July 9, 1940. W. O. PROUTY 2,207,412

TUNNEL KILN WARE SUPPORT

Filed June 1, 1937 3 Sheets-Sheet 1

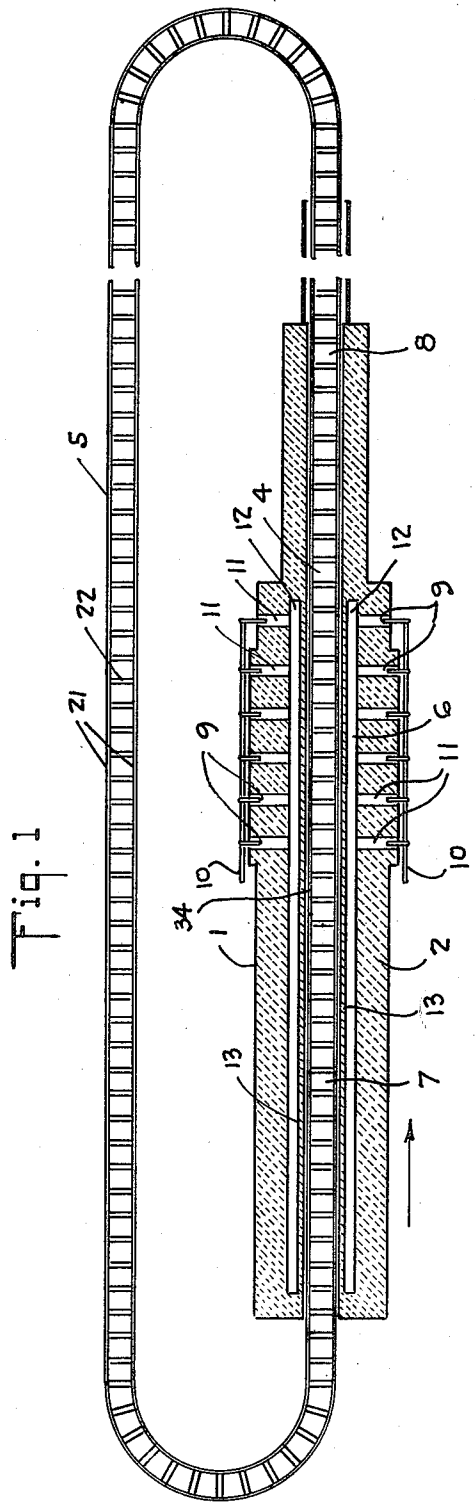



Fig. 1

