Jan. 25, 1927. 1,615,217

P. D'H. DRESSLER

TUNNEL KILN HEATING MEANS

Filed April 26, 1926 2 Sheets-Sheet 1

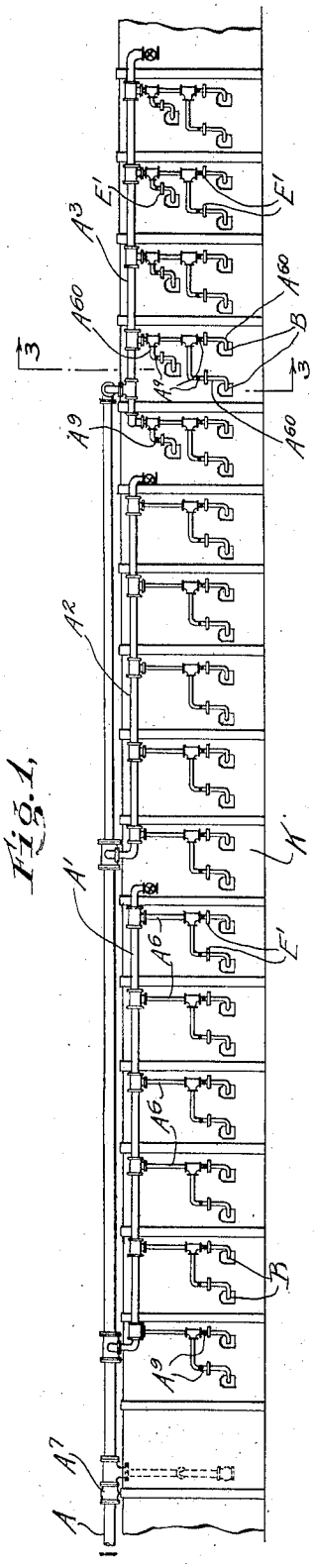


Fig. 1.

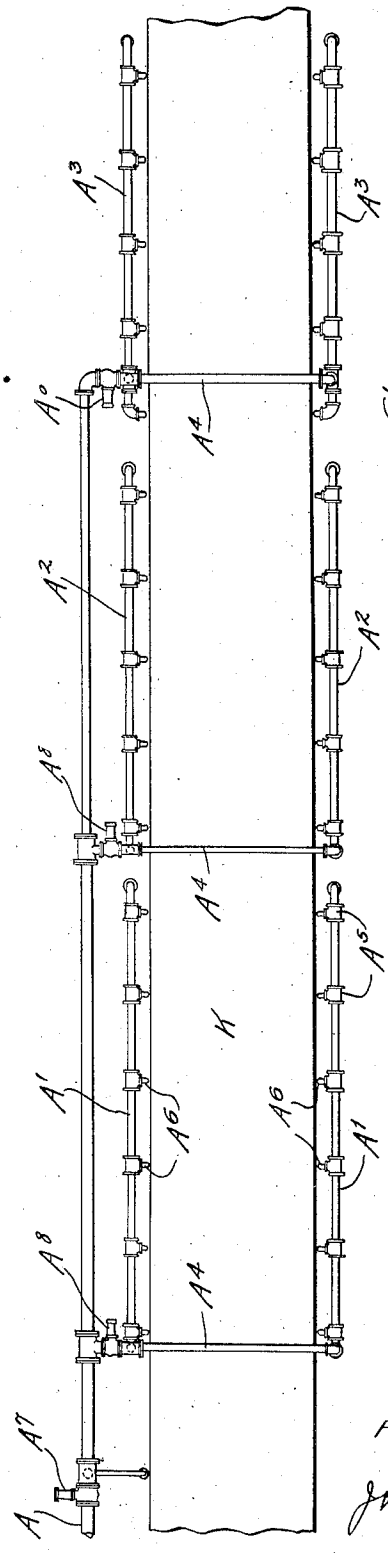


Fig. 2.

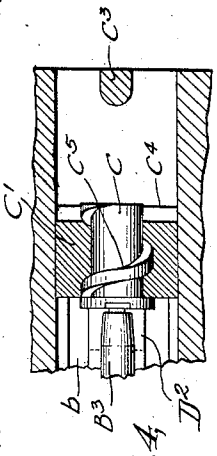


Fig. 4.

