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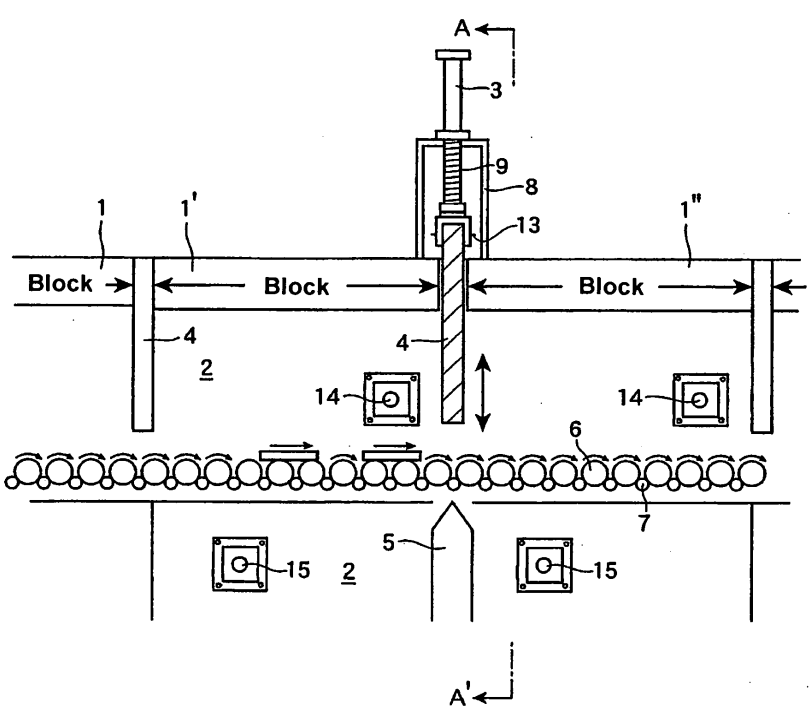
(54) **CONTINUOUS FURNACE**

(57) The present invention relates to a continuous furnace including movable unit furnaces connected with each other for adjusting the baking temperature of molded products. A plurality of such unit furnaces are connected with each other with vertically movable shielding plates being interposed therebetween. Burner ports are arranged out of registration with each other in facing side walls of each unit furnace, and conveyor means is provided passing through the connected unit furnaces.

**Fig. 2**

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## Description

[0001] The present invention relates to a continuous furnace which utilizes a plurality of unit furnaces continuously, depending on the amount of molded products to be baked or the duration of baking.

[0002] Continuous furnaces are conventionally known, wherein a continuous baking path is provided through a furnace casing having partitions for sequentially carrying molded products into the furnace casing. There is also proposed a continuous furnace wherein the partitions are provided with discharge ports for discharging exhaust gas generated by baking in the baking path, so as to precisely control the temperature in the baking region (JP-3218719-B (JP-6-82162-A)).

[0003] On the other hand, there is proposed a continuous furnace having a tunnel-like furnace casing, which is provided with a first baking region, a second baking region, a first cooling region, a second cooling region, and a third cooling region. These regions are divided into cooling air supply ports, burners, waste heat air recovery ports, and furnace gas discharge ports, and the temperature of each region is controlled to keep an appropriate heat curve (JP-2859987-B (JP-5-172465-A)).

[0004] Though the continuous furnace disclosed in JP-6-82162-A has partitions in the baking region, these partitions are not of a type to move vertically for controlling the furnace temperature. Thus the furnace temperature is not controlled by the partitions per se, but rather by another mechanism. Further, the invention disclosed in this publication is not of a type wherein burner ports in the facing side walls are arranged out of registration with each other to generate whirl or vortex flows of combustion gas to uniformly apply the gas over molded products.

[0005] On the other hand, the continuous furnace disclosed in JP-5-172465-A is not of a type to adjust the temperature of molded products by displacement of the partitions, or to apply the combustion gas uniformly over molded products.

[0006] The present invention aims to solve the above problems. It is therefore an object of the present invention to provide a continuous furnace that may be structured in a small scale, which is nearly a batch type, or a medium or even large scale, by continuously disposing unit furnaces.

[0007] It is another object of the present invention to provide a continuous furnace wherein not only a plurality of unit furnaces are connected, but also shielding plates are provided at predetermined locations in the furnace, so that the baking temperature between the shielding plates is controllable.

[0008] It is still another object of the present invention to provide a continuous furnace wherein the burner ports in the facing side walls are arranged out of registration with each other to generate whirl flows of gas in the furnace for substantially uniformly baking molded products.

[0009] It is yet another object of the present invention to provide a continuous furnace wherein the shielding plates are positioned at a predetermined height above the conveyor means in the furnace, i.e., at a height allowing passage of molded products on the conveyor means, so that molded products are baked with burners from above and below the conveyor means.

[0010] It is still another object of the present invention to provide a continuous furnace that is capable of producing ceramic products in a short time, by providing the furnace with a combustion fan for introducing air and gas into the furnace and an exhaust fan for forced-discharge of exhaust gas out of the furnace, at the front and rear sections of the furnace, respectively.

[0011] It is yet another object of the present invention to provide a continuous furnace that is movable to a construction site of buildings, housing, tunnels, or highways, or to a site where combustion ash is available for producing ceramic products, or even to a plant site of a customer, for finishing, on-site, ceramic products such as tiles, bricks, and exterior plates, as well as thermal treatment devices such as ceramic electronic components for vehicles and the like.

[0012] According to the present invention, which has been made in light of the above objects, there is provided a detachable, movable, continuous furnace, comprising:

unit furnaces,
burners for projecting gas into said unit furnaces, and
a control panel for controlling ignition of gas, flame size and duration, and extinction of the burners,

wherein a plurality of said unit furnaces of the continuous furnace are arranged continuously via interposed shielding plates for controlling the furnace temperature,

wherein, in at least a part of said plurality of unit furnaces, ports of said burners are arranged in facing side walls of each unit furnace in predetermined positions out of registration with each other for forced-generating whirl flows of flames in the furnace, and

wherein conveyor means is provided passing through the plurality of continuous unit furnaces.

[0013] According to the present invention, a continuous furnace of a desired scale, depending on the size, shape, and amount of molded products, may be obtained by continuously arranging a desired number of unit furnaces. Further, by arranging the shielding plates at predetermined locations in the continuous furnace, the temperatures between the shielding plates may be controlled separately. In addition, in each unit furnace between the shielding plates, the gas flame in the form of whirl flows is uniformly applied to molded products, so that ceramic products of better quality may be obtained.

[0014] Since the burner ports in the facing side walls are arranged out of registration with each other in each desired unit furnace in the continuous furnace, whirl flows may be forced-generated in the unit, which helps uniform projection of the flames over molded products.

**[0015]** According to the present invention, the continuous furnace is made movable for transportation to a construction site of tunnels or the like, or to a plant site of a customer, which enables on-site baking of ceramic products such as tiles, or heat treated products of ceramic electronic components such as vehicle parts as metallic products. Thus ceramic products may be baked in a short time, which eliminates need for a stock of ceramic products. This contributes to saving in overall cost.

**[0016]** According to the present invention, the continuous furnace is made movable, so that tiles and bricks, or heat treated products as metallic products such as vehicle parts, may be baked at a construction site of buildings or the like, or in a plant site of a customer. This eliminates need for warehouses located in a separate place for stock of these products, and transportation of these products, and thus ceramic products may be provided efficiently at a lower cost.

**[0017]** In another embodiment of the present invention, when the furnace casing is made in the form of a substantially rectangular cylinder having a pair of facing side walls, one of said burner ports is arranged in each of the facing side walls so that a total of two burner ports per unit furnace are arranged out of registration with each other for forming flames from the two burner ports into a clockwise or counterclockwise whirl flow, or alternatively, two of said burner ports are arranged in each of the upper and lower sections of the facing side walls so that a total of four of said burner ports per unit furnace are arranged out of registration with each other for forming flames from the four burner ports into upper and lower whirl flows in the same clockwise or counterclockwise direction, or in the reverse directions.

**[0018]** In the present invention, when one burner port is provided in each side wall of the substantially rectangular cylinder of the furnace, the burner port in one side wall is arranged near the lower right corner and oriented inwards, while the burner port in the facing side wall is arranged near the lower right corner and oriented inwards. In such an arrangement, the two burner ports located in the lower sections of the facing side walls are out of registration with each other, so that the flames from the burner ports whirl clockwise.

