Sept. 23, 1924. 1,509,195

C. DRESSLER

TUNNEL KILN

Original Filed Oct. 28, 1919 4 Sheets-Sheet 1

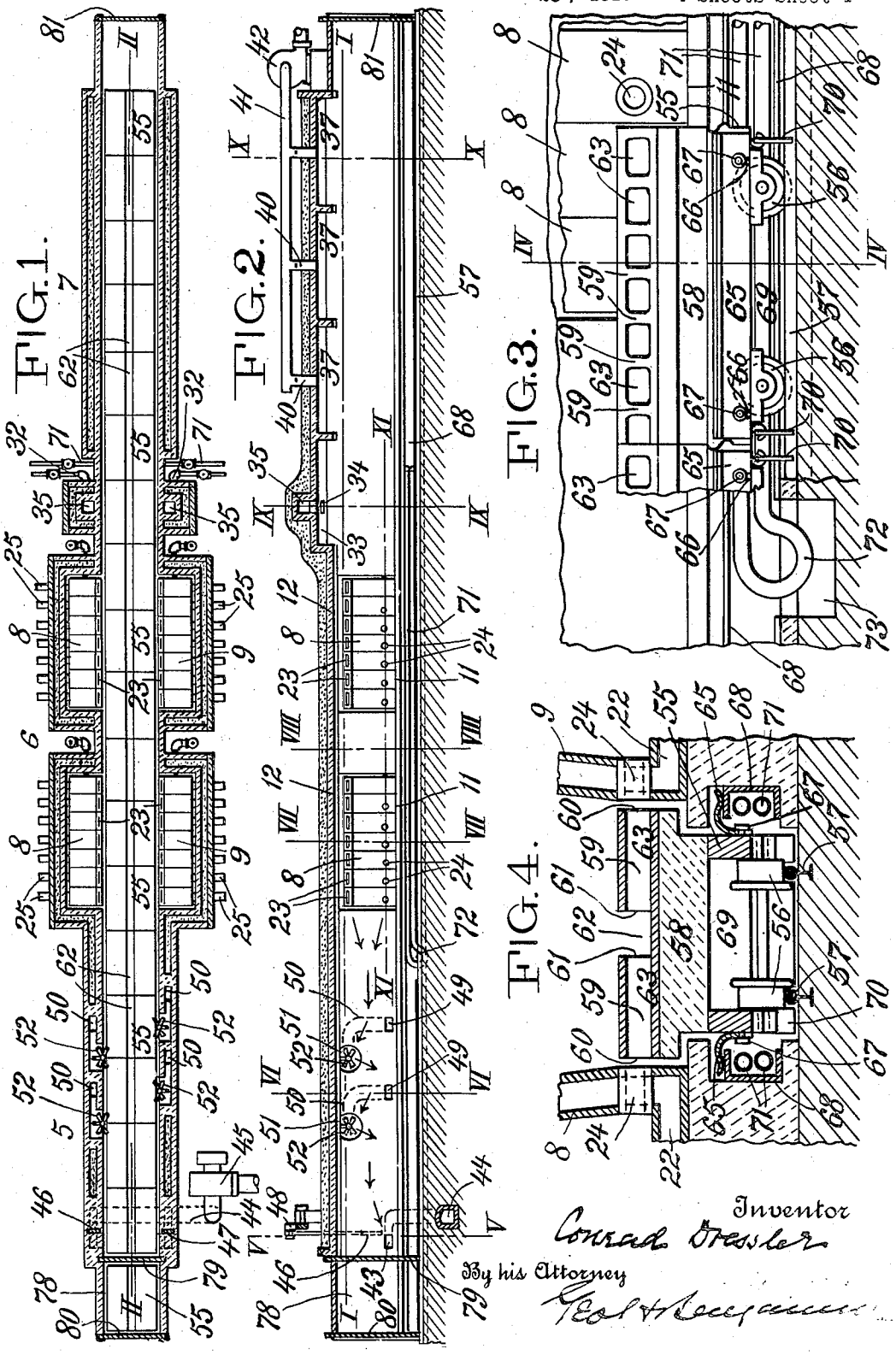

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FIG. 7.

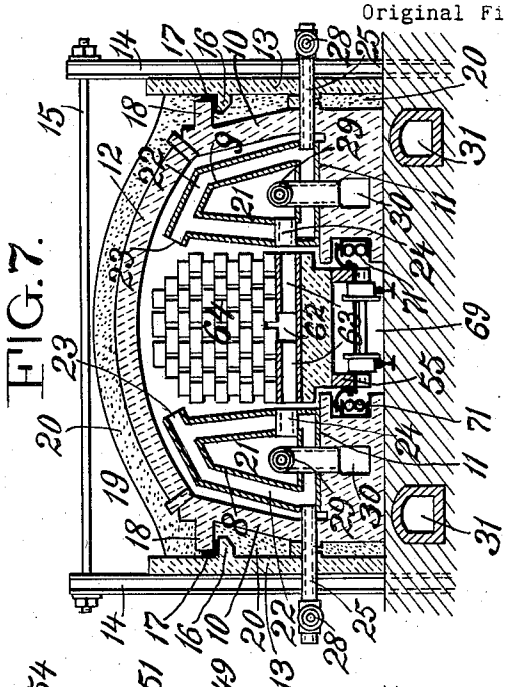

FIG. 10.