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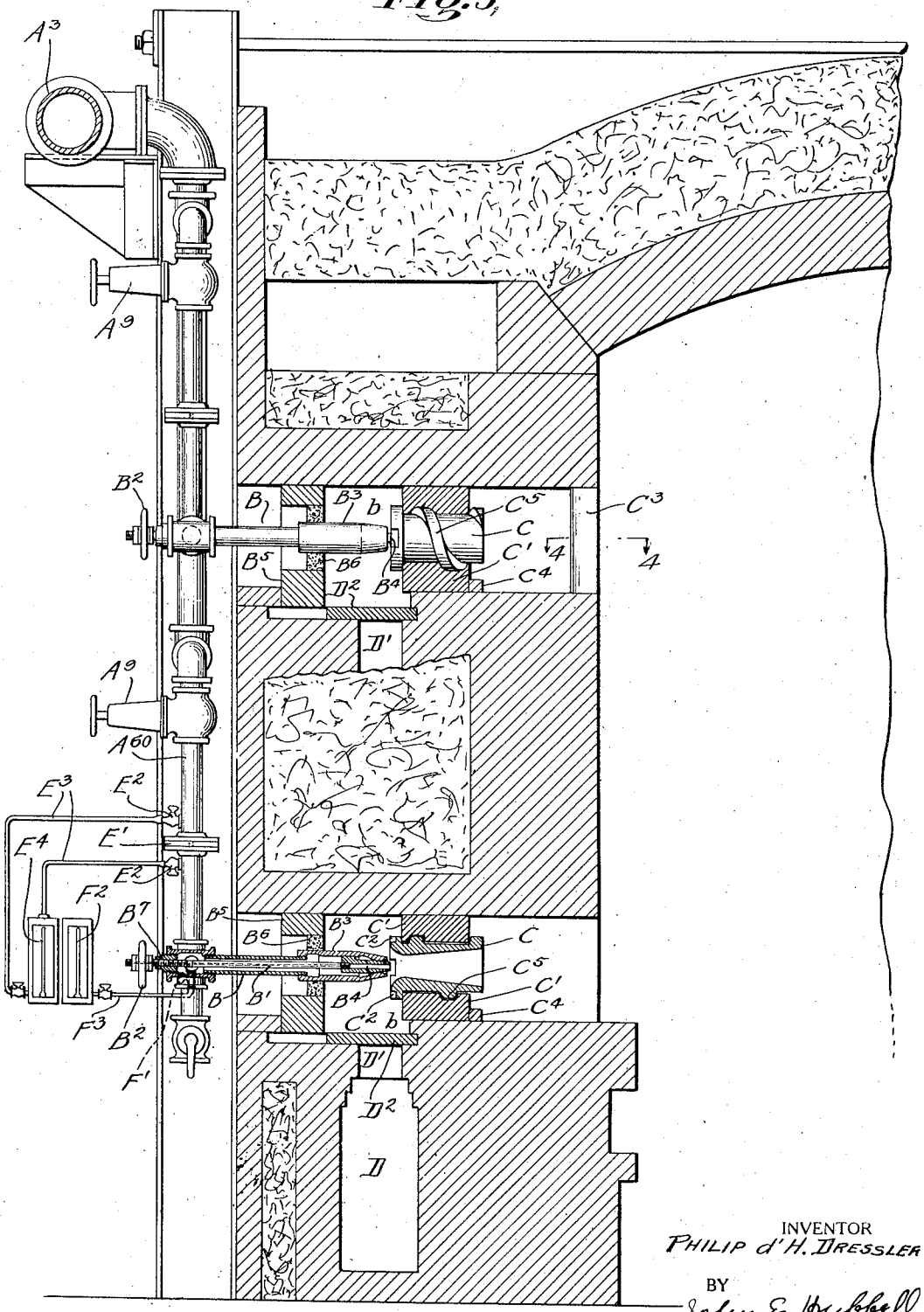
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Fig. 3.



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UNITED STATES PATENT OFFICE.

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TUNNEL-KILN-HEATING MEANS.

Application filed April 26, 1926. Serial No. 104,548.