**[0019]** When two burners are provided in each side wall of the substantially rectangular cylinder of the furnace, the two burner ports in one side wall are arranged near the upper right and lower left corners, while the two burner ports in the facing side wall are also arranged near the upper right and lower left corners. In such an arrangement, the burner ports arranged in the facing side walls are out of registration with each other. In other words, when seen through one side wall toward the facing side wall (the burner ports are arranged in the upper right corner of respective side walls), the burner port located in the upper right corner of one side wall projects flame toward the facing side wall, while the burner port located in the upper right corner of the facing side wall projects flame, when seen through the said one side wall, from the upper left corner on the far side toward the upper left corner on the near side, so that the flames whirl counterclockwise. On the other hand, each of the two burner ports located near the lower left corner of each of the facing side walls similarly projects flame from one side wall toward the other, so that the flames whirl in the reverse direction, i.e., clockwise.

**[0020]** While the burner ports are arranged near the upper right corners of the facing side walls and oriented inwards in the above embodiment, when the burner ports are arranged near the upper left corners, the flames whirl clockwise in the unit, unlike the above. Further in the above embodiment, the burner ports are arranged near the lower left corners of the facing side walls and oriented inwards, but when the burner ports are arranged near the lower right corners, the flames whirl counterclockwise in the unit.

**[0021]** Thus, the burner ports near the corners of the side walls may be arranged so that the upper and lower ports are located in the right or left corner for forming the upper and lower flames to whirl in the same counterclockwise or clockwise direction, or one of the flames may be made to whirl counterclockwise while the other clockwise.

**[0022]** Further, in projecting gas into the furnace, the directions of projection through the burner ports into the furnace may be adjusted automatically with the control panel or manually within the ranges such that, when one burner port, for example, is provided in each side wall near the upper right corner, the flame from the burner port in one side wall is projected toward the right half of the inner surface of the facing side wall, whereas the flame from the burner port in the facing side wall near the upper right corner is projected toward the left half of the inner surface of the said one side wall on the near side. With such adjustment, the flame flow may be optimized for each size of molded products as far as a smooth whirl flow in the clockwise or counterclockwise direction is not disturbed.

**[0023]** According to another embodiment of the present invention, the shielding plates are moved transversely into the furnace, and moved vertically up and down in the furnace to adjust the height of the plates, so as not to hit molded products being transferred on the conveyor means in the furnace. Thus the temperature between the shielding plates may be adjusted more precisely.

**[0024]** According to the present invention, the height of the shielding plates interposed between the unit furnaces may be adjusted vertically by manual operation or by automatic operation under control of the control panel. Thus the time and temperature for baking may be adjusted to the values desired in relation to the conveyor means, so that uniform ceramic products may be produced quickly.

**[0025]** Further, by moving the shielding plates transversely into the furnace and operating the plates from outside the furnace for vertical movement, heat leakage due to operation of the shielding plates from both sides of the furnace ceiling for vertical movement, may be prevented.

**[0026]** According to another embodiment of the present invention, the shielding plates are made insertable into and drawable out of the furnace by transversely moving the plates from side to side in the furnace so as not to hit molded products being conveyed on the conveyor means.

**[0027]** According to the present invention, since the shielding plates are movable transversely in the furnace, the furnace temperature may be adjusted readily, and maintenance, such as repairing or replacement, of the shielding plates are facilitated by drawing out the shielding plates from either the left or right side.

**[0028]** According to another embodiment of the present invention, each of the shielding plates is split above the conveyor means into the upper and lower sections, and the lower section is made movable vertically or transversely, while the burners are capable of baking molded products from above and below the conveyor means. With this structure, a wide variety of designs may be applied, and molded products may be baked in a wider range by means of the burners from above and below rollers of the conveyor means to achieve uniform baking of molded products.

**[0029]** Further, the lower section of each shielding plate is made adjustable in height either manually or automatically by means of liftingmeans such as power cylinders and screws, so that the furnace temperature is adjusted more precisely.

**[0030]** According to another embodiment of the present invention, the conveyor means includes heat-resistant rollers rolling on bearings, and the burners are arranged so as to bake molded products fromabove andbelowthe rollers with heat-resistance.

**[0031]** According to another embodiment of the present invention, in the front section of the continuous furnace, air and gas are introduced into the furnace with a combustion fan and exhaust gas is discharged out of the furnace with an exhaust fan for baking molded products, whereas in the rear section of the continuous furnace, air or cool air is introduced into the furnace with a cooling fan and hot air is discharged outside the furnace with a cooling exhaust fan for rapidly cooling the furnace, to thereby reduce the baking time.

**[0032]** According to the present invention, air and gas are introduced into the front half of the continuous furnace, and air or cool air is forced-introduced into the rear half of the continuous furnace, while the exhaust gas and combustion air in the furnace are discharged out of both halves. Thus fresh air may be taken into the furnace to facilitate quick baking of molded products.

**[0033]** Since the continuous furnace of the present invention is composed of a plurality of unit furnaces continuously arranged via interposed shielding plates, a suitable continuous furnace may be provided depending on the kind or size of ceramic products, for example, buildingmaterials such as tiles, or ceramic electronic components for vehicle engines.

**[0034]** The burner ports in the side walls of the furnace are arranged out of registration with each other, that is, the burner ports are arranged so that the flames from the burner ports in the facing side walls whirl clockwise or counterclockwise in the unit. With this arrangement, the flames substantially uniformly hit molded products positioned in the middle between the side walls, and thus uniformly baked ceramic products may be obtained in a short time.

**[0035]** According to the present invention, by vertically moving the shielding plates up and down in the furnace, the temperature of the furnace partitioned with the shielding plates may be adjusted suitably depending on the kind or size of molded products to be baked.

Fig. 1 is a general schematic view of the continuous furnace according to the present invention.

Fig. 2 is an enlarged partial detail view of Fig. 1.

Fig. 3 is a sectional view taken along lines A-A' in Fig. 2.

Fig. 4 is a graph showing the relation between the baking time (60 minutes) and the baking temperature of ceramic products in the continuous furnace of the present invention.

Fig. 5 illustrates the supply lines of gas and air for the burners and the discharge line of exhaust gas for the continuous furnace shown in Fig. 1.

Fig. 6 is an enlarged partial detail view of another continuous furnace, different from Fig. 2.

Fig. 7 is a sectional view taken along lines B-B' in Fig. 6.

Fig. 8 is a graph showing the relation between the baking time (20 minutes) and the baking temperature of ceramic products in another embodiment of the present invention shown in Figs. 6 and 7.

Fig. 9 is a schematic view showing the relation between the temperature and the conventional baking time of 20 minutes, together with the overall length of the furnace.

Fig. 10 is a graph showing the temperature against time for the annealing process of stainless steel parts to be subjected to hot exhaust gas from an engine, compared to Figs. 4 and 8 showing the examples for tiles as a ceramic product.

Fig. 11 is a graph showing the temperature against time for the annealing process of the same stainless steel parts as used in Fig. 10, wherein the annealing process run in a still shorter time.

**[0036]** According to the present invention, a continuous furnace is formed with a desired number of unit furnaces and shielding plates. Thus a continuous furnace suitable for each plant may be obtained.

**[0037]** Between the shielding plates, combustion conditions according to the degree of shielding in the furnace may be achieved. Further, in the furnace defined between the shielding plates, the burner ports arranged out of registration with each other form whirl or vortex flows of flames to facilitate uniform baking of molded products.

**[0038]** The present invention will now be explained with reference to preferred embodiments taken along attached drawings.

<u>Example 1</u>

**[0039]** Fig. 1 is a schematic longitudinal sectional view of a continuous furnace, wherein unit furnaces are connected in a single row from left to right. Fig. 2 is an enlarged partial explanatory view of Fig. 1. Fig. 3 is a sectional view taken along lines A-A' in Fig. 2. Fig. 4 is a graph showing an example of the relation between the baking time and the baking temperature for producing ceramic products according to the present invention. Fig. 5 is an explanatory view illustrating the line in the continuous furnace including the combustion fan, the interior of the furnace, the exhaust fan and the cooling fan, the interior of the furnace, and the cooling exhaust fan, in this order. Fig. 6 is an enlarged partial detail view of another continuous furnace different from the one shown in Fig. 2. Fig. 7 is a sectional view taken along lines B-B' in Fig. 6. Fig. 8 is a graph showing the continuous furnace of the present invention composed of ten unit furnaces each of 1 m long, in total of 10 m, for baking ceramic products in 20 minutes, together with the baking temperature against time. Fig. 9 shows a conventional example of a continuous furnace of 45 m long for the baking in 20 minutes as in Fig. 8.

