United States Patent [19]

Benard

[11] **3,818,181**

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[54] **TUNNEL FURNACE, RESISTANCE TYPE**

[75] Inventor: **Claude Benard,** L'Etang-la-Ville, France

[73] Assignee: **Saint-Gobain Industries,** Neuilly-sur-Siene, France

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[52] **U.S. Cl.** **219/388,** 13/20, 219/403

[51] **Int. Cl.** **F27b 9/06**

[58] **Field of Search** 219/388, 403, 405, 523; 34/39, 217; 263/28; 13/6, 20, 22, 25

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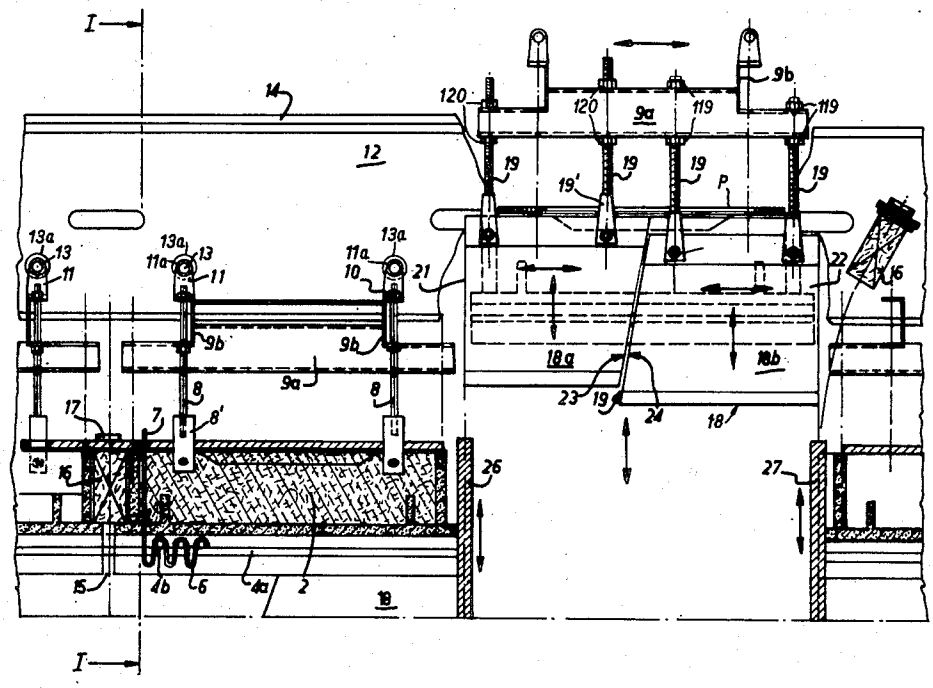
Primary Examiner—Volodymyr Y. Mayewsky
Attorney, Agent, or Firm—Pennie & Edmonds

[57] **ABSTRACT**

A tunnel furnace of electrical resistance type comprising means to transport objects which are to be heated through the tunnel, means to heat the objects as they pass through the furnace comprising separate banks of resistances and means to supply each bank with current individually, means to mount each bank in operating position individually, means to remove each mounting means and its bank of resistances individually from the furnace, and means to maintain any remaining banks at operating temperature. A method of controlling the heating of glass moving through a tunnel furnace of electrical resistance type which comprises arranging the resistances in separate gangs separately supplied with current, arresting the movement of the glass when a gang of resistances is to be repaired, sealing off the portions of the tunnel adjacent the gang which is to be repaired, thereby maintaining such portions at operating temperatures, replacing the inefficient gang of resistances, removing such seals, and returning the furnace to operation.