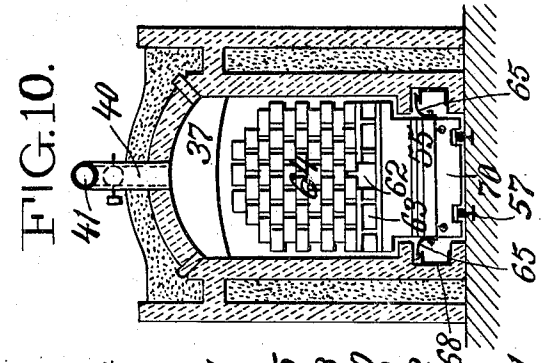

FIG. 6.

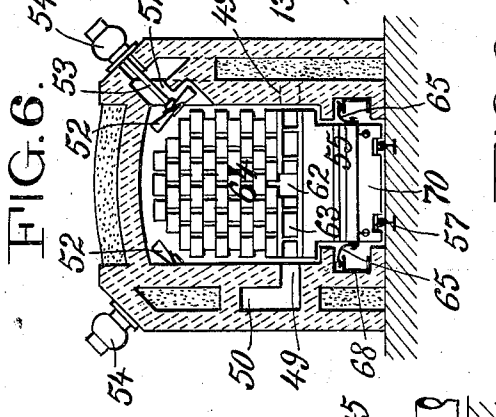

FIG. 9.

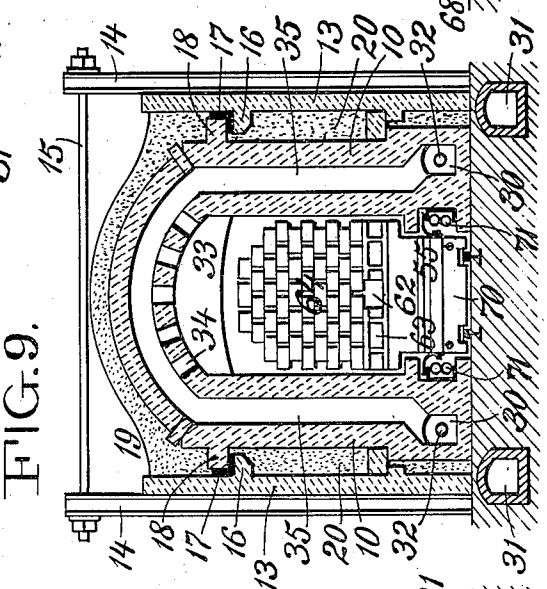

FIG. 5.

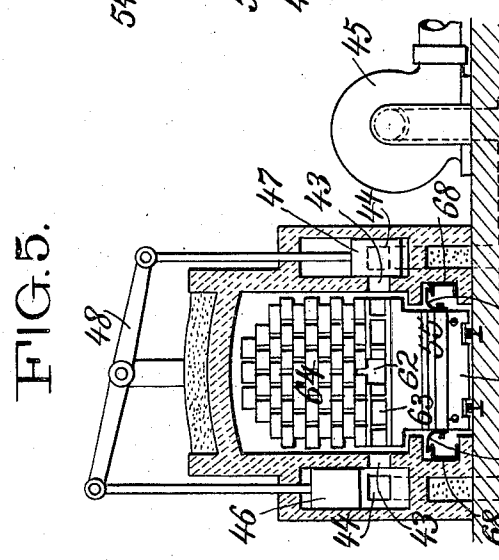

FIG. 8.

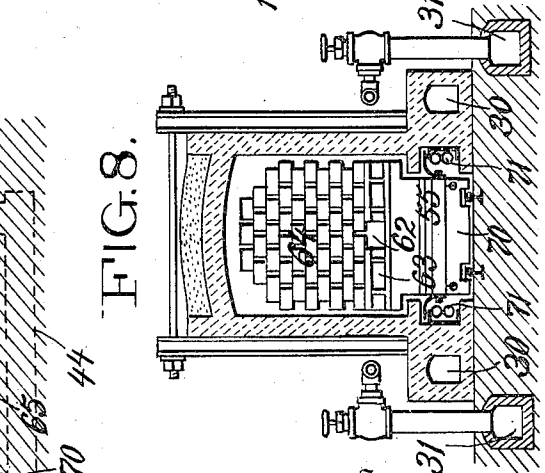

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FIG. 11.

