough and each presenting an upwardly facing channel, a plurality of pairs of relatively short tubular guide members formed of metal which is resistant to temperatures to which they are subjected within the kiln, said guide members being arranged in longitudinal alignment in said channels with the ends of each pair of guide members in alignment transversely of said tracks, a sheet of metal resistant to temperatures to which it is subjected within the kiln carried by each of said pairs of guide members for receiving ware to be fired, means for pushing said pairs of guide members along said tracks and through said kiln, and rods positioned within said tubular guide members and extending from one tube to another to hold said guide members in alignment.

6. A tunnel kiln having a pair of parallel tracks extending longitudinally therethrough and each presenting an upwardly facing channel, a plurality of pairs of relatively short tubular guide members formed of metal which is resistant to temperatures to which they are subjected within the kiln, said guide members being arranged in longitudinal alignment in said channels with the ends of each pair of guide members in alignment transversely of said tracks, a sheet of metal resistant to temperatures to which it is subjected within the kiln carried by each of said pairs of guide members for receiving ware to be fired, said sheet being separable from the guide members to permit limited relative movement of the sheet and guide members during their travel through the kiln, means for pushing said pairs of guide members along said tracks and through said kiln, and rods positioned within said tubular guide members and extending from one tube to another to hold said guide members in alignment.

7. Means for supporting ware as it is moved through a tunnel kiln comprising carriages, each of which embodies a pair of tubular metal guide members arranged in parallel positions and formed to engage tracks in the kiln, a sheet of metal supported by said guide members for receiving the ware to be fired, said sheet being loosely engageable with said guide members to permit limited movement of the guide members relative to the sheet, and longitudinally extending metal connecting members located in the tubular guide members and carried thereby for holding the guide members in longitudinal alignment with other carriages when passed through a kiln.

GEORGE F. WILDE.

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