5 Claims, 2 Drawing Figures



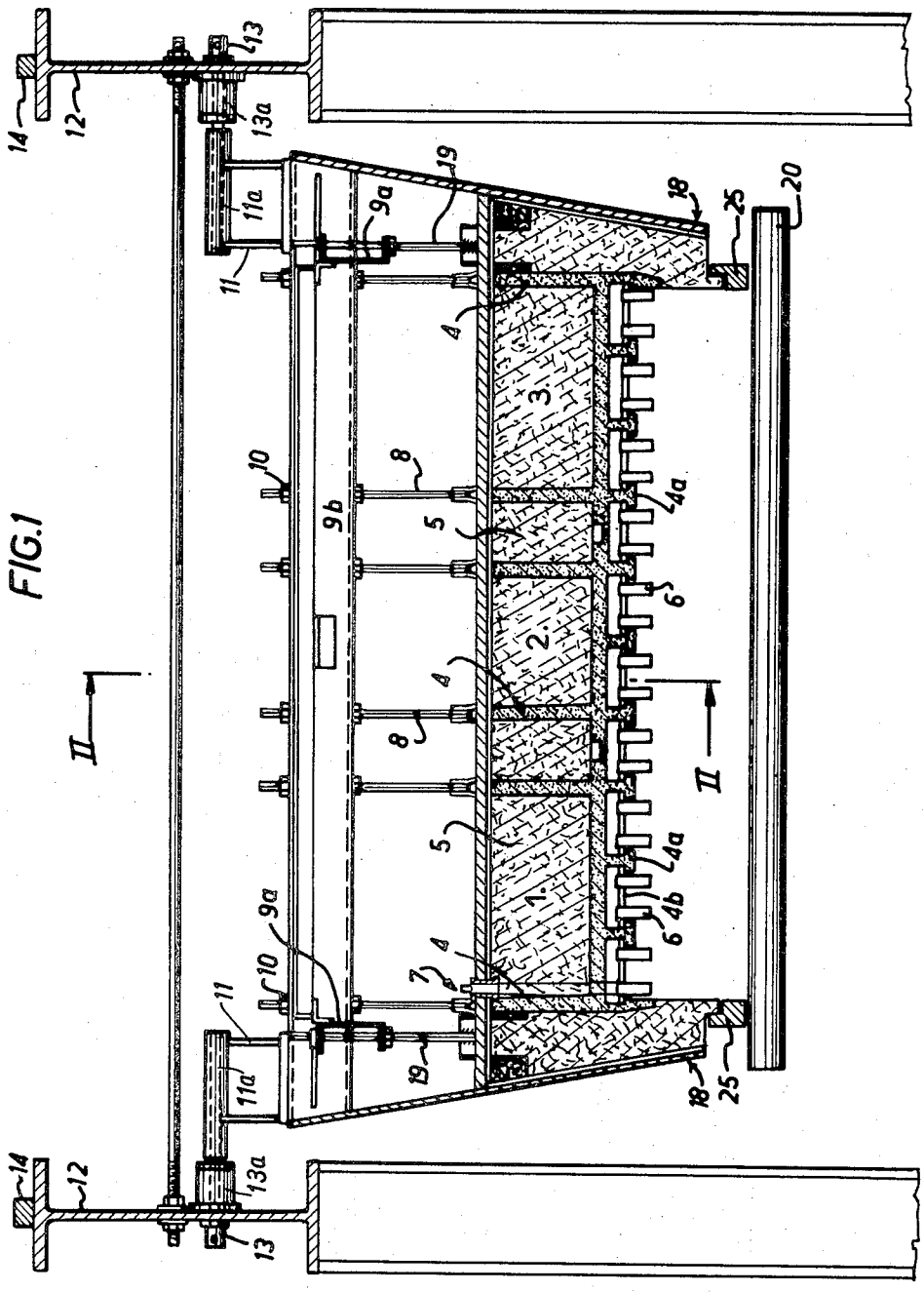
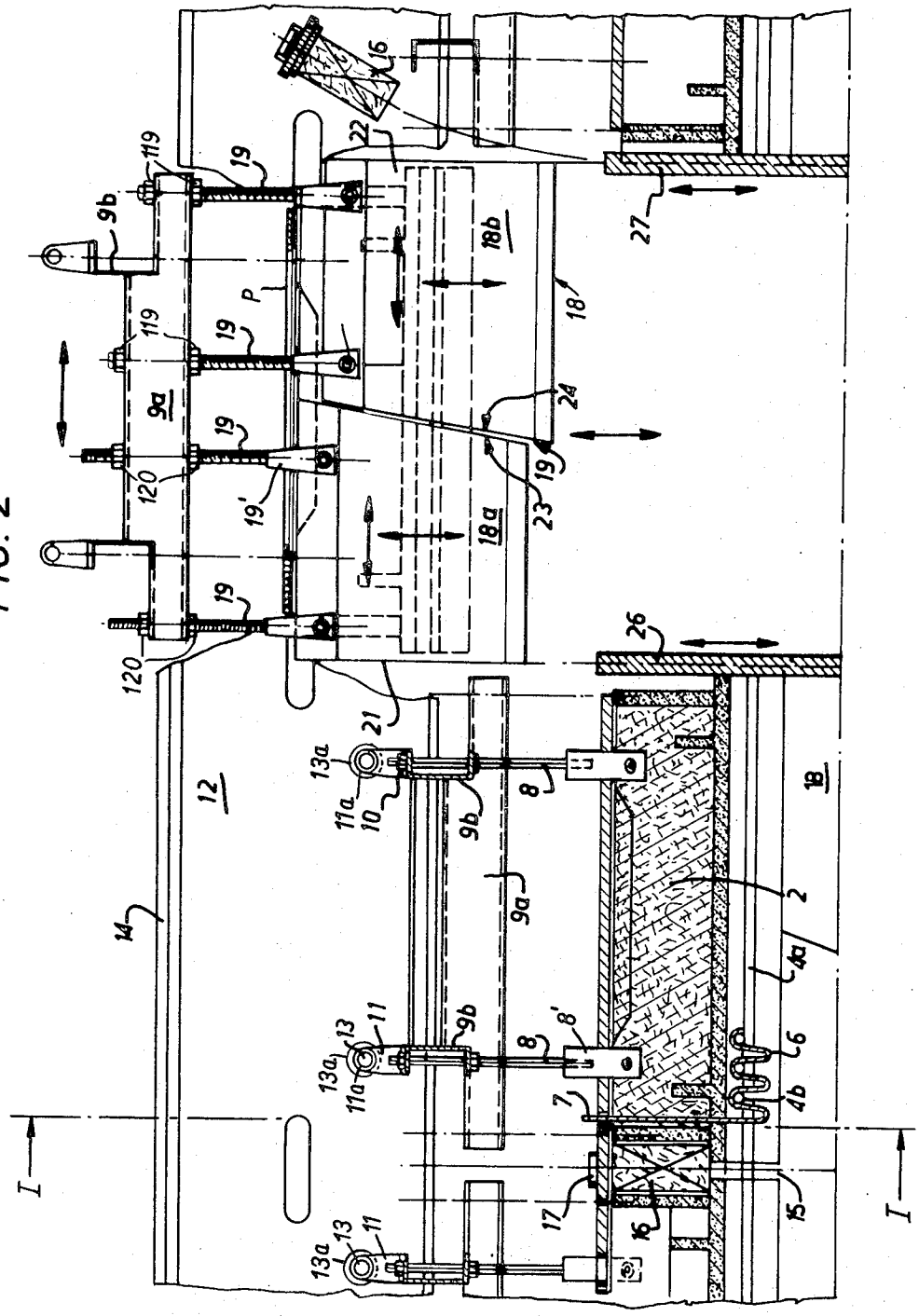