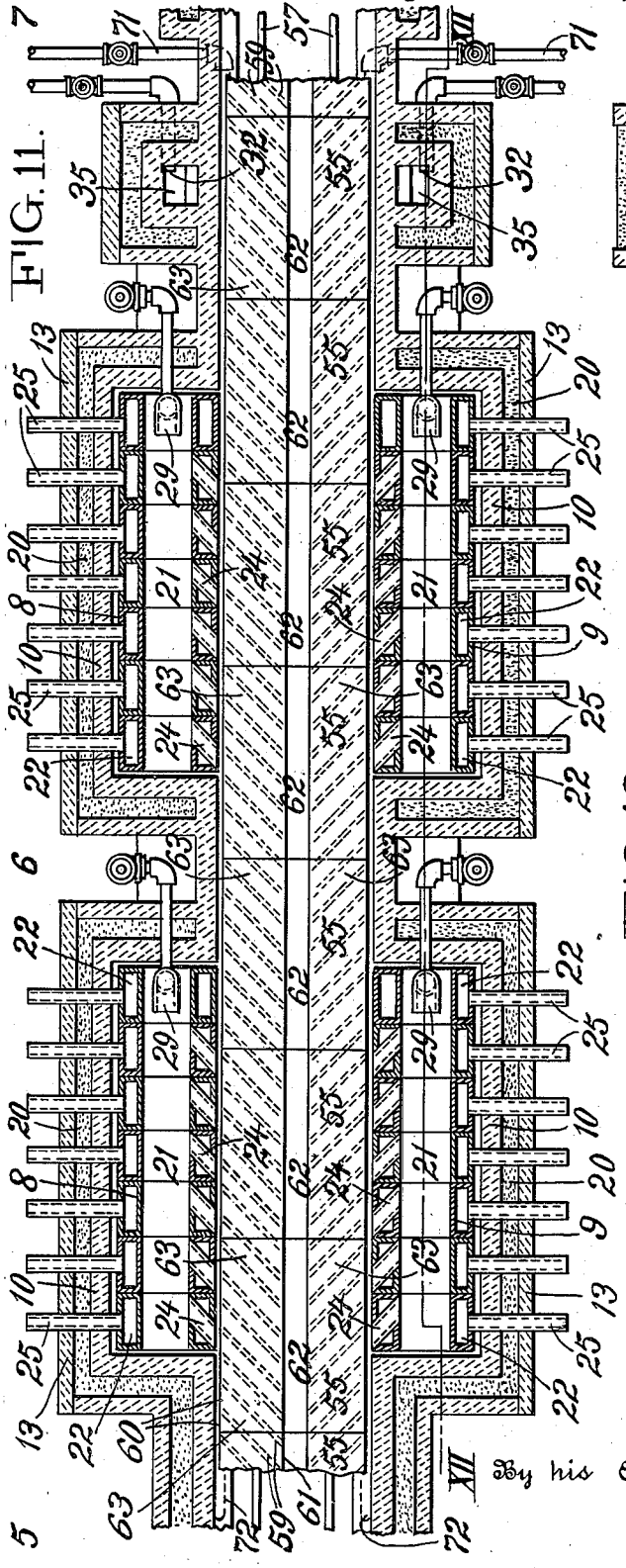
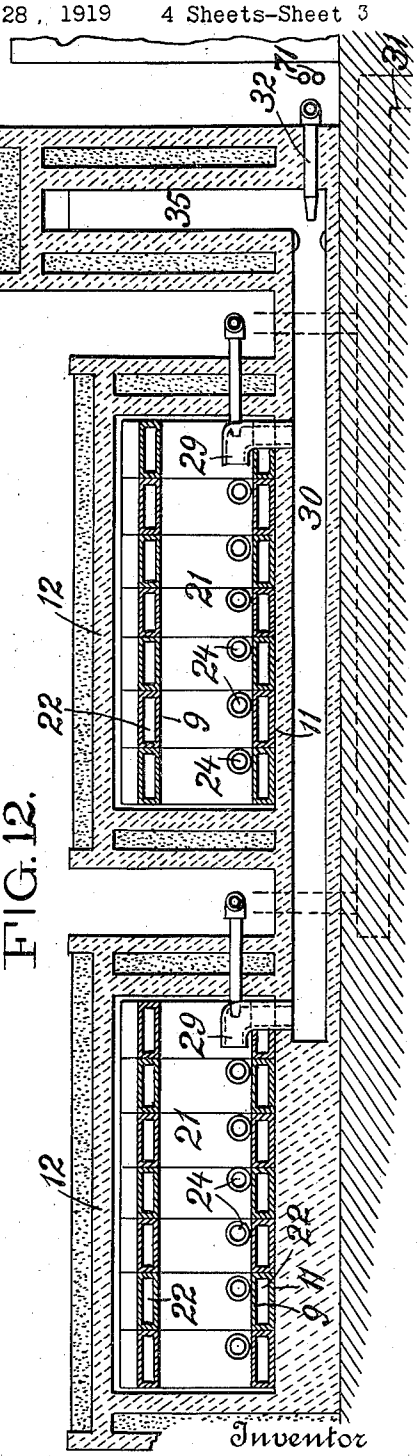


FIG. 12.



