

March 14, 1961

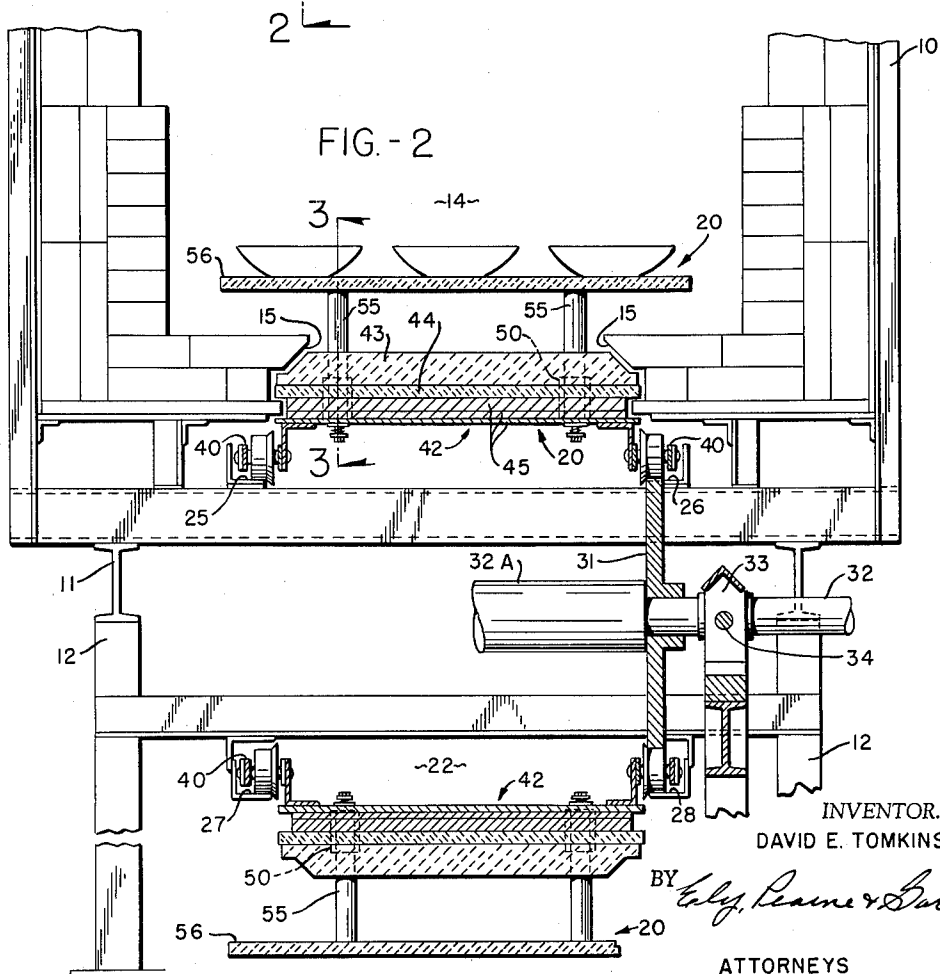
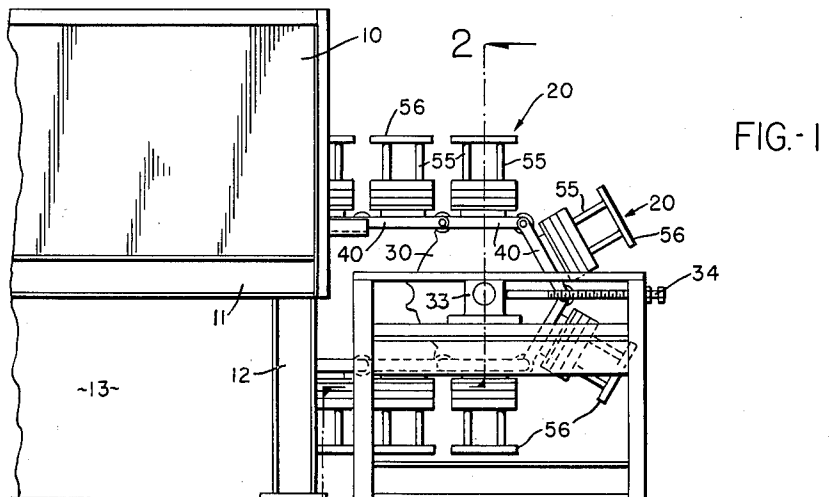
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TUNNEL KILN AND CONTINUOUS CONVEYOR SYSTEM