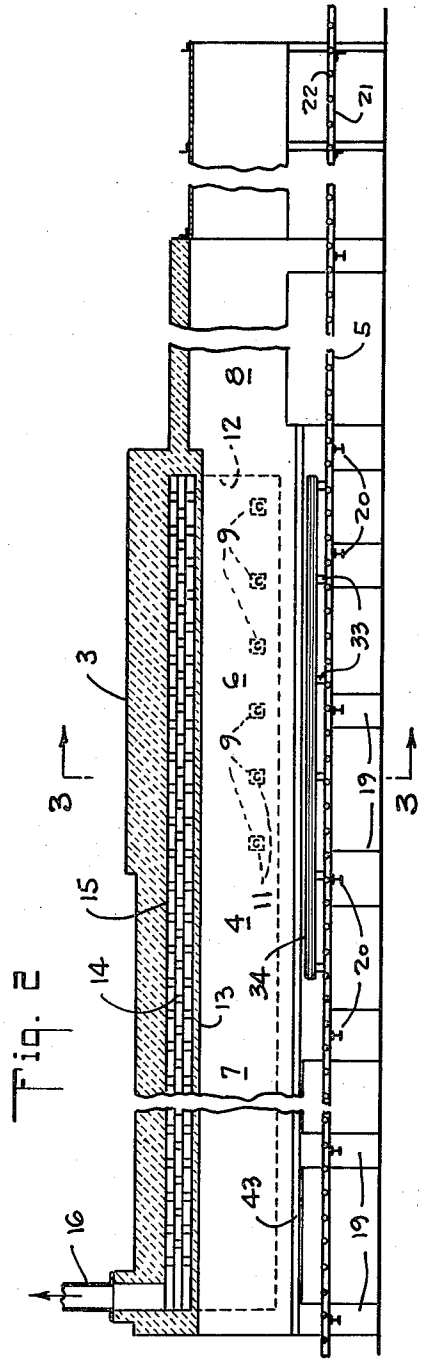



Fig. 2

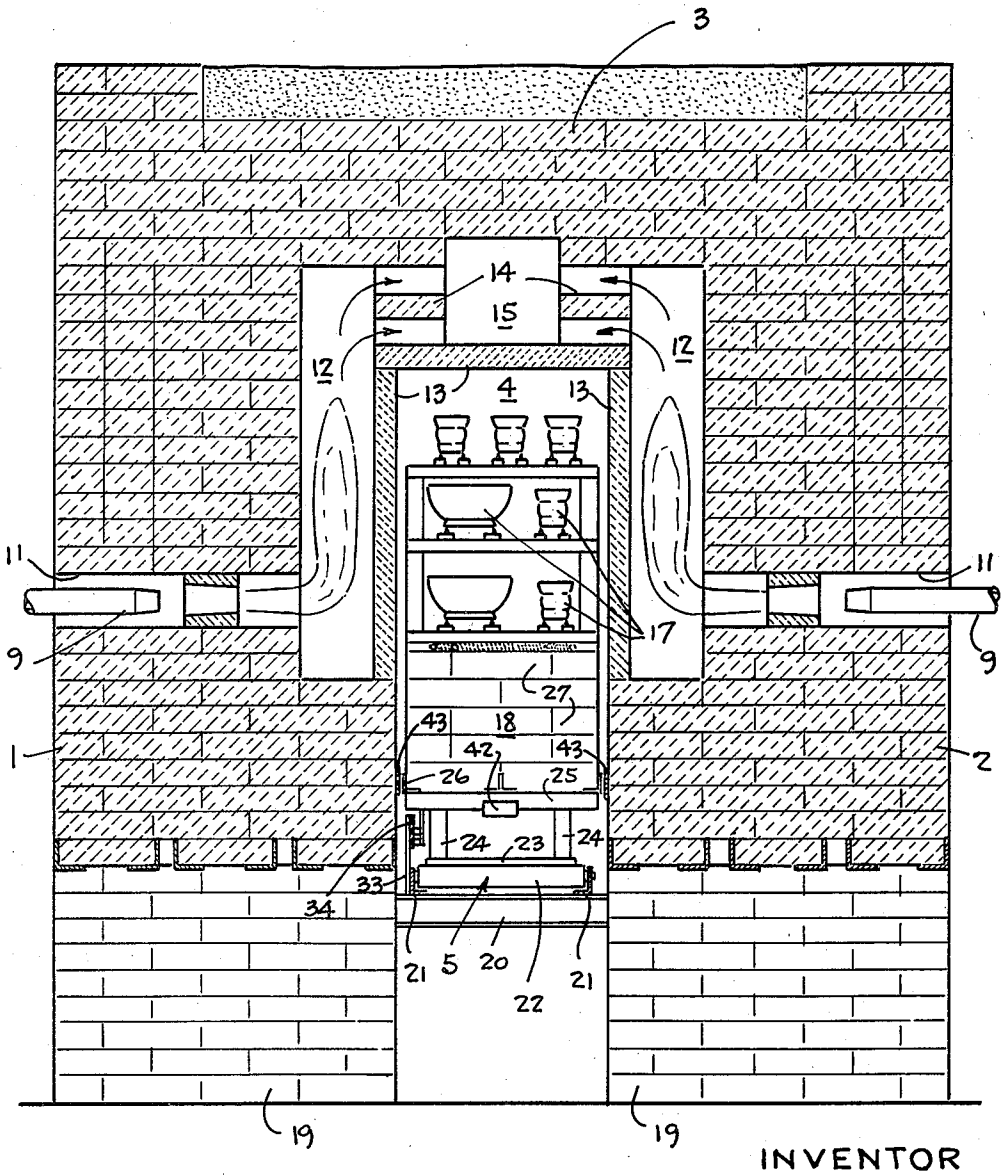
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Fig. 3