**[0040]** Referring to Figs. 1 to 3, each of the reference signs (1, 1', 1" ...) shows one unit of a furnace, and a plurality of such unit furnaces are connected to form continuous furnace A. The furnace A has tubular tunnel 2 with a rounded-top in contour as a furnace casing defined by ceiling 43, side walls 49, and partition walls 5, all made of firebricks (preferably AG BLOCK manufactured by MARUKOSHI KOGYO K.K.), and furnace floor 45. At each boundary between the unit furnaces (1, 1', 1" ...), shielding plate 4, which is connected to one end of power cylinder 3 with screws 13 for vertical movement, is disposed in approximately the upper half, while the partition wall 5 and the furnace floor 45 made of firebricks are provided in approximately the lower half. The tubular tunnel 2 passing axially through the unit furnaces (1, 1', 1" ...) is provided with conveyor means rolling on bearings 7 in one way from left to right in Fig. 1 (moving into the tunnel) in an endless manner, i.e., a number of heat-resistant ceramic rollers 6 as an endless conveyor 12. The rollers 6 are rotatably arranged side by side on the endless conveyor 12 associated with motor 10, pulley and chain 11, with the roller axes being supported by the furnace casing (not shown).

**[0041]** The shielding plate 4 may be provided for each unit furnace as shown in Fig. 1. Alternatively, one shielding plate 4 may be provided for two or more of the unit furnaces, depending on the baking conditions of molded products. The shielding plate 4 is moved in the vertical direction through the ceiling between the unit furnaces by means of the power cylinder 3, which operation may be performed either automatically or manually, via receiving plate 8 fixed to the furnace casing. Screw 9 is screwed to the receiving plate 8 for adjusting the range of the vertical movement of the shielding plate 4 by the power cylinder 3.

**[0042]** The side walls 49 of each unit furnace (1, 1', 1") are provided with burners 14, 15, 16, 17, which are arranged such that one pair is in the upper section, and the other pair in the lower section, with each pair being arranged out of registration with each other. The upper burner port in one side wall 49 project flame, while the upper burner port in the other side wall project flame in a staggered manner (the same is true for the lower section). In other words, in both the upper and lower sections, the burner ports 14, 15, 16, 17 are arranged either to the right or left in the facing side walls 49 (in the drawings, in one of the side walls, the upper burner port is shown in the upper right corner, while the lower burner port is shown in the lower left corner).

**[0043]** This means that, when two burners are provided diagonally right up in each of the right and left side walls of each unit furnace (1, 1', 1" ...), i.e. in total of four burners in both side walls, the burner ports 14, 16 are arranged in the walls on the right and left of the tunnel axis, respectively, in the upper half of the unit furnace (above the conveyor means), while the burner ports 15, 17 are arranged in the walls on the right and left of the tunnel axis, respectively, in the lower half of the unit furnace (below the conveyor means), so that the two facing burner ports are arranged out of registration with each other. Incidentally, for cooling molded products, in the rear section of the furnace (right side in Fig. 1), only two burner ports may be provided in either of the right and left walls below the conveyor 12, or only one burner port may be provided in each of the right and left walls (in total of two), or even no burner ports are provided at all, depending on the design.

**[0044]** Referring to Fig. 5, in the front half of the continuous furnace A, there are provided combustion fan 30 for projecting gas and air through the burner ports 14 to 17 into the furnace and combusting at the ignition command from the control panel (not shown) (line 32), and a line for discharging the gas generated by combustion in the furnace through combustion flue 22 out of the furnace by means of exhaust gas fan 20 (line 33). In the rear half of the furnace A, there are provide a line for introducing cool air (air) into the furnace by means of cooling fan 31 (line 34), and a line for discharging the combustion gas through cooling flue 23 out of the furnace by means of cooling exhaust fan 21 (line 35).

**[0045]** The process for baking tiles is explained below, using the continuous furnace of the above structure under the control with the control panel (not shown).

**[0046]** Fig. 4 shows a 60-minute baking process in a medium scale continuous furnace from the initial stage to the final stage. The 60-minutes baking process is divided into the following stages: drying stage 24 for the first 7 minutes, wherein molded products are dried with one or two burners in the unit furnace; temperature raising stage 25 for the following 14 minutes, wherein molded products are baked with three to four burners; high-temperature retaining stage 26 for the following 9 minutes, wherein molded products are baked with all of the four burners; rapid cooling stage 27 for the following 6 minutes, wherein the four burners are extinguished; slow cooling stage 28 for the following 12 minutes, wherein one or two burners are ignited; and cooling stage 29 for the last 12 minutes, wherein all the burners are extinguished. The molded products pass through the drying stage, wherein the temperature in the unit furnace is gradually raised from 143 °C to 271 °C, and then through the temperature raising stage, wherein the firepower is increased by elevating the gas combustion rate of the burners, while the shielding plate in the furnace is lowered, so that the temperature is rapidly raised up to 790 °C. Then the molded products pass through the high-temperature retaining stage over 9 minutes, wherein the temperature in the unit furnace is raised to the maximum of 1125 °C while the temperature increase in the unit furnace is controlled by lowering the shielding plate 4 to the extent to allow passage of the molded products. The molded products pass through the subsequent rapid cooling stage, wherein atmospheric air is introduced into the unit furnace to lower the temperature down to 675 °C, and then through the tunnel of slow cooling stage at an average temperature of 573 °C, and finally through the cooling stage, wherein the shielding plate 4 is raised for cooling. In this way, tiles, as an example of ceramic products, are baked.

Example 2

**[0047]** In Example 1 shown in Figs. 1 to 5, the 60-minute baking process was explained with reference to the embodiment wherein the shielding plate 4 penetrating the ceiling 43 of the unit furnace (1, 1', 1" ...) is vertically movable by means of the power cylinder 3. Now in another embodiment shown in Figs. 6 to 8, in each of the side walls 49 on both sides of the endless conveyor 12 at a boundary between unit furnaces (1, 1', 1" ...), slot 36 having vertically offset portions is provided for receiving two shielding plates, which are vertically slid with respect to each other like a double sliding door, and inserted transversely into the slot. Upper shielding plate 42 for fixing is inserted into the slot 36 in its upper right portion in Fig. 6, whereas lower shielding plate 43 is disposed vertically movably in the lower left portion of the slot 36, partially overlapping the upper shielding plate 42. The vertical movement of the lower shielding plate 43 is effected by means of power cylinders 3 fixed thereto via telescopic motion of cylinder rods 46. The outer cylinder of the cylinder rod 46 is provided with outer cylinder threads 48, which are screwed to flange 47 fixed to the furnace casing, so that the power cylinder 3 in its entirety is moved vertically for adjusting the range of the telescopic motion of the cylinder rod 46.

**[0048]** With reference to Figs. 6 to 8, an example will be explained, wherein baking is performed in ten connected unit furnaces (1,1',1"...) each of 1 m long over 20 minutes, in comparison to baking in a conventional furnace of 5 m x 9 units = 45 m in total over the same 20 minutes.

**[0049]** The upper graph in Fig. 8 shows the relationship between the temperature and the time for baking molded products in the ten unit furnaces shown in the lower figure. As shown in Fig. 8, molded products are subjected to the drying stage for the first 2 minutes, wherein the temperature is raised from 230 °C to 300 °C; the temperature-raising stage for the following 6 minutes, wherein the temperature is raised to 1200 °C; the high-temperature retaining stage for the following about 2 minutes and 15 seconds, wherein the temperature is maintained at 1200 °C; the rapid cooling stage for the following 4 minutes, wherein the temperature is lowered down to 573 °C; the slow cooling stage for the following 3 minutes and 45 seconds, wherein the temperature is further lowered down to 475 °C; and the cooling stage for the final 2 minutes, to thereby finish the ceramic products in total of 20 minutes.

**[0050]** Incidentally, in the prior art shown in Fig. 9, the furnace needs to have an entire length of as long as 45 m for producing the ceramic products from the molded products in the same baking time as in Example 2. According to the present invention, the entire length of the furnace can be remarkably reduced to as short as 10 m. This reduction is realizedbecause the baking temperature is quickly raised and lowered while the temperature increase required for the baking is maintained, by rapid raising of the furnace temperature and by rapid extinction and introduction of cool air into the furnace. The rapid raising of the furnace temperature is achieved by the fact that the height of the shielding plates between the unit furnaces is made adjustable, and that the burner ports are arranged in the facing side walls above and below the conveyor means, for example, two of the burner ports are arranged out of registration with each other in each side wall 49 (in Fig. 5, the squares in solid lines represent burners projecting flames from the near side toward the far side, whereas the squares in dotted lines represent burners projecting flames from the far side toward the near side) for forming whirl flows of the flames to uniformly hit the molded products.