The general object of my present invention is to provide improved heating means for kilns, and more specifically to provide improved means for heating a continuous tunnel kiln by the combustion of fluid fuel and air supplied to an injection type of fuel burner at a relatively high temperature.

Another and more specific object of the invention is to provide simple and effective means for regulating the operation of a multiplicity of fluid fuel burners distributed longitudinally of the kiln along a portion thereof of considerable length. In the type of kiln to which the invention pertains, the number of separate burners required are too great to make it practically feasible to separately adjust each individual burner whenever changes in the general rate of heat supply to the kiln, or changes in the relative rates of heat supply to different portions of the kiln are required.

In accordance with the present invention, I connect the burners to the fuel supply means in separately regulable groups, each of which includes the burners distributed along a relatively short section of the kiln in which regulation requirements are ordinarily satisfied by a similar simultaneous adjustment of the fuel supply to the corresponding burners, I preferably provide means whereby the rate of fuel supply to all the burners may be simultaneously adjusted, and I also preferably provide individual regulating provisions for the different burners, for such adjustment of the latter as may be required in starting the kiln into operation, or as may be required from time to time to meet changing conditions of operation.

The invention is of especial value when the burners are of the injection type of my prior application Serial No. 730,179, filed August 5, 1924, wherein the fluid fuel supplied by each burner acts as an impelling agent to carry into the combustion chamber the proper amount of preheated air for combustion of the fuel. The present invention also comprises an improvement in the burner construction proper, facilitating the regulation of the ratio of combustion air to fuel supplied by each burner.

The various features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, however, and the advantages possessed by it, reference should be had to the accompanying drawings and descriptive matter in which I have illustrated and described a preferred embodiment of the invention.

In the drawings:

Fig. 1 is a side view of a portion of a tunnel kiln;

Fig. 2 is a plan view of the kiln shown in Fig. 1;

Fig. 3 is an enlarged section on the line 3—3 of Fig. 1; and

Fig. 4 is a partial section on the line 4—4 of Fig. 3.

In the drawings, K represents a continuous tunnel kiln of the open fire heated type, though the preheating zone of the kiln may contain muffle heating provisions of the character disclosed in my prior Patent No. 1,360,625, granted November 30, 1920, into which the products of combustion from the firing zone of the kiln are withdrawn to prevent their contact with the ware during an initial stage of the ware heating process. Distributed along the elongated firing zone portion of the kiln are fluid fuel burners B which supply fluid fuel, usually and preferably, though not necessarily, clean producer gas, to burner chambers b into which preheated air is drawn by the aspirating or injection effect of the fuel jets discharged by the burners B as hereinafter described.

The fluid fuel is supplied to the burners B by a fuel supply piping system which, as shown, comprises a supply main A, and separately regulable branches therefrom each supplying fuel to a group of burners B distributed along the length of a corresponding section of the firing zone of the kiln. As shown, there are three pairs of branch pipes A', A^2, and A^3, the pipes of each pair being connected to the main A by a transverse branch pipe A^4 receiving gas from the main through a corresponding regulating valve A^8. The two pipes A' supply fuel to the burners B at the opposite sides of the pre-

heating or low temperature end portion of the firing zone. The two pipes A^2 supply fuel to the burners at the opposite sides of an intermediate section of the firing zone, while the pipes A^3 supply fuel to the burners at the opposite sides of the high temperature end portion of the firing zone. Each burner B is connected to the corresponding branch pipe A', A^2, or A^3 by an individual pipe A^{60} containing a regulating valve A^9. The pipes A^{60} of two or three adjacent burners are shown as connected to the corresponding branch pipe A', A^2, or A^3 through a single branch A^6. A valve A^7 in the supply main forms a means for regulating the total amount of fuel supplied to the burners.

In the preheating and intermediate sections of the firing zone, the fuel burners B are shown as all arranged at the level adjacent the bottom of the goods pathway through the kiln, and preferably so that they may discharge directly into the usual transverse channels formed in the refractory kiln car bodies just beneath the ware supporting platforms of the cars which are perforated to permit the heating gases to pass upward into the goods supported on the platform. Advantageously, the burners are so arranged and operated that the opposing jets of burning fuel and products of combustion discharged into the kiln from its opposite sides will impinge at the center of the kiln and the heating gases will largely pass upward through the central portion of the stacks of ware carried on the cars.