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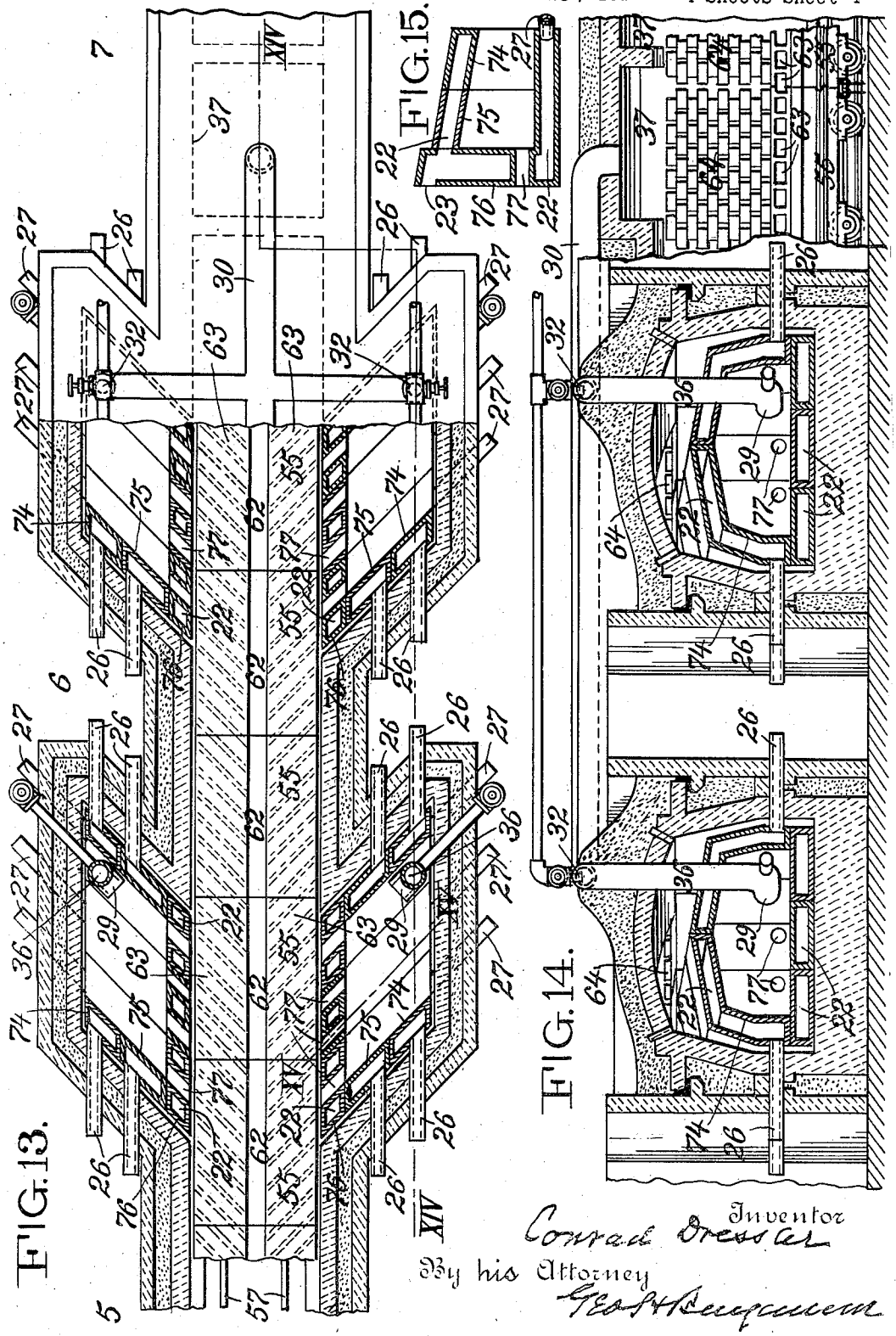

FIG. 13.

FIG. 14.

FIG. 15.

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UNITED STATES PATENT OFFICE.

CONRAD DRESSLER, OF CLEVELAND, OHIO, ASSIGNOR TO AMERICAN DRESSLER TUNNEL KILNS, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

TUNNEL KILN.

Application filed October 28, 1919, Serial No. 333,900. Renewed March 17, 1924.

To all whom it may concern:

Be it known that I, CONRAD DRESSLER, a subject of the Kingdom of Great Britain, residing at Cleveland, county of Cuyahoga, and State of Ohio, have invented certain new and useful Improvements in Tunnel Kilns, of which the following is a specification.