**[0051]** The second embodiment of the invention particularly differs from the first embodiment in that the upper and lower shielding plates 42, 43 located between the unit furnaces are inserted transversely through a slit (not shown) in one of the side walls 49 of a unit furnace toward the other and positioned therein, while the ceiling 43 is entirely sealed with firebricks. In the furnace, the lower of the two shielding plates is moved up and down within the extent of the slot 36 (in the figures, over almost twice the length of the plate in the vertical direction), by means of power cylinders on both ends of the plate positioned outside the side walls, so that the temperature may be adjusted in each unit furnace above the conveyor means (Needless to say, there is sufficient clearance for allowing passage of molded products on the conveyor means without hitting the shielding plate.). Of course, each of the facing side walls is provided with a slit (not shown) of a size to accommodate the thickness of the shielding plate, through which slit the shielding plate is inserted into the furnace. After the shielding plate is bridged between the facing side walls, the slits are filled in with refractory fibers, such as ceramic fibers. The lower shielding plate may be moved up and down in the slot 36 either automatically by means of the cylinders, or manually.

Example 3

**[0052]** Another example will be discussed next, wherein stainless steel vehicle parts for use as engine parts or the like (referred to as metallic parts hereinbelow) are annealed (after press working of stainless steel) in the continuous furnace of the present invention, instead of the ceramic products mentioned above.

**[0053]** The metallic parts are subjected to repeated pressing for shaping. I f not annealed, the metallic parts will break at the point where the stress applied by the press is concentrated. Thus the pressing and annealing are repeated alternately.

**[0054]** The pressed metallic parts are placed on a thin refractory plate of 5 m to 8 m thick (called "setter"). The setter is in turn placed on the ceramic rollers 6, which are the conveyor means for the continuous furnace shown in Fig. 5, and passed through the furnace. According to Fig. 10, the annealing process is started at about 120 °C. The temperature is gradually raised, and after 6.3 minutes the maximum temperature is reached, and maintained for about 4 minutes. Then until about 12.8 minutes from the start, the temperature is rapidly lowered for two minutes, and finally slowly lowered for about 8.2 minutes to finish the annealing process.

**[0055]** According to this example, the annealing process was completed in 21 minutes, compared to a conventional annealing process requiring 45 minutes to finish. This is because the flame size of the burners may be adjusted precisely in each area between the shielding plates. In addition, rapid burning and cooling are achieved by, in the front half of the furnace, introducing air and gas into the furnace by means of a combustion fan and discharging the exhaust gas out of the furnace by means of an exhaust fan, and in the rear half of the furnace, introducing air or cool air into the furnace by means of a cooling fan and discharging the air out of the furnace by means of the cooling exhaust fan.

Example 4

**[0056]** Fig. 11 shows an example wherein the same vehicle parts as in the example shown in Fig. 10 were annealed in a still shorter time. According to this graph, the annealing process was started at about 120 °C. The temperature was raised for 4.8 minutes, and the maximum temperature (1100 °C) was maintained for about 3.7 minutes (until 8.5 minutes from the start). Then the temperature was rapidly lowered for 1. 5 minutes, and finally slowly lowered for 6 minutes.

**[0057]** In this example, the vehicle parts were annealed in 16 minutes in total, which is still shorter than in the previous example.

**[0058]** The above examples have been discussed in relation to ceramic products. However, it is understood that a variety of articles may be treated according to the present invention by selecting suitable conditions, such as attachment and height adjustment of the shielding plates, the burning temperature and time of the burners, and the temperature and time for cooling with the cooling air.

**Claims**

**1.** A detachable, movable, continuous furnace comprising:

a plurality of unit furnaces;
burners for projecting gas into said unit furnaces; and
a control panel for controlling ignition of gas, flame size and duration, and extinction of the burners;

wherein said plurality of unit furnaces of the continuous furnace are arranged continuously via interposed shielding plates for controlling the furnace temperature,

wherein, in at least a part of said plurality of unit furnaces, ports of said burners are arranged in facing side walls of each unit furnace in predetermined positions out of registration with each other for forced-generating whirl flows of flames in the furnace, and

wherein conveyor means is provided passing through the plurality of continuous unit furnaces.

**2.** The continuous furnace of claim 1, wherein, when a furnace casing is in the form of a substantially rectangular cylinder having a pair of facing side walls, one of said burner ports is arranged in each of the facing side walls so that a total of two of said burner ports are arranged out of registration with each other for forming flames from said two burner ports into a clockwise or counterclockwise whirl flow, or alternatively, two of said burner ports are arranged in each of the upper and lower sections of the facing side walls so that a total of four of said burner ports are arranged out of registration with each other for forming flames from said four burner ports into upper and lower whirl flows in the same clockwise or counterclockwise direction or in the reverse directions.

3. The continuous furnace of claim 1, wherein directions of projection through the burner ports into the furnace are controllable either automatically with said control panel or manually.

4. The continuous furnace of claim 1, wherein each of said shielding plates is vertically movable up and down within a range of height in the furnace without hitting molded products being conveyed on the conveyor means.

5. The continuous furnace of claim 1, wherein each of said shielding plates is insertable into and drawable out of the furnace by transversely moving from side to side at a height in the furnace without hitting molded products being conveyed on the conveyor means.

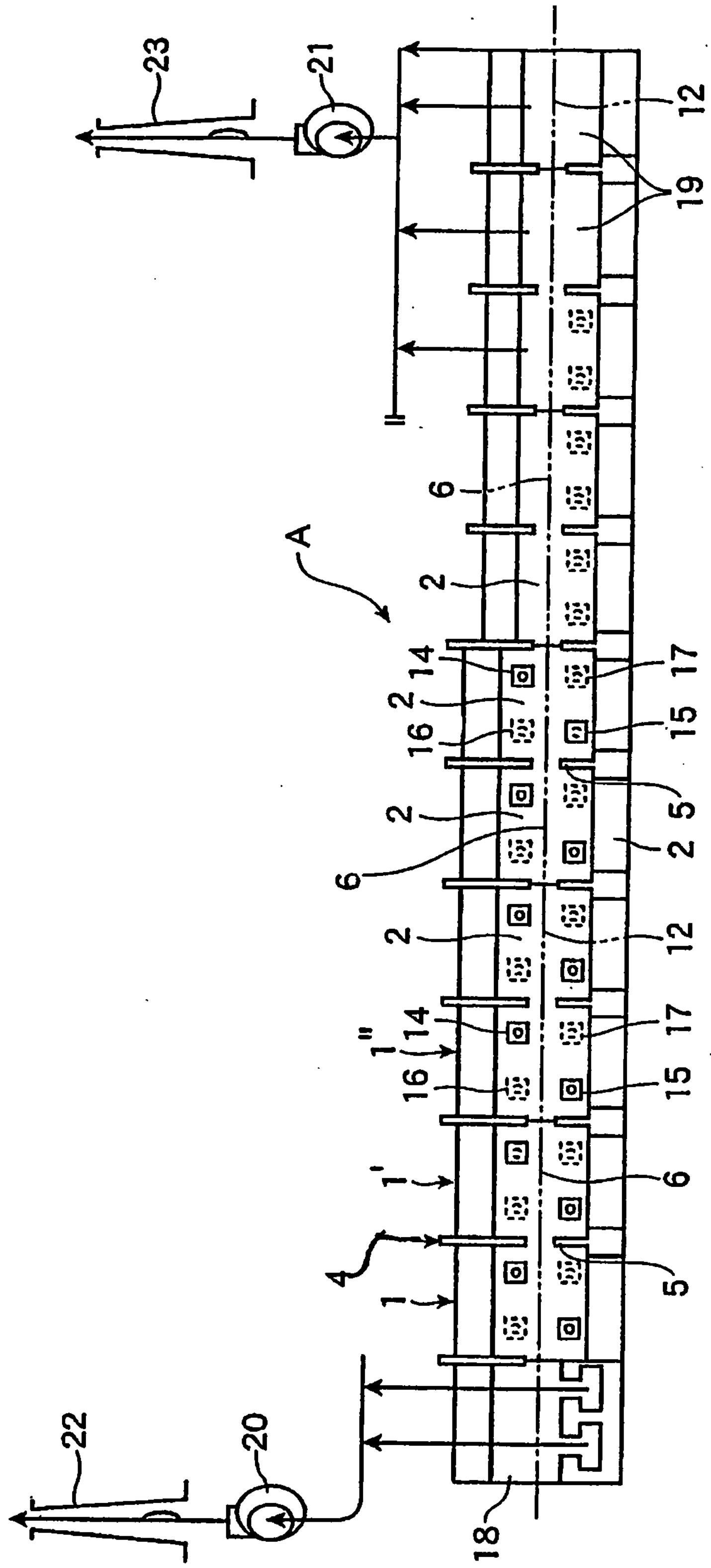
6. The continuous furnace of claim 1, wherein each of said vertically or transversely movable shielding plates is split into upper and lower sections above the conveyor means, and said lower section is vertically or transversely movable, and wherein the burners are capable of baking molded products from above and below the conveyor means.

7. The continuous furnace of claim 6, wherein each of said lower shielding plates is adjustable in height either manually or automatically by means of lifting means provided outside the unit furnace, for controlling the temperature of each unit furnace separately.