Filed April 21, 1958

2 Sheets-Sheet 1



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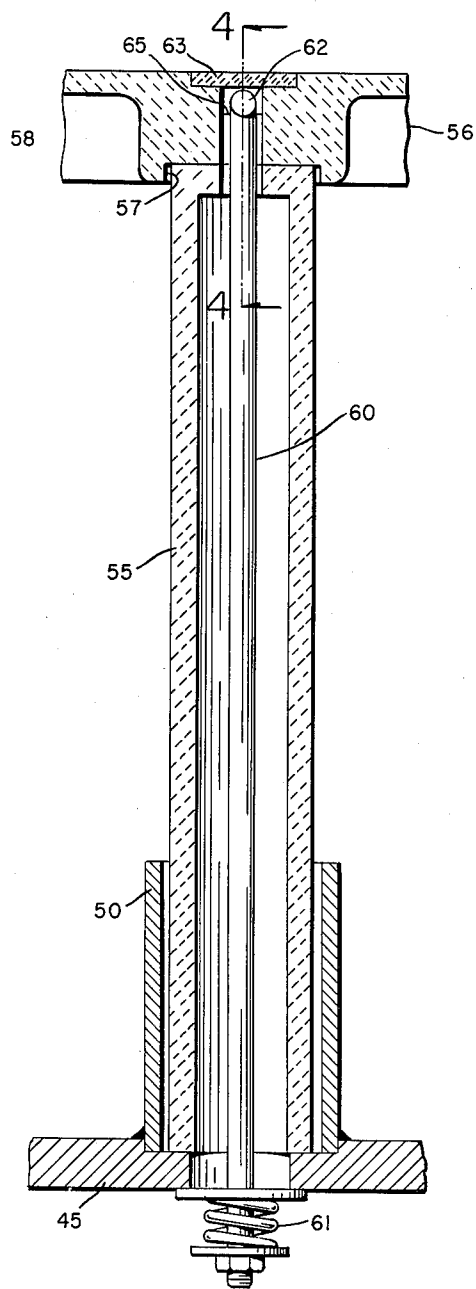


FIG-3

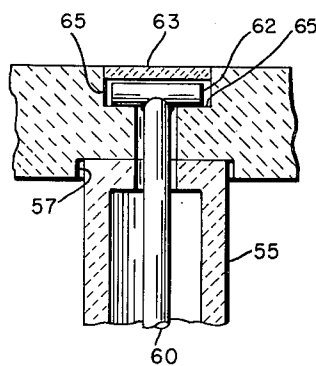


FIG-4

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TUNNEL KILN AND CONTINUOUS CONVEYOR SYSTEM

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The present invention relates to feeding apparatus for straight tunnel kilns and particularly to kiln cars adapted for arrangement in an endless train but each of which is provided with kiln furniture which stays primarily associated with its car rather than having to be loaded thereon at the beginning of each pass through the kiln.

The invention contemplates securing the kiln furniture to the kiln cars by means of shrouded tie rods, and returning the train of cars along a reach immediately below the reach of the tunnel kiln itself by inverting the cars. The arrangement is such as to allow lost motion in the furniture to accommodate the abrupt local temperature gradients and distortions which are common at the high operating heats of ceramic kilns while at the same time constraining the structure against damaging shocks and breakage during inverting of the cars. Accordingly, there is provided a straight tunnel kiln which is well adapted to automated ware decoration.

A feature of the invention is the employment of the above-mentioned tie rods as hangers for supporting the furniture associated with each car during passage of the car along the return reach outside of the tunnel. The organization is such that tension on the metal tie rods is relatively low when they are subjected to the high temperature of the kiln and becomes relatively high only when they are performing their hanger function during the return reach when they are not subjected to the high temperature of the kiln.

An important feature of the invention is that all the above may be accomplished without the occurrence of impact loads on the tie rods, particularly during inversion of the tie rods shortly after their passage through the kiln.

The several features of the invention will be more clearly understood from the following description of one example of the invention.

In the accompanying drawings:

Figure 1 is a side elevation of one end of a straight tunnel kiln in connection with which the invention is employed.