In the high temperature portion of the firing zone, burners B are arranged at the level of the bottom of the kiln chamber as in the preheating and intermediate sections, and in addition other burners B are provided at a higher level to project the burning jets discharged against the sides of the ware stacks. Where the character of the ware makes violent flame impingement against the kiln undesirable, deflectors C^3 are provided in the inner ends of the corresponding burner chambers B, as shown in Figs. 3 and 4.

The various burner chambers *b* and associated burner parts may be all similar in construction and arrangement. Each burner chamber *b* as shown, is in the form of a horizontally extending channel in the masonry side wall of kiln chamber to which the burner chamber opens at its inner end. The air for combustion, which is preferably preheated and may be drawn from the cooling zone or from a recuperator, is supplied to the burner chambers *b* through longitudinal flues D located one in the lower portion of each side wall of the kiln chamber. Each burner chamber *b* is connected to the corresponding flue D by a port D' which may be closed by a damper D^2 when the corresponding burner chamber is out of use. A partition is formed across each burner chamber between its end open to the kiln chamber and the corresponding port D'. As shown, this partition is formed by a block C' which is formed with a passageway receiving a nozzle member C. The latter has a Venturi shaped nozzle passage and is mounted in the block C' in a manner permitting the adjustment of the nozzle part C in the axial direction of its nozzle passage. To facilitate this adjustment, the nozzle part C is formed with an external thread C^5 of coarse pitch received in a thread groove formed in the block C'. The nozzle part C is formed with notches C^2 in its outer end for engagement by a forked hook or the like, which may be used to rotate the nozzle part C in its seat and thereby axially adjust said nozzle part.

Each burner B comprises a tubular body to the inner end of which is secured a nozzle part B^3 which is coaxial with the nozzle part C. The nozzle part B^3 passes through a refractory bushing B^6 removably seated in a passageway in a block B^5 which extends across the burner chambers *b* at the outer side of the corresponding port D'. By removing the burner and the bushing B^6, ready access to the nozzle part C is provided. Within the nozzle part B^3 which is tapered at its end, is a conical part B^4 which acts like a needle valve to vary the size of the annular orifice between the part B^4 and the nozzle part B^3 through which the gas is discharged and thereby regulate the velocity of the jet discharged. As shown, the part B^4 is secured to the end of a tubular stem B' and is formed with an axial passage in register with the bore of the tube B'. The tube B', which may or may not normally have its outer end closed, serves as a peep sight through which the operation of the burner may be inspected, and may also serve to supply a small amount of atmospheric air to the interior of the burning jet discharged from the burner in order to quicken combustion. The outer end portion of the tube B' is threaded through a bushing B^7 closing the outer end of the fitting part through the burner body is connected to the corresponding supply connection A^{60}. A hand wheel B^2 secured to the outer end of the tube B' forms a convenient means for rotating the tube B' and thus adjusting the part B^4 axially of the nozzle part B^3. The nozzle parts B^3, B^4, and C may be made of fire clay, carborundum, or like non-metallic refractory material, though advantageously the parts, and particularly the parts B^3 and B^4, are made of highly refractory metals, as this permits of a more accurate construction and the use of higher gas pressures without objectionable gas leakage.

With the described arrangement, each

nozzle C forms the mixing nozzle of an injector in which the impelling action of the fuel discharged through the burner nozzle part B^3 acts to draw air from the flue D and to discharge it with the fuel into the kiln chamber through the nozzle C. The aspirator or injection effect of the parts depends upon the quantity of the fuel discharged through the nozzle B^3, the velocity of jet discharged, the latter being a joint function of the quantity of fuel discharged and of the cross sectional area of the annular passage between the nozzle parts B^3 and B^4, and upon the relative axial adjustment of the parts B^3 and C. All of these factors governing the injection action of each burner are adjustable by means of the regulating provisions already described.