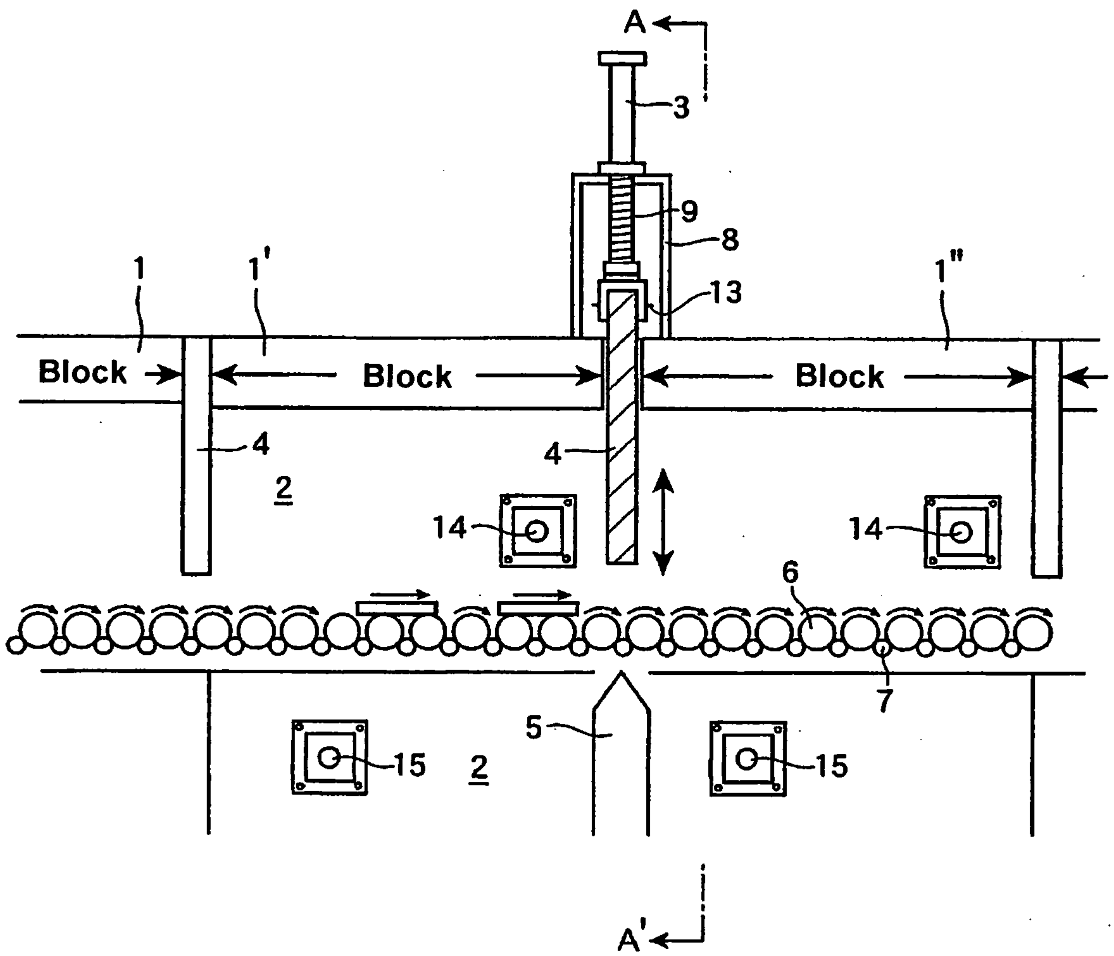
8. The continuous furnace of claim 1, wherein said conveyor means comprises heat-resistant rollers rolling on bearings, wherein said burners are arranged so as to bake molded products from above and below said rollers.

9. The continuous furnace of claim 1, wherein, in the front section of the continuous furnace comprising said plurality of unit furnaces, air and gas are introduced into the furnace with a combustion fan and a combustion flue is provided for discharging exhaust gas out of the furnace with an exhaust fan, and in the rear section of the continuous furnace, air or cool air is introduced into the furnace with a cooling fan and a cooling flue is provided for discharging air out of the furnace with a cooling exhaust fan.