Figure 2 is a fragmentary sectional elevation, partly broken away, taken from the planes of line 2-2 in Figure 1.

Figure 3 is a further enlarged detail view taken from the plane of line 3-3 in Figure 2.

Figure 4 is a view taken from the plane of line 4-4 in Figure 3.

There is provided according to the illustrated example of the invention a straight tunnel kiln 10, lined with suitable refractory material, as best shown in Figure 2. The tunnel kiln 10 is supported by suitable frame members 11 and 12, and the mechanism of the tunnel kiln 10 may be shielded against dust and the like by a wall 13. The tunnel of the kiln is indicated by the reference numeral 14 in Figure 2. Along the bottom of the tunnel 14 is formed a slot 15. A number of tunnel cars 20 are entrained and are guided for movement in upright position along the slot 15 and in inverted position along a

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return reach 22 immediately below the slot 15. The means for so guiding the cars 20 includes an upper railway comprising the rails 25 and 26 and a lower railway comprising the rails 27 and 28, the lower railway being located directly under the upper railway. The guide means also includes sprockets aligned with the rails of the railways at each end thereof and extending between the levels of the upper and lower railways respectively; for example, the sprocket 30 (see Figure 1) extends between the levels of the upper and lower railways 25 and 27 and an additional sprocket 31 (see Figure 2) extends between the levels of the upper and lower railways 26 and 28. The sprockets 30 and 31 are mounted on a drive shaft 32, 32a which is connected to a power drive (not shown). The shaft 32, 32a is mounted in pillow blocks 33 for adjustment of the chain to be associated with the sprockets by means of the adjusting screws 34. The opposite end of the tunnel 10 (not shown) may exactly duplicate the structure described above, with the exception that the sprocket shaft may be simply an idler shaft and may be fixedly mounted, no pillow blocks 33 or adjusting screws 34 being required since adjustment from one end of the structure is all that is necessary. The chains which engage the sprockets 30 and 31 and the additional sprocket at the opposite ends of the tunnel comprise links 40, which are coupled to the outer ends of the wheel axles of the cars 20, as shown in Figure 2. It will be clear then that the chains, made up of the links 40, link together the cars 20 and also extend along the length of the railways 25-28 and operatively engage with the sprockets 30 and 31 and the corresponding sprockets at the opposite end of the kiln 10.

Each car 20 has a base portion which extends across the slot 15 when the car is positioned in the slot 15, such base portion, including a deck, being generally indicated by the reference numeral 42. The deck 42 is lined on its upper side with ceramic material 43, 44 and the deck 42 has a metal lower side comprising the metal portions 45. Metal sleeves 50 extend upwardly from such metal lower side to such ceramic upper side.

On each car 20 is kiln furniture projecting upwardly into the tunnel 14 when the car is in the slot 15. The furniture comprises a plurality of ceramic hollow columns 55 which are received within the metal sleeves 50 and are end-abutted against the lowermost plate of the metal portions 45 (see Figure 3) and which extend upwardly through the ceramic upper side of the deck 42, that is, through the ceramic members 43 and 44, and into the tunnel 14. A ceramic platform 56 is supported at the top of the kiln associated with each car. The platform is provided with sockets 57 (see Figures 3 and 4) on its underside to loosely receive the columns 55. The underside of the platform 56 may include hollowed-out portions 58.

Tie rods 60 extend through the columns 55 and are engaged at their upper ends with the platform 56. For example, the tie rods may have a T-shaped head 62 (see Figure 4) which is shielded from heat by a ceramic plug or insert 63. The T-shaped head is suspended from the shoulders 65 formed in the platform 56. The tie rods extend downwardly through the columns 55, being shrouded and protected thereby against the kiln fire during the passage of the cars through the kiln tunnel 14, and the lower ends of the tie rods extend to the base portion of their associated car and to and through the metal lower side of their associated platform 42, that is, the metal tie rods extend through the base portion of their associated car, as most clearly seen in Figures 2 and 3. The rods 60 are tied to the base portion of their associated car by spring means such as the springs 61, such spring means urging the lower ends of the rods downwardly from the metal lower side of their base