My invention relates to tunnel kilns of the open fire type. The object of my invention is an improved construction by reason of which there is obtained, great economy of fuel, more perfect distribution of heat, and greater resistance to deterioration of the fire mouths of the combustion chambers, than has heretofore been obtained.

The accompanying drawings will serve to illustrate my invention, in which:

Fig. 1 is a section through the kiln taken substantially on the line I—I of Fig. 2.

Fig. 2 is a section taken substantially on the line II—II of Fig. 1, with the pipes and pump for drawing heated air from the right hand end of the kiln, shown in elevation.

Fig. 3 is a view of one side of the interior of the kiln with one of the cars in the kiln, the cooling pipes at the bottom of the kiln, and the bottom of the kiln in vertical section.

Fig. 4 is a transverse section taken on the line IV—IV of Fig. 3.

Figs. 5, 6, 7, 8, 9 and 10 are transverse sections taken respectively on the lines V—V, VI—VI, VII—VII, VIII—VIII, IX—IX and X—X of Fig. 2.

Fig. 11 is an enlarged horizontal section taken substantially on the line XI—XI of Fig. 2.

Fig. 12 is a vertical section taken substantially on the line XII—XII of Fig. 11.

Fig. 13 is a horizontal section corresponding to the view shown in Fig. 11, and also a partial plan view showing a modification of the construction.

Fig. 14 is a vertical section taken on the line XIV—XIV of Fig. 13.

Fig. 15 is a transverse vertical section taken substantially on the line XV—XV of Fig. 13.

The kiln, for the purpose of description, may be constructed as having its interior chamber, through which the goods pass, divided into three zones, i. e., the heating up zone 5, in which the goods are uniformly heated to the required temperature before being subjected to the highest temperature for the purpose of firing or vitrifying; furnace zone 6, in which the highest temperature of the kiln is developed for the purpose of firing or vitrifying the goods previously heated in zone 5; and cooling zone 7, in which the goods are cooled before being withdrawn from the kiln.

The zone 5 may be of any required length, depending somewhat upon whether or not a so-called soaking effect is to be attained in addition to the heating effect.

The zone 6 may have a pair or a series of pairs of oppositely disposed combustion chambers 8—9, depending upon the temperature it is desired the goods shall be subjected to, or the length of time of application of the temperature.

The zone 7 may be of any required length to effect proper cooling of the goods, the length depending somewhat upon the temperature to which the goods are subjected in furnace zone 6.

Owing to the fact that it is the tendency of the burned gases flowing from furnace zone 6 into zone 5, to rise to the top of the kiln, and also to flow along the sides of the kiln, in order to promote circulation of said burned gases in zone 5 and thus obtain an equality of temperature along the zone from the zone 6 to the entrance of zone 5, provision must be made to overcome the tendency of the burned gases to flow along the top of the kiln and along the sides, and a construction for effecting this result is a part of my invention and will be fully described later on in this specification.

Owing to the further fact that the goods, after they pass through the furnace zone, radiate much heat, provision must be made for carrying off such heat, and a construction for this purpose is a part of my invention and will be fully described in this specification.

Owing to the further fact that in prior constructions, due to the arrangement of the heating means in the furnace chamber, the heat was unequally developed throughout the furnace chamber, thereby not only seriously acting on the goods passing through the furnace chamber but acting destructively upon the structure of the chamber itself, provision must be made to overcome this objection, and a construction

for this purpose is a part of my invention and will be fully described in this specification.

Owing to the further fact that the heat developed within the kiln, tends to act destructively upon the support for the carriages, wheels and trackway, provision must be made for protecting such parts by preventing the access of heat thereto, and a construction for this purpose is a part of my invention and will be fully described in this specification.

The combustion chambers 8—9, which in their main features are substantially the same as those described in prior patents granted to me, are shown as arranged in pairs on opposite sides of the kiln. The general construction of the kiln and combustion chambers is best shown in Fig. 7. A modification of the construction of the combustion chambers is shown in Fig. 14. In Figure 7, 10 indicates the lateral walls of the kiln, 11 bench and 12 roof, made of any suitable refractory material. 13 outer walls separated from the lateral walls 10, and 14—15 buck staves and tie irons. The outer walls 13 are provided with inwardly projecting brackets 16, on which are located angle irons 17 on which rest projections 18, extending outward from the lateral walls 10. Located in the space 19 between the outer and inner walls, and covering the roof, is a body of refractory material 20, such as diatomaceous earth, or any other substance which will act as a non-conductor.