With the described arrangement, the general rate of heat supply to the kiln may be varied by the adjustment of the valve A^7. The relative amounts of fuel supply to the preheating, intermediate and high temperature sections of the firing zone of the kiln may be varied as conditions make desirable by suitable relative adjustments of the various valves A^8. The relative performance of the different burners supplied with fuel through each valve A^8 may be varied by proper adjustments of the corresponding valve A^9 and by the adjustment of the corresponding burner parts B^4. In general, however, I prefer to adjust the parts B^4 with the idea of controlling the velocity of the jet discharged rather than of controlling the amount of fuel discharged by the jet. In the initial adjustment of the burners care should be taken to adjust the parts B^4 and the mixing nozzle part C and the valve A^9 to insure an injection or aspirating effect which will draw into each burner chamber *b* the air required to maintain an approximately constant air fuel ratio with the varying rates of fuel supply which may thereafter result from the required adjustments of the valves A^7 and A^8.

Since the aspirating effects of each burner may be independently varied, it is possible to maintain a much higher air fuel ratio with some burners than with others. This is of advantage; for example, in burning various clay products it may well be desirable to maintain a strongly oxidizing atmosphere in the preheating section of the firing zone, a neutral atmosphere in the intermediate section of that zone, and a reducing atmosphere in the high temperature section of the zone.

To facilitate the initial adjustment of each burner and such readjustments thereof as may be necessary from time to time, I provide means for determining the fuel pressure in each burner when the burner is passing fuel at some definite rate, since with any given rate of fuel supply to a burner, the fuel pressure within the burner depends upon the adjustment of the burner nozzle part B^4 and determines the corresponding jet velocity. To facilitate such determinations, I provide an apertured measuring orifice disc E′ in each of the individual burner supply connections A^{60}, and connect a cock E^2 to the pipe A^{60} at each side of the measuring orifice so that the pressure drop through the measuring orifice and thereby the gas flow through the latter may be readily measured by a manometer or differential pressure gage E^4 having the usual rubber tubes E^3 for detachable connection to the cocks E^2. To measure the fuel pressure at the burner, I attach to the latter, or to the adjacent piping, a cock F′ to which a manometer or gage F^2 may be readily connected as by means of a rubber tube F^3 so that the difference between the fuel pressure in the burner and the pressure of the atmosphere may be measured. The manometers or gages E^4 and F^2 may well be of the mercury sealed U-type, and may be mounted on a convenient stand or support to facilitate their movements required for the measurement of conditions at the different burners.

With the producer gas as a fuel, the gas and combustion air will be of substantially similar volumes. When a fuel gas of higher B. t. u. value is used, the volume of combustion air will be substantially greater than the volume of fuel gas, and in this case it may be desirable to premix a portion of the required combustion air with the gas supplied through the main A in order to reduce the aspirating effect otherwise needed to secure the proper air-gas ratio at each burner.

Those skilled in the art will realize that the invention provides desirable and practically feasible means for a desirably close regulation of the multiplicity of burners required in a kiln of the type disclosed.

The present invention is an improvement on the invention disclosed in my co-pending application Serial No. 730,179. Features of novelty disclosed but not claimed in this application are claimed in my said prior application, Serial No. 730,179.

While in accordance with the provisions of the statutes, I have illustrated and described the best form of embodiment of my invention now known to me, it will be apparent to those skilled in the art that changes may be made in the form of the apparatus disclosed without departing from the spirit of my invention as set forth in the appended claims, and that in some cases certain features of my invention may be used to advantage without a corresponding use of other features.

Having now described my invention, what I claim as new and desire to secure by Letters Patent, is:

1. In an open fired tunnel kiln, a multiplicity of burners distributed longitudinally

of the kiln, and fuel supply piping comprising a plurality of separately regulable branches to which said burners are connected in groups, each of which includes a plurality of burners connected to a single one of said branches and distributed along a section of the kiln longitudinally displaced from the sections to which the other burner groups pertain.

2. In an open fired tunnel kiln, a multiplicity of burners distributed longitudinally of the kiln, and fuel supply piping comprising a plurality of separately regulable branches and separately regulable connections to the various burners through which the latter are connected to said branches in groups, each of which includes a plurality of burners connected to a single one of said branches and distributed along a section of the kiln longitudinally displaced from the kiln sections to which the other burner groups pertain.