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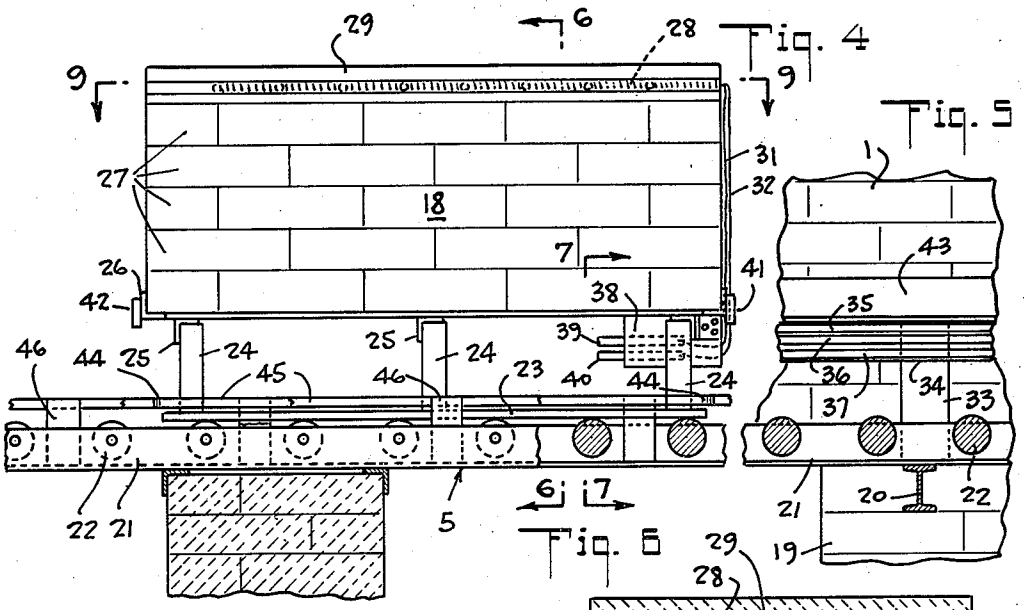