Located within the kiln and on each side of the kiln, are the combustion chambers 8—9. In the drawings, these chambers in general construction are substantially the same as shown in my prior patents, but modified as follows: These chambers consist of a central chamber 21, and an enveloping chamber 22, the walls of the chambers (as in my prior constructions) separated to leave a space between them. The enveloping chambers have at their top, open air mouths 23 through which air heated by combustion in chamber 22 and passing through the space between the walls of the central chamber 21 and the enveloping chamber 22, is discharged into the interior of the kiln. The central chambers 21 are provided with fire mouths 24, through which the products of combustion of the gas and air burned in said chambers are discharged into the interior of the kiln. These fire mouths may vary in construction. In Figs. 7 and 11 they are shown as tubes extending from the outer wall of the central chamber 21 to the outer wall of the enveloping chamber 22. The shape of these fire mouths is immaterial. Thus they may be tubular, square or any other shape. They may be arranged at right angles to the walls of the central and enveloping chambers, or as shown in the drawings, at an angle to the enveloping walls and inclined to discharge toward the zone 5 of the kiln, the purpose of which arrangement will hereinafter be stated.

In Fig. 13 there is shown a modification of the combustion chamber with the fire mouths. In this figure the front walls of the central and enveloping chambers are integral and openings corresponding to the fire mouths 24 are located within the walls. Air is supplied to the enveloping chambers 22 through pipes 25 (Fig. 7) and pipes 26—27 (Fig. 13). The delivery of air may be controlled by valves, such as indicated at 28. Gas and air is supplied to the central chambers 21 through the burners 29, the burners being arranged to project a stream of gas and air horizontally along the chambers 21, whereby the best combustion effects are obtained. In prior constructions, the air used to effect combustion is usually kept at the temperature of the atmosphere or slightly heated. The best results are obtained by using highly heated air. My improved construction provides means for effecting this purpose and will be fully set forth in the specification.

Referring to Fig. 12. Hot air is fed to the burners 29 through the air duct 30, and gas through the gas duct 31. The gas and air are preferably under pressure. Gas is usually obtained under pressure direct from the producers and the air is put under pressure by an air injector 32. The air delivered through the injector 32 may be hot or cold, as desired. The heated air used in combustion, may be derived from any suitable source, but preferably from a chamber 33 located at the top of the left hand end of the cooling zone 7. The top of the chamber 33 has openings 34 which communicate with ducts 35, which lead to the horizontal air ducts 30.

In Fig. 14 the air duct 30 is located at the top of the kiln instead of at the bottom, as in Fig. 12, and situated between this duct and the burners, are vertical air ducts 36. In this construction the air injectors 32 are located at the top of the vertical ducts 36 instead of at one end of the air ducts 30, as shown in Fig. 12. The functional operation of both constructions is the same, the only difference being, that that shown in Fig. 14 is a modification of that shown in Fig. 12.

It will be understood from the description, that the gas and air fed to the burners 29, are partially or wholly burned within the central chamber 21, and the burned gases, i. e., the products of combustion, pass out of this chamber through the fire mouths and are projected under the goods on the carriages. At the same time, the air introduced into the enveloping chamber 22, in passing through the space between the chambers 21

and 22, is delivered through the air mouths 23.

In the practical operation of a kiln such as described, the tendency of the heat set free in zone 6 is to flow towards the zones 5 and 7. As heretofore described the heated air passing toward the zone 7, is picked up in the chamber 33 at the left hand end of the zone and carried to the central combustion chamber 21. This not only furnishes high temperature air for use in effecting combustion in the central chambers 21, but also serves to cool the left hand end of zone 7. The zone 7 is likewise provided at the top with a series of chambers 37 (see Figs. 2 and 10) each of which is connected through suitable tubes or ducts 40—41 to the inlet of pump 42. The outlet of pump 42 may be connected to any device where the heated air delivered from the pump may be utilized. It will be manifest that the heated air drawn from pump 42 may be combined with heated air from the chamber 33, and the combined air delivered at the burners. I consider it preferable, however, to feed the burners with air drawn from the chamber 33, as this air has a more uniform and higher temperature than would be obtained if the two bodies of air were combined. As previously stated, the heat and gases from zone 6 are unequally distributed through zone 5, and it is essential that the heat should be equalized so that the goods entering the chamber shall be uniformly heated, and by the term equalized I wish to have understood that at any given section of the length of zone 5 the heat at the bottom of the chamber shall be substantially the same as the heat at the top of the chamber.