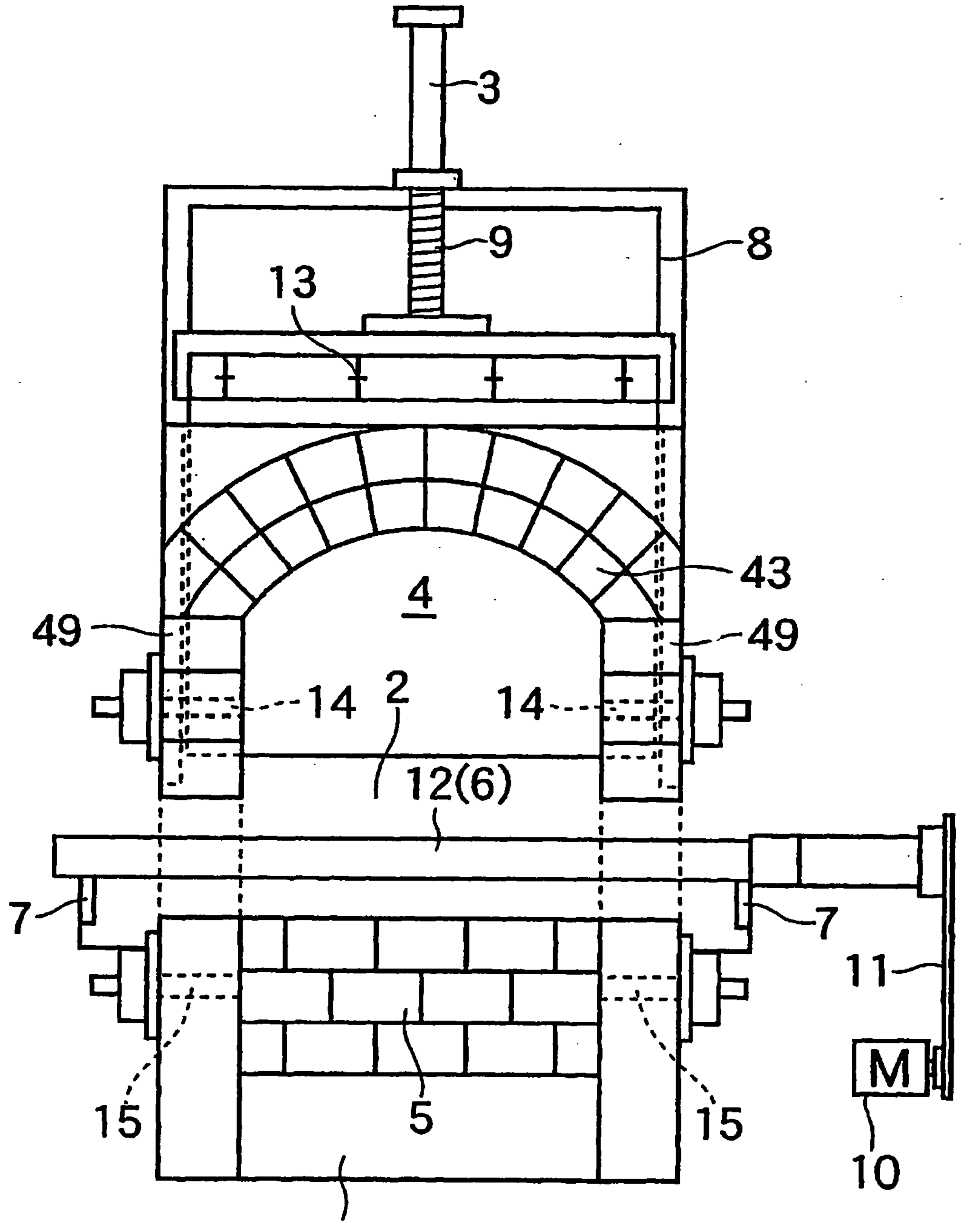
Fig. 1



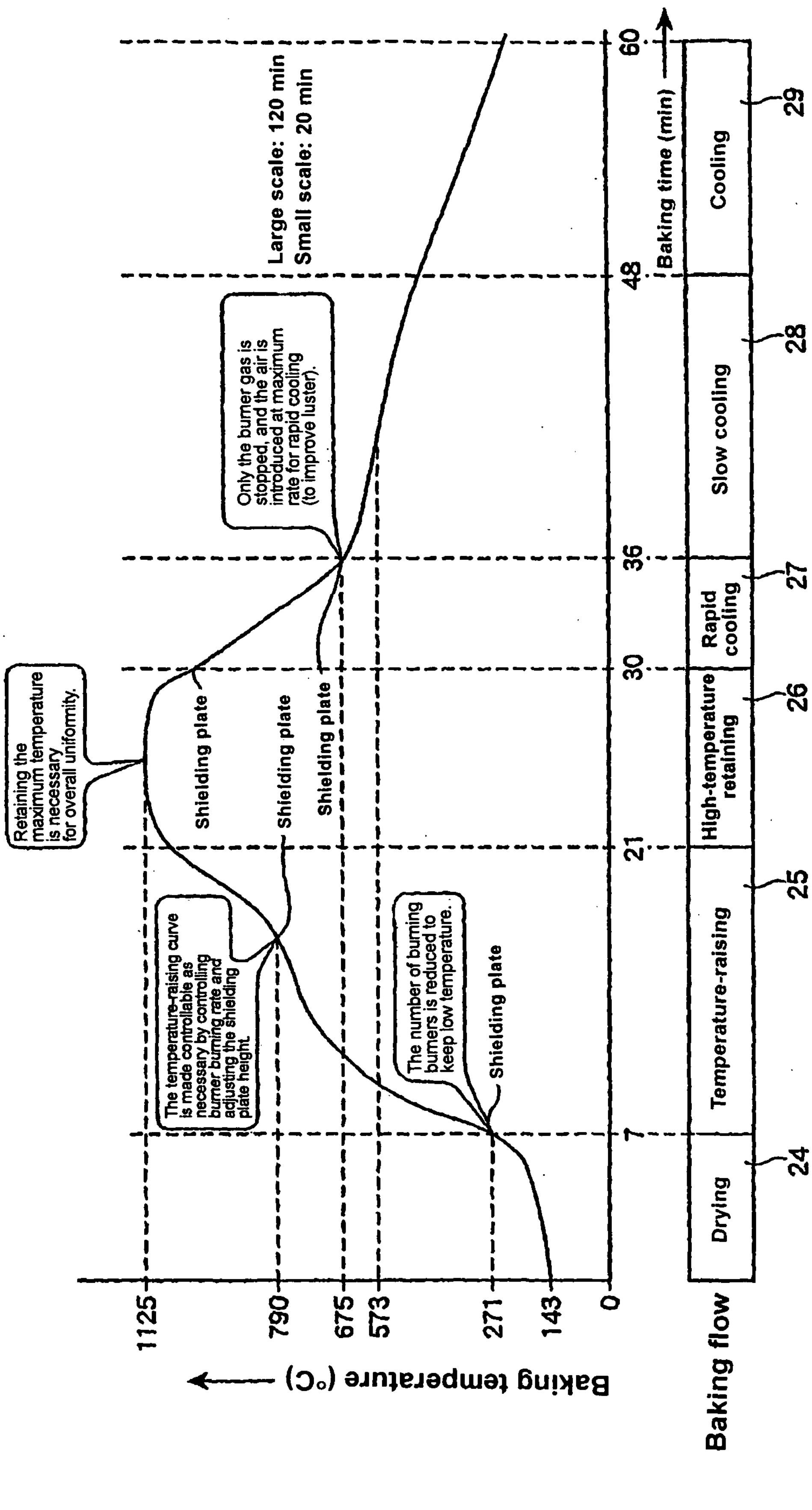
# Fig. 2



# Fig. 3



# Fig. 4


Retaining the maximum temperature is necessary for overall uniformity.
The temperature-raising curve is made controllable as necessary by controlling burner burning rate and adjusting the shielding plate height.
Only the burner gas is stopped, and the air is introduced at maximum rate for rapid cooling (to improve luster).
The number of burning burners is reduced to keep low temperature.
Shielding plate
Shielding plate
Shielding plate
Shielding plate
Large scale: 120 min
Small scale: 20 min
Baking temperature (°C)
1125
790
675
573
271
143
0
7
21
30
36
48
60
Baking time (min)
Baking flow
Drying
Temperature-raising
High-temperature retaining
Rapid cooling
Slow cooling
Cooling
24
25
26
27
28
29

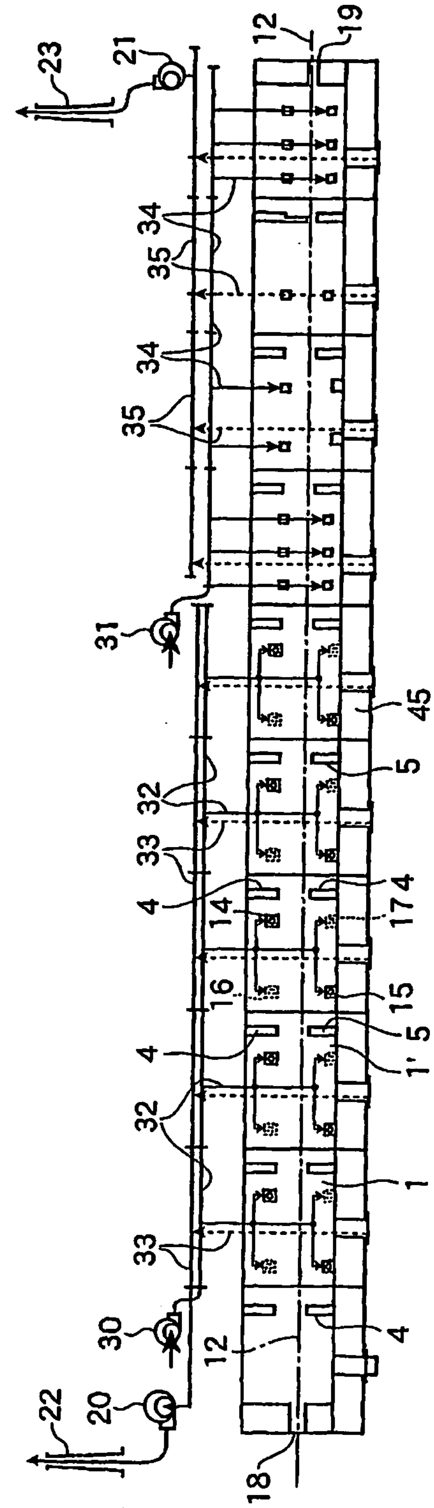

23
21
12
19
34
35
34
35
31
45
5
32
33
4
174
14
16
15
4
1' 5
32
1
33
30
12
4
22
20
18