Fig. 4

Fig. 5

Fig. 6

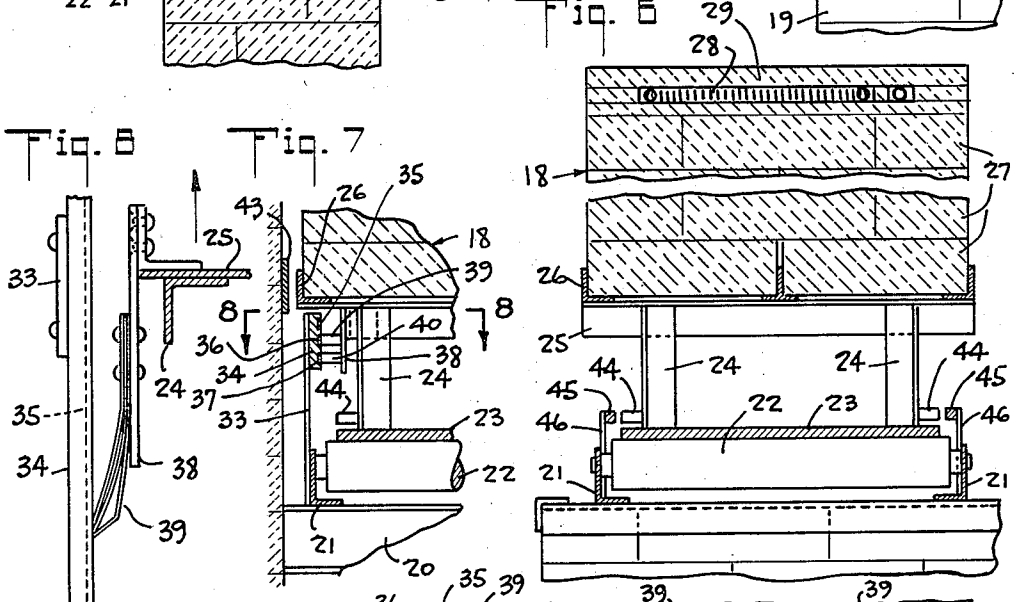



Fig. 8

Fig. 7




Fig. 9

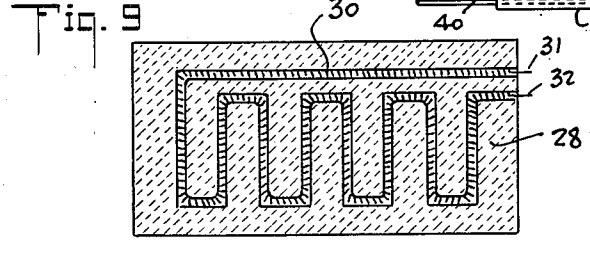



Fig. 10

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# UNITED STATES PATENT OFFICE

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## TUNNEL KILN WARE SUPPORT

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Application June 1, 1937, Serial No. 145,833

2 Claims. (Cl. 25—142)

This invention relates to tunnel kilns, especially for firing ceramic ware.

Continuously operated kilns of this character are now well-known. These kilns are usually provided with full burners, such as oil or gas, to provide heat for the firing zone; this zone is shown in the form of a muffler. The tunnel is extended on both ends of the firing zone to provide a preheating zone and a cooling zone, so that the ware is first gradually heated before it enters the firing zone, and is gradually cooled after its exit therefrom.

The ware is usually stacked on appropriate supports upon movable cars or skids, which are advanced at a definite slow rate through the kiln.

In order to obtain uniformly high grade results, either for making the biscuit or for glazing, it is essential that the heating of the ware in the firing zone be kept as uniform as possible. This presents some problems when, as is usual, the ware is stacked quite deeply in tiers upon the car or skid, since some pieces are more exposed than others. In order to overcome this, it has been customary to direct heaters adjacent the lower portion of the stack, the products of combustion being directly introduced into the tunnel. In this way the products of combustion are intended to rise through the ware.

This expedient is still in many respects unsatisfactory. In practice it has been found that the heating is still far short of uniform. The introduction of the products of combustion directly into the tunnel is also undesirable.

It is one of the objects of this invention to obviate these disadvantages. More particularly, this object is attained by utilizing electrical energy as a source of heat supplemental to the usual fuel consuming sources.

It is another object of the invention to make it possible to place this supplemental source of heat where it is most effective to equalize the temperature, and particularly by arranging the source on the moving support (such as a skid or car). In this way, the heat actually generated is dependent upon the presence of the support in the heating or firing zone; and there is little wasted heat by radiation, conduction or convection.

It is still another object of this invention to improve in general the construction and operation of tunnel kilns of this character.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawings accompanying and forming part of the present specification. This form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 represents a tunnel kiln that incorporates the invention, shown in horizontal section, and a runway associated therewith;

Fig. 2 is a vertical sectional view of the kiln, the kiln being shortened in order to reduce the size of the figure;

Fig. 3 is an enlarged transverse sectional view taken along plane 3—3 of Fig. 2, but showing the tunnel kiln in use;

Fig. 4 is an elevation of a portion of the runway and a movable ceramic ware support thereon;

Fig. 5 is a fragmentary view illustrating the inside of the kiln passageway;

Fig. 6 is a transverse sectional view taken along plane 6—6 of Fig. 4;

Fig. 7 is a fragmentary view similar to Fig. 6, illustrating the manner in which the electrical connections may be obtained;

Fig. 8 is a detail section taken along plane 8—8 of Fig. 7;

Fig. 9 is a horizontal sectional view taken along plane 9—9 of Fig. 4; and

Fig. 10 is a diagram illustrating the manner in which a three-phase source of electrical energy may be utilized to energize the electrical heater.