The means employed to obtain equalization of the heat, is as follows: Referring first to Figs. 1, 2 and 5. Arranged on each side of the zone 5, at its left hand end, i. e., the end at which the goods to be treated are introduced into the kiln, are openings 43 connected to ducts 44 which in turn are connected to the inlet orifice of a pump 45. The function of the pump is to draw the hot air and the burned gases at the top and along the sides of the chamber in this zone, in a downward direction to the openings 43, thence to the pump 45, to be discharged to the atmosphere or at any place where it can be utilized. The openings 43 may be controlled by any suitable mechanism, such for instance as valves 46—47 mounted on cross arm 48. By rocking the arm at intervals, the openings 43 at opposite sides of the chamber may be successively opened and closed and thus the heated air and gases drawn at one time through one of the openings, and at a subsequent time through the other of the openings, which arrangement tends to change the direction of movement of the heat and burned gases from the top of the chamber diagonally across the chamber to the opening which is at the time in connection with the chamber, and thus by varying the direction of movement of the heat and burned gases across the chamber, overcoming the tendency of these bodies to rise and hug the walls, and finally to effect equalization of the temperature at any given point along the zone. Further means may be provided to aid equalization. Located at the left hand end of the zone 5, at the bottom of the chamber, are openings 49 which are in staggered relation at opposite sides of the chamber, and which openings are connected to flues 50 (see Fig. 6) vertically arranged, which flues discharge through openings 51 in the upper part of the chamber and in the rear of fans 52, which fans are located on the ends of shafts 53 adapted to be driven by motors 54, or other suitable devices located outside of the kiln structure. These fans serve to draw the heat and burned gases from the bottom of the kiln upward through the flues 50 and discharge them out of the openings 51, where they are picked up by the fans and propelled downward by them in opposite directions. It will be observed that the openings 49 are placed nearer to the zone 6 than the fans which distribute the heat and burned gases entering such openings. This is desirable, as the heat and gases are higher in temperature nearest to the source of origin, i. e., in the heating zone 6. I wish it understood that I do not limit myself to the instrumentalities described for effecting equalization or diffusion of the heat and burned gases, as many devices having the same purpose in view may be used.

To carry the goods through the kiln, carriages 55 are provided. These carriages are mounted on wheels 56 which move over rails 57. The carriages may be of any well known construction. That shown in the drawings consists of a platform 58 (Fig. 4) made of refractory material. On the top of this platform are two series of partitions 59, placed at an angle, open at their outer end 60 at the sides of the carriages, and communicating at their inner end 61 with a longitudinal channel 62 between the partitions and channels 63. In the drawings the channels 63 are shown as disposed at an angle to the longitudinal axis of the carriage, which angle corresponds to the angle of the long axis of the fire mouths 24. This arrangement is not essential as the channels 63 may be placed at right angles to the longitudinal axis of the carriage, the fire mouths being similarly disposed. The purpose of the channels 63 and 62 is to direct the hot products of combustion from the fire mouths upward through the body of goods 64 on the carriages, where it meets in its upward movement, the descending hot air currents

projected from the air mouths 23, as previously described. Connected to the platform 58 at each side, are cast iron plates 65. These plates have formed in their vertical portion, a slot 66 in which is placed a bolt 67, which serves to support the plate but does not fasten it, the plate 65 being permitted thereby to have an up and down movement. The end of the plate 65 rests on the top of the angle iron 68, and as the plate is free to move up and down, maintains contact with the angle iron and thus prevents the hot gases in the kiln chamber from passing into the space 69 under the platform 58, and conversely, the cold air from the space 69 from rising into the kiln chamber.

Mounted on the front and back ends of the carriages 55 are swinging plates 70. These plates have for their purpose to prevent the heated gases and air in the space 69 from being drawn, under the action of the pumps 42 and 45, towards either the zone 5 or the zone 7, which if permitted, will prevent equalization of the temperature in the zone 5, and effect cooling in the zone 7. As the temperature in the space 69 is apt to become so high as to injure the wheeled supports for the carriages, it is advisable to cool the space, and this is effected by means of pipes 71 which are disposed parallel in the space 69, and on their inner end are provided with a loop 72 located in the pit 73. These pipes 71 are fixedly secured in the wall of the kiln at one end, and the purpose of the loop is to compensate for the expansion and contraction of these pipes, which takes place in the space 69, without subjecting the ends of the pipes where secured in the structure, to undue strain.

In the modification shown in Fig. 14, the chamber 33 in zone 7 is omitted, and the hot air used to aid combustion is drawn through duct 30 from chamber 37, which corresponds to chamber 37 of Fig. 2. In Fig. 15, a modification of the construction of the combustion chambers is shown. In this construction the chamber is made up of a series of independent sections 74, 75, 76. At the front sections 76 there is formed a passage 77 which acts as a fire mouth. In the construction shown in Fig. 7, as well as in this figure, the air introduced at the bottom of the enveloping chamber 22 passes upward and around the fire mouths, and as this air is considerably lower in temperature than the hot gases delivered through the fire mouths, the material of the fire mouths is protected against the destructive action of the heat.

I wish it understood that I do not limit myself in any wise to the particular construction of the fire mouths as shown in any of the figures as it is evident that a variety of constructions may be used, all air-cooled, which will be within the intent of my invention.

The operation of my improved kiln will be readily understood. The goods to be fired are mounted upon carriages similar to 55 and first introduced into the closed chamber 78, the door 79 at the time being closed. After the carriages are introduced, the door 80 is closed and the door 79 opened. The carriages are then moved progressively through the kiln chamber and subjected to a gradually increasing temperature equalized throughout the chamber, until the end of zone 5 is reached; then through a much higher temperature in zone 6; then through a gradually decreasing temperature until the end of the kiln chamber is reached, when the carriages pass out through the door 81.