Fig. 5

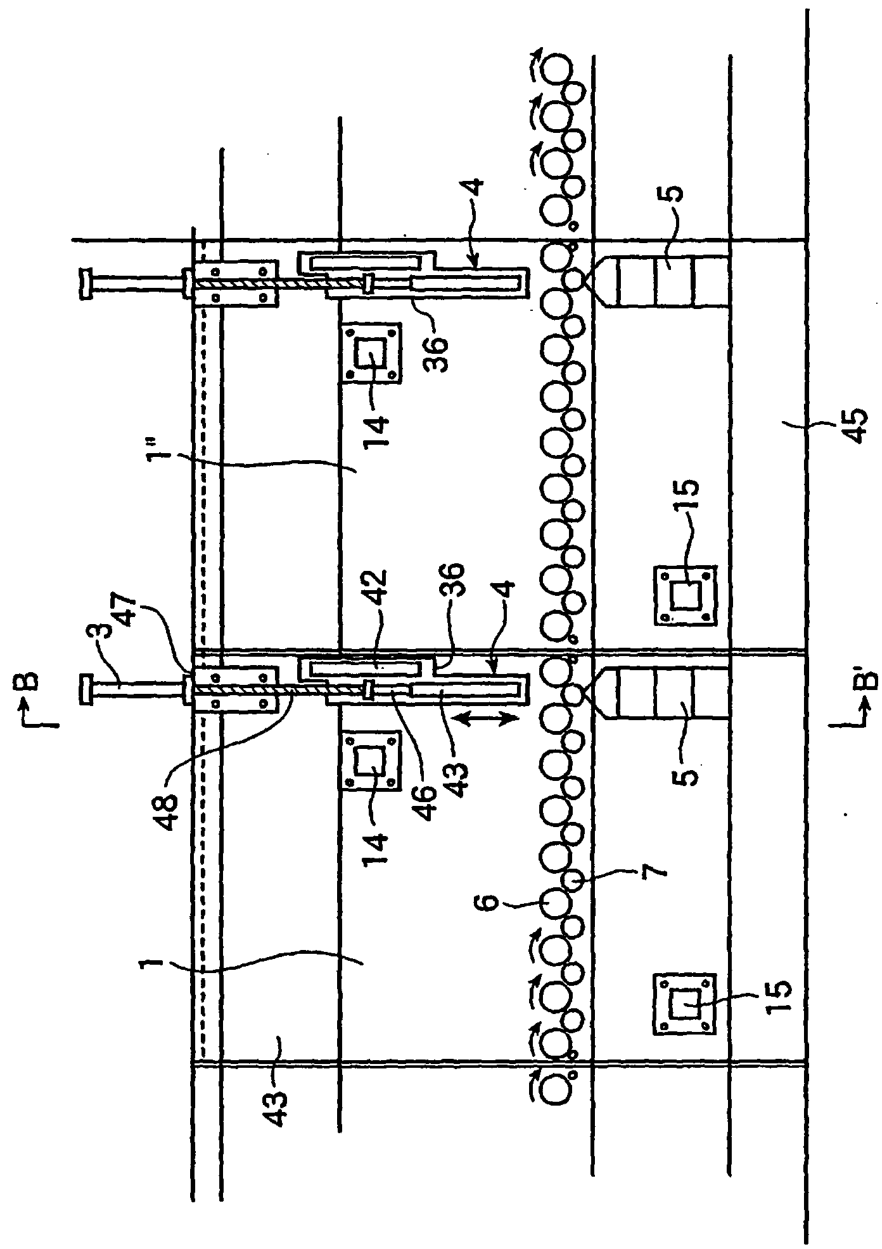
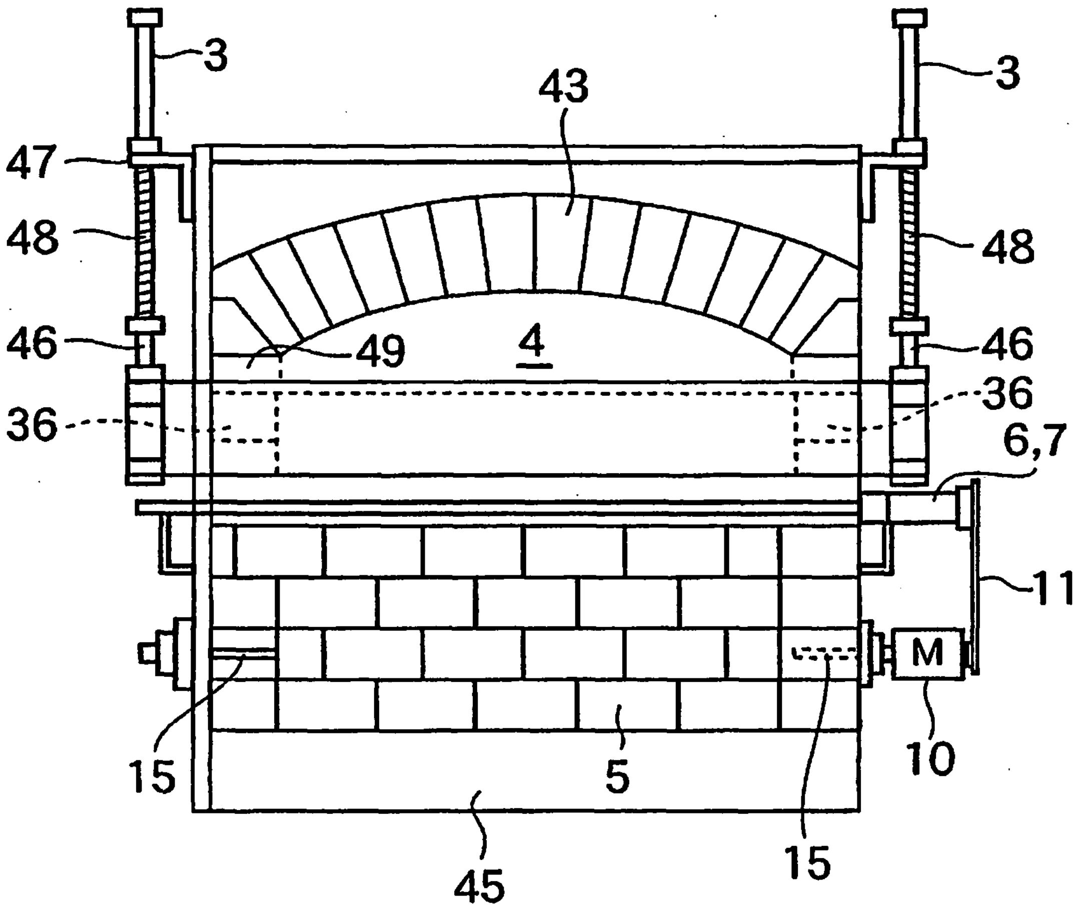



Fig. 6

# Fig. 7



# Fig. 8

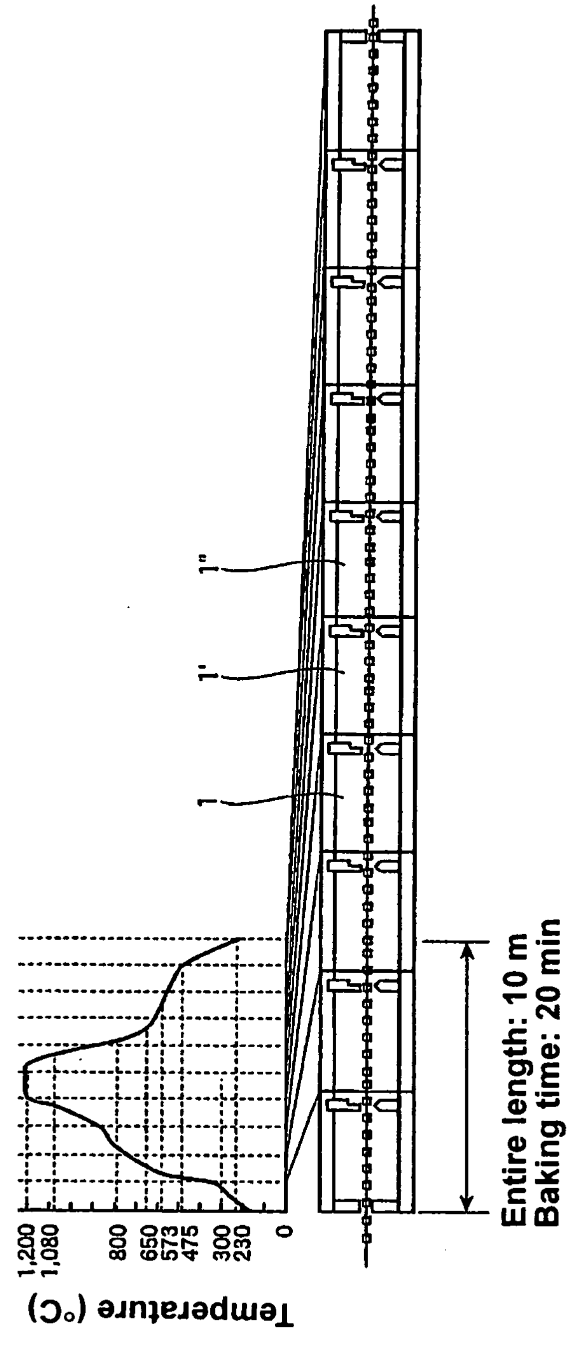

Temperature (°C)
1,200
1,080
800
650
573
475
300
230
0
1
1'
1"
Entire length: 10 m
Baking time: 20 min