The tunnel kiln is best illustrated in Figs. 1, 2 and 3. Brick work may be provided to form the sides 1, 2, and top 3. In this way a central longitudinal passageway 4 is formed through which the runway structure 5 (Fig. 1) extends.

The tunnel kiln may be provided, as is usual, with a firing zone 6, a preheating zone 7, and a cooling zone 8. The heating is shown in the present instance as secured by a pair of banks of fuel burners 9, fed with fuel as by the manifolds 10. These burners extend from the outside into the horizontal transverse apertures 11 in the walls 1 and 2. The products of combustion are conducted into the chambers 12 separated from the passageway 4 into the preheating zone 7, so as to transfer some heat to this zone, from the hot products of combustion. But the most intense heat is secured adjacent the burners 9, thus providing the firing zone 6.

The two longitudinal chambers 12 serve as passages for the hot products of combustion around and over the muffle formed by the brick work 13. These gases emerge through the brick checker work 14 into the top longitudinal passageway 15 connecting to the stack 16 (Fig. 2) shown adjacent the entrance region of the kiln.

The firing zone 6 is thus intensely heated by the conduction of heat through the walls 13 of the passageway 4. The products of combustion do not enter into this passageway 4, the heating being accomplished primarily by conduction.

In Fig. 3, there is diagrammatically illustrated a stack of a plurality of layers of ceramic ware 17 arranged on a supporting structure 18 adapted to be moved at a slow rate through the passageway 4.

The runway 5 upon which the supports 18 are moved through the kiln is supported by the aid of the brickwork piers 19 upon which the tunnel kiln as a whole is supported. Thus extending transversely across the lower portion of opening 4 and anchored within the piers 19 are a plurality of girders, such as the I-beams 20 (Figs. 2, 3 and 5). These I-beams in turn support the longitudinal channel members 21. These channel members are disposed with vertical legs in which are pivotally mounted a plurality of supporting rollers 22. They are quite closely spaced as indicated in Figs. 4 and 5, so as to form a rolling runway for the supports 18.

The structure of these supports may now be set forth. They are in the form of rectangular cars which may be placed end to end and pushed at a slow rate through the tunnel kiln in any appropriate manner, so as to subject the ware stacked thereon to the heating action of the kiln.

The support 18 comprises a bottom plate member or skid 23 adapted to rest upon and to roll upon the rollers 22. Projecting upwardly from the skid 23 are a number of uprights 24, there being six indicated in the present instance. These uprights 24 may be formed of angle irons; and corresponding transverse horizontal angle irons 25 may be provided to form a support for the framework 26. Upon this framework 26 there may be supported deep layers of refractory material to serve as a heat insulation between the substructure of the support and the interior of the kiln. This refractory material may be in the form of a plurality of layers of brick 27.

As illustrated most clearly in Fig. 3, this brick work 27 forms the bottom wall of the passageway 4 while the support 18 is disposed therein. Upon the top of the material 27 may be disposed the racks or other supporting elements upon which the ceramic ware 17 is stacked.

It is essential that during the firing operation, that is, while the support 18 is moved through the firing zone 6, the heat imparted to the ware 17 should be as uniform as possible. It has been customary in the past to attempt to effect this result by directly burning fuel in the lower portion of the passageway 4. In this way it was hoped that the lower portion of the stack of ceramic ware would have sufficient heat imparted to it to equalize the temperature through the stack. However, it was difficult of attainment because there is no reasonably certain way of controlling the heating, or distributing it.