What I wish to have understood is that I believe I am the first to describe a kiln construction in which the burned gases in the kiln are distributed uniformly throughout that portion of the kiln chamber included within zone 5, whereby uniform heating is obtained; and further, the first to draw out from zone 7, the highly heated air partially radiated from the fired goods and the utilization of this air for promoting combustion of the introduced gas in the combustion chambers in zone 6; further, a construction where the top of the cooling zone is formed as a series of heated chambers from which the excess heat in the cooling zone may be drawn away for useful purposes.

Having thus described my invention, I claim:

1. A tunnel kiln comprising a main chamber through which the goods to be treated are moved, means situated approximately at the center of said chamber for developing a high temperature therein, and gas propelling mechanism located within the kiln and associated with the forward heating zone of said main chamber and adapted by its propulsion to equalize the heat distribution in said zone.

2. A tunnel kiln, comprising a main chamber through which the goods to be treated are moved, combustion chambers situated in said main chamber, each combustion chamber comprising a central chamber and a spaced enveloping chamber, an air delivery mouth for the enveloping chamber and a fire delivery mouth for the central chamber, both of said delivery mouths opening to the main chamber; means for feeding air to the interior of the enveloping chamber, and means for feeding gas and air to the interior of the central chamber.

3. A tunnel kiln, comprising a main chamber through which the goods to be treated are moved, means located in the forward end of said chamber which has for its pur-

pose to equalize the distribution of the heat and burned gases in said portion of the chamber, combustion chambers located in said main chamber, means for feeding gas and air to the combustion chambers, and means for feeding air to the interior of the main chamber and around the combustion chambers.

4. A tunnel kiln, comprising a main chamber through which the goods to be treated are moved, combustion chambers located in said main chamber, a collecting chamber located in the cooling zone of, the main chamber, means for conveying heated air from said collecting chamber to the combustion chambers, means for feeding gas to the combustion chambers, and means for feeding heated air to the interior of the main chamber and around the combustion chambers.

5. A tunnel kiln, comprising a main chamber through which the goods to be treated are moved, combustion chambers adapted to heat said chamber, means situated in the heating zone of said chamber and adapted to equalize the heat distribution therein, said means consisting of externally driven devices producing circulation of the heated bodies in various directions, and externally driven devices for exhausting from the chamber the circulating bodies, together with means for varying at intervals the direction of movement of the heated bodies.

6. A tunnel kiln, comprising a main chamber through which the goods to be treated are moved, combustion chambers opening to the main chamber adjacent its bottom, gas and air burners located in said combustion chambers, means for feeding gas to said chambers, means for heating air and feeding it to said chambers, said means comprising a collecting chamber situated at the top of the cooling zone of, and in open communication with the main chamber and flues leading from said connecting chamber to said gas burners.

7. In a tunnel kiln, a main chamber through which the goods are moved, having in its rear or cooling end a series of heat collecting chambers situated in the roof of, and in open communication with said main chamber, together with means for exhausting heated air, from said collecting chambers.

8. In a tunnel kiln, a main chamber having its forward or heating end provided with a series of devices for mechanically distributing the air or burned gases in said portion of the chamber.

9. In a tunnel kiln, a main chamber provided at its forward or heating end and on opposite sides of the bottom portion thereof with ports; together with exhaust means acting in connection with said ports and adapted to exhaust the heat and burned gases from the bottom of the forward portion of said main chamber.

10. In a tunnel kiln, a main chamber and series of combustion chambers arranged on opposite sides of the central portion of said chamber; said combustion chambers made up of a central chamber in which gas and air are burned, and provided with a fire mouth through which the burned gases are expelled into the cavity of the main chamber; and an enveloping chamber separated from the central chamber and provided with a mouth through which highly heated air is expelled into the main chamber, together with means for feeding gas and air into the central chamber and means for feeding air into the enveloping chamber.

11. In a tunnel kiln, the combination of a main chamber and series of cooling pipes situated on opposite sides of the bottom of said chamber, said cooling pipes secured at one end to the kiln wall, and at the opposite end formed as a depending loop and connected to the parallel pipes.

12. In a direct fired tunnel kiln, a main chamber provided adjacent its forward end with outlet ports from the chamber at the opposite sides thereof for the heating gases, dampers regulating the flow through said ports and operating provisions for said dampers adapted to throttle the flow out of the chamber at either side while at the same time increasing the flow out of the chamber at the opposite side.

13. In a direct fired tunnel kiln, a main chamber provided adjacent its forward end with an outlet from the chamber for the heating gases at each side of the chamber, a damper controlling each outlet, and adjusting provisions for said dampers, whereby, when either damper is adjusted to throttle the corresponding outlet, the other damper is moved to open the outlet to which it pertains.

In testimony whereof, I affix my signature.

CONRAD DRESSLER.