Fig. 9

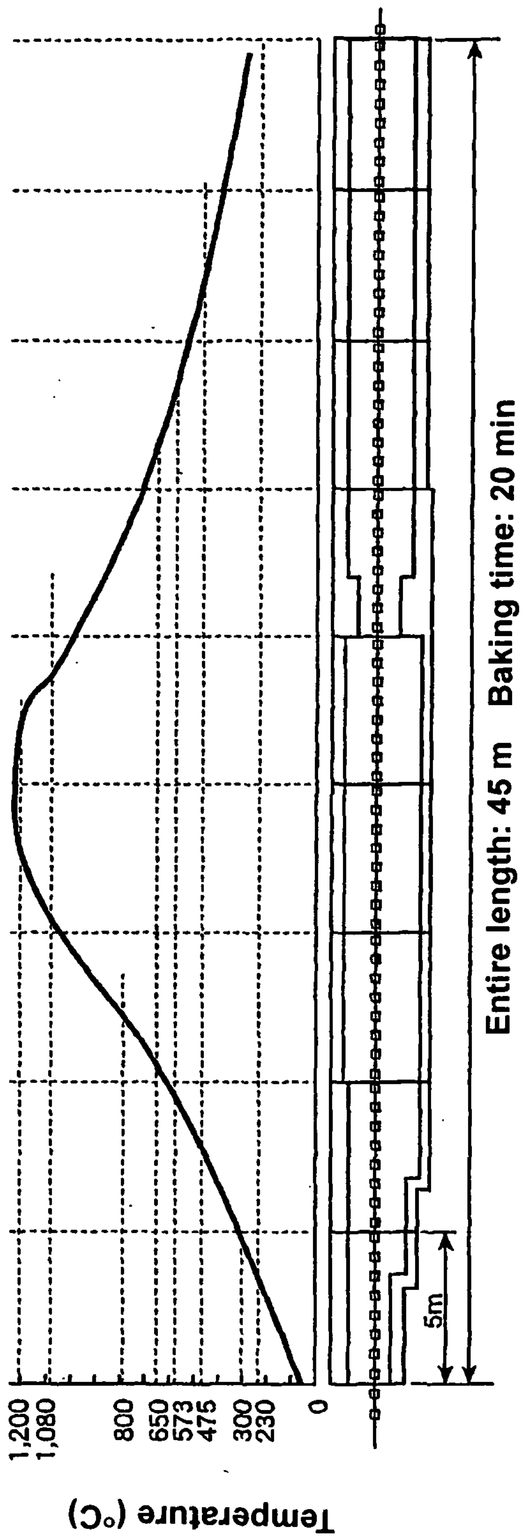
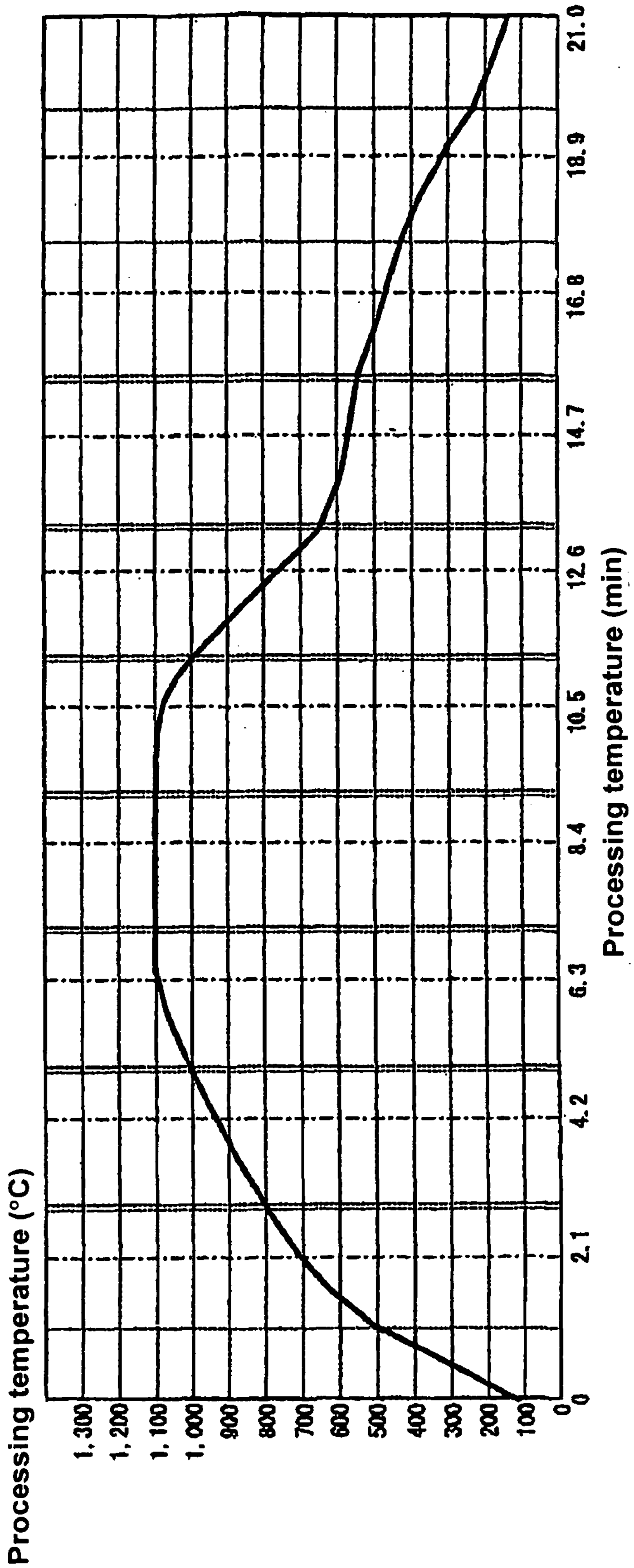

Temperature (°C)
1,200
1,080
800
650
573
475
300
230
0
5m
Entire length: 45 m Baking time: 20 min

Fig. 10


Processing temperature (°C)
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0
2.1
4.2
6.3
8.4
10.5
12.6
14.7
16.8
18.9
21.0
Processing temperature (min)

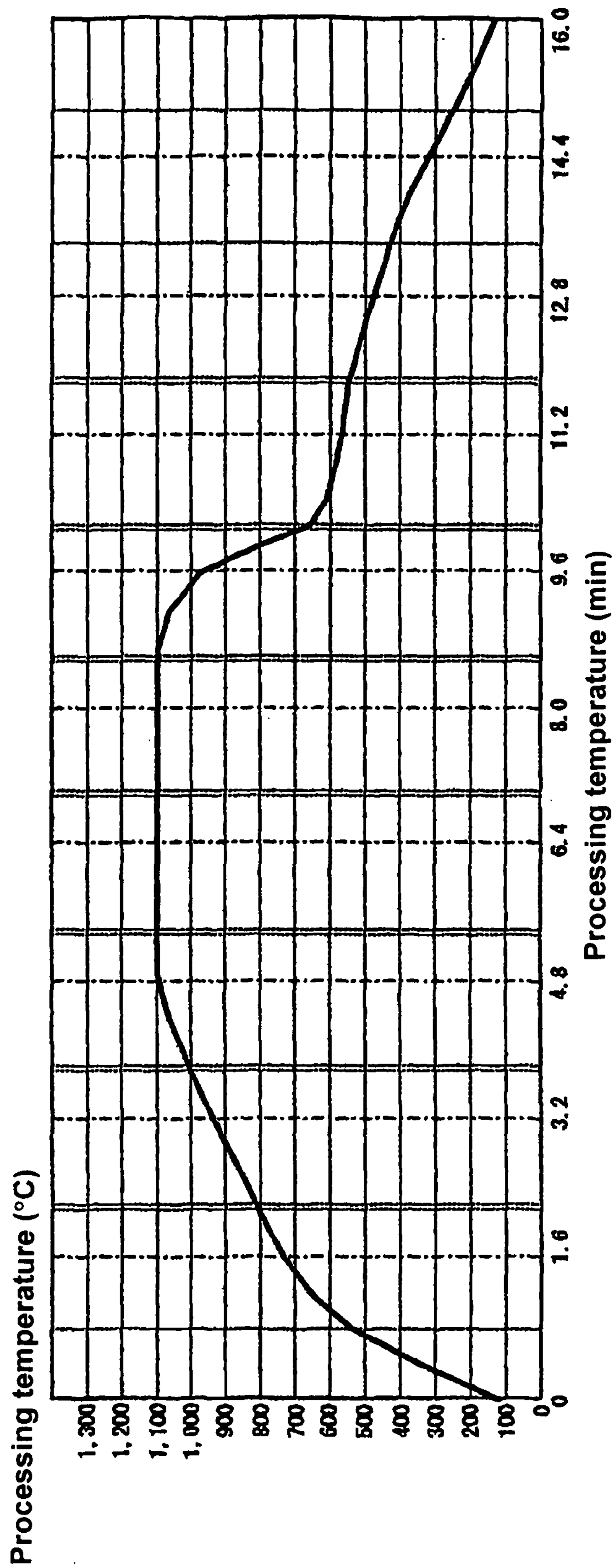

Processing temperature (°C)
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
0
0
1.6
3.2
4.8
6.4
8.0
9.6
11.2
12.8
14.4
16.0
Processing temperature (min)

Fig. 11

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP03/13516

**A. CLASSIFICATION OF SUBJECT MATTER**
Int.Cl[7] F27B9/02

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] F27B9/00-9/40

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

| | | | |
|---|---|---|---|
| Jitsuyo Shinan Koho | 1922-1996 | Toroku Jitsuyo Shinan Koho | 1994-2004 |
| Kokai Jitsuyo Shinan Koho | 1971-2004 | Jitsuyo Shinan Toroku Koho | 1996-2004 |

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | US 4249895 A (Welko Industriale S.p.A.), 10 February, 1981 (10.02.81), & GB 2007810 A & JP 54-99111 A | 1-9 |
| A | JP 5-239558 A (Kawasaki Steel Corp.), 17 September, 1983 (17.09.83), (Family: none) | 1-9 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

| | |
|---|---|
| Date of the actual completion of the international search<br>20 January, 2004 (20.01.04) | Date of mailing of the international search report<br>03 February, 2004 (03.02.04) |
| Name and mailing address of the ISA/<br>Japanese Patent Office<br><br>Facsimile No. | Authorized officer<br><br>Telephone No. |

Form PCT/ISA/210 (second sheet) (July 1998)