By the aid of the present invention, the stack of ceramic ware 17 is heated from below by a supplemental source of heat. For this purpose a heater is carried by each support 18. For example, the heater may take the form of an electrical heating unit 28 disposed on top of the brick work 27, so as to be in good heat conducting relationship with the top 29 upon which the stack of ceramic ware is disposed. The structure of the heater is shown most clearly in Fig. 9. It may comprise a long helix of resistance wire 30 embedded in the body of the heater 28 and having the two terminals 31 and 32. The body of the heater may be conveniently formed of a ceramic refractory molded material.

It is thus seen that the supplemental heating can occur only when a support 18 is present within the passageway 4. Furthermore, contacting devices are so arranged that the electrical heaters on the supports 18 are energized only during the presence of the supports 18 in and near the firing zone 6.

For this purpose use is made of a series of bus bars illustrated most clearly in Figs. 1, 2, 5, 7, 8 and 10. These bus bars are supported along the sides of the passageway 4 by the aid of the upright supporting members 33. These supporting members may be fastened on one of the vertical legs of the angle iron 21. These uprights 33 in turn support a long strip 34 of insulation material, such as Bakelite. Inlaid within this material are the three parallel bus bars 35, 36 and 37 forming the three mains of a three-phase system and appropriately connected to an external source of electrical energy. These bus bars, as indicated in Figs. 1 and 2, extend slightly beyond the firing zone and into the preheating zone 2.

Each of the movable supports 18 carries a pair of brushes adapted to contact with two of the three bus bars 35, 36 and 37 so as to conduct electrical energy to the corresponding heater unit 28. This brush construction is illustrated most clearly in Figs. 4, 7 and 8. Thus a supporting member 38 of refractory insulation material is fastened to the framework on the support 18. A pair of laminated brush structures 39 and 40 are fastened to the support 38 and are urged resiliently against a pair of the bus bars 35, 36 and 37. As illustrated in Fig. 10, these two brushes 39 and 40 are appropriately spaced apart in a vertical direction so that they may contact with a chosen pair of bus bars. Thus the pair of brushes 39 and 40 at the left hand end of Fig. 10 are arranged to contact the bus bars 35 and 37. The brushes 39 and 40 in the center portion of Fig. 10 are arranged to contact with the bus bars 36 and 37. The brushes 39 and 40 at the right hand end of Fig. 10 are arranged to contact bus bars 35 and 36. Since there is a succession of supports 18 pushed through the tunnel kiln, the brushes 39 and 40 on each of them may be arranged in succession to correspond with the arrangement shown in Fig. 10, whereby the three-phase load is balanced.

The supports 18 are preferably provided with front and rear bumpers 41 and 42. They may also be arranged to be guided within the passage 4 as by the aid of the side bumper strips 43 (Fig. 2). These bumper strips 43 are disposed opposite the bottom frame 26 of the supports.

Immediately above the skids 23 of each of the supports 18, there are provided a pair of longitudinal guard bars 44 (Figs. 4 and 6). These bars 44 are confined against undue lateral motion by the guide rails 45 supported upon the runway 5, as by the upright supports 46.

What is claimed is:

1. In combination with a muffle fired tunnel kiln having a preheating zone, a hot zone and

a cooling zone, a ceramic ware support adapted to be moved through the kiln, an electric heater carried by the support, a bus bar supported within the tunnel, and a contact means carried by the support and cooperating with the bar to supply electrical energy to the heater, said bus bar extending substantially the length of the hot zone, whereby the heater is energized only when the support is within said zone.

2. A ceramic ware support for use in a tunnel kiln, comprising a super structure, and a skid with a flat lower surface, said superstructure including a frame mounted on the skid and supporting a body of refractory material, and heating means supported by said body near its upper surface.

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