3. In an open fired tunnel kiln, a series of burners distributed longitudinally of the kiln, fuel supply piping to which burners are connected in groups, said piping comprising a separate branch supply pipe for each burner group, separate supply pipes from each branch supply pipe to the individual burners of the corresponding group, and a regulating valve in each of said pipes.

4. In an open fired tunnel kiln, a multiplicity of fuel burners distributed longitudinally of the kiln, a fuel supply pipe to each of said fuel burners, means controlling the supply of fuel to all said pipes, and means regulating the supply of fuel through each of said pipes.

5. In an open fired tunnel kiln, a heating system comprising a plurality of burners, a main fuel supply piping, branch supply pipes from said main fuel supply each connected to a separate group of fuel burners, and valves in said main fuel supply piping and branch supply pipes whereby the fuel supply to the several groups of burners may be varied simultaneously or independently.

6. In an open fired tunnel kiln, a series of burners, a main fuel supply pipe, separate branch fuel supply pipes, a series of pipes leading from each branch pipe to a corresponding series of burners, and a valve in each of said pipes whereby the burners may be controlled independently, in groups, or simultaneously.

7. In an open fired tunnel kiln, a main fuel supply piping, a plurality of groups of longitudinally distributed fuel burners, branch supply pipes leading from said main to said groups, and valves in said branch supply pipes whereby the fuel burners in each group may be controlled simultaneously.

8. In an open fired tunnel kiln, a series of fuel burners distributed longitudinally of the kiln, fuel supply pipes to the burners, a control valve and a measuring orifice in each supply pipe, and manometer connections to each pipe on the opposite sides of said orifice whereby the amount of fuel passing to each burner may be controlled and measured.

9. In an open fired tunnel kiln, a series of burners distributed longitudinally of the kiln, fuel supply pipes to the burners, a control valve and a measuring orifice in each supply pipe, and manometer connections to each supply pipe for measuring the difference in pressures at opposite sides of the orifice therein and for measuring the static pressure at the burner side of said orifice.

10. In an open fired tunnel kiln, a burner chamber opening to the kiln chamber, an air inlet to said burner chamber, a refractory wall across said chamber between the air inlet and kiln chamber, a nozzle tube threaded in and opening through said wall, and a fuel supply nozzle mounted in the outer portion of said chamber and adapted to discharge a fuel jet into the outer end of said tube.

11. In an open fired tunnel kiln, a fuel burner chamber opening to the kiln chamber, an air inlet to said burner chamber, a refractory wall across said chamber between the air inlet and kiln chamber, a refractory nozzle tube opening through and axially adjustable in said wall, and a fuel supply nozzle adapted to discharge a fuel jet into the outer end of said tube.

12. In an open fired tunnel kiln, a burner chamber opening to the kiln chamber, an air outlet to said burner chamber, a removable refractory body in said burner chamber between the air inlet and kiln chamber, a refractory nozzle tube threaded in and opening through said body, and a fuel supply nozzle adapted to discharge a fuel jet into the outer end of said tube, said tube having provisions at its outer end to facilitate its rotation to vary the relative positions of said nozzle and tube.

13. In an open fired tunnel kiln having a burner chamber in its side wall, a refractory body normally fixed in position in said burner chamber, and an injection burner comprising a mixing nozzle tube threaded into said refractory body.

14. The combination in an open fired tunnel kiln formed with a burner chamber in its side wall, of a refractory body with a mixing nozzle opening therein to said burner chamber, said body being adjustable longitudinally of said burner chamber, with a fuel supply nozzle of heat resisting metal in said chamber concentric with the mixing nozzle opening.

15. The combination in an open fired tunnel kiln formed with a series of burner chambers in the side wall of the kiln cham-

ber, of fuel supply nozzles located in said burner chambers, fuel supply pipes leading to said nozzles, means for controlling the fuel supply in said pipes, independent means for registering the pressure and volume of the fuel in each pipe, and means for varying the fuel discharge pressure in each nozzle, whereby the relative fuel rates of fuel supply by said nozzles may be accurately regulated.

Signed at New York city, in the county of New York, and State of New York, this 16th day of April, A. D. 1926.

PHILIP D'HUC DRESSLER.