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portion. It will thus be understood that the metal rods are maintained under spring-loaded tension, and that rod tension is relatively low when the cars 20 are upright and at all times when the rods are subjected to the elevated temperature within the tunnel 14, and that rod tension is relatively high only when the cars are inverted outside the tunnel as during the time their associated car passes along the return reach 22. It will be further understood that impact shocks are avoided as the tunnel cars 20 are inverted following their pass through the tunnel 14. In this respect the spring-loaded tie rod feature is to be contrasted to previously proposed kiln tie rods, such as that shown, for example, in U.S. Patent No. 1,895,408 to Davis. It is preferable that the spring means be almost expanded to zero deflection when the associated car is upright so that as each upright car passes through the tunnel 14, the rods 60 are subjected substantially only to the load of their own weight plus a very slight additional tension sufficient to prevent the occurrence of any unsprung lost motion during car inversion. The spring rate and the amount of lost motion which is possible should be sufficiently great that when the cars are inverted and the rods 60 support the full weight of the furniture, such full weight is entirely sprung.

As previously stated, the above description is given by way of example only. The invention is not limited to all the details thereof. Its scope is defined by the following claims.

What is claimed is:

1. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said cars each having a base portion extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns, a ceramic platform at the top of the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

2. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said guiding means including an upper railway under said slot and a lower railway below said upper railway, sprockets aligned with the rails of the railways at each end thereof and extending between the levels of said upper and lower railways respectively, and chains linking said cars, extending along said rails and engaged with said sprockets, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

3. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach im-

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mediately below said slot, said guiding means including an upper railway under said slot and a lower railway below said upper railway, sprockets aligned with the rails of the railways at each end thereof and extending between the levels of said upper and lower railways respectively, and chains linking said cars, extending along said rails and engaged with said sprockets, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the metal lower side of the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

4. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through the metal lower side of the base portion of their associated car and being tied thereto by spring means urging the lower ends of said rods downwardly from said metal lower side for maintaining said rods under spring-loaded tension.

5. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said guiding means including an upper railway under said slot and a lower railway below said upper railway, sprockets aligned with the rails of the railways at each end thereof and extending between the levels of said upper and lower railways respectively, and chains linking said cars, extending along said rails and engaged with said sprockets, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through the metal lower side of the base portion of their associated car, spring means urging the lower ends of said rods downwardly from said metal lower side for maintaining said rods under spring-loaded tension.

6. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach im-

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mediately below said slot, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said metal lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the metal lower side of the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

7. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said guiding means including an upper railway under said slot and a lower railway below said upper railway, sprockets aligned with the rails of the railways at each end thereof and extending between the levels of said upper and lower railways respectively, and chains linking said cars, extending along said rails and engaged with said sprockets, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the metal lower side of the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

8. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said metal lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through the metal lower side of the base portion of their associated car, spring means urging the lower ends of said rods downwardly from said metal lower side for maintaining said rods under spring-loaded tension.

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9. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said metal lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and end-abutted against said metal lower side and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through to the base portion of their associated car and being tied thereto by spring means for maintaining said rods under spring-loaded tension.

10. In apparatus for firing ceramic articles, a kiln in the form of a straight tunnel, a slot along the bottom of the tunnel, an endless train of tunnel cars, means guiding said cars for movement in upright position along said slot and in inverted position along a return reach immediately below said slot, said guiding means including an upper railway under said slot and a lower railway below said upper railway, sprockets aligned with the rails of the railways at each end thereof and extending between the levels of said upper and lower railways respectively, and chains linking said cars, extending along said rails and engaged with said sprockets, said cars each having a base portion comprising a deck lined on its upper side with ceramic material, said deck having a metal lower side, metal sleeves extending upwardly from said lower side to said ceramic upper side, said deck extending across said slot when the car is in said slot, kiln furniture on each car projecting upwardly into said tunnel when the car is in said slot, the furniture comprising a plurality of ceramic hollow columns received within said metal sleeves and end-abutted against said metal lower side and extending upwardly through said ceramic upper side of said base, a ceramic platform at the top of the columns, the platform having sockets to loosely receive the columns, tie rods extending through the columns and engaged with the platform, the lower ends of the tie rods extending through the metal lower side of the base portion of their associated car, spring means urging the lower ends of said rods downwardly from said metal lower side for maintaining said rods under spring-loaded tension, whereby rod tension is relatively low when said cars are upright and at elevated temperatures within said tunnel and relatively high only when said cars are inverted outside said tunnel and high impact loads are avoided during car inversion.

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