FIG.1

FIG. 2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TUNNEL FURNACE, RESISTANCE TYPE

This invention relates to a tunnel furnace for the heating of sheets of glass, traveling horizontally, to the temperature necessary to their treatment, for example for tempering or bending. It is useful as an improvement over the tunnel furnace disclosed in U.S. Pat. No. 3,637,912.

In such tunnel furnaces the glass sheets are supported by and transported on rollers or air cushions and pass by electric heating resistances which supply necessary heat by radiation. We will not attempt to describe the various heating systems that have been found to be useful. The temperature control of such furnaces is precise to prevent the occurrence of deformations and even the breaking of the glass. The heating resistances are normally at a temperature of at least 1,000°C., which degrades them rapidly and requires that they be replaced at relatively frequent intervals. When replacement becomes necessary the operation is stopped, the furnace is cooled down, the resistances are replaced and a long time passes before the furnace is again at equilibrium temperature and able to perform its function properly.

It is an object of this invention to make a furnace in which defective resistances can be replaced rapidly without cooling down the furnace and which can go back into operation as soon as the resistances have been replaced. Another object is to conserve heat in the operation of tunnel furnaces. Another object is to provide a tunnel furnace having a sectional vault and satisfactory thermal characteristics. Another object is to provide a sectional furnace with construction capable of ready handling of sections needing repair and with means for conserving the heat in sections not under repair. Another object is to establish an operating method whereby the repair of a part of a furnace will not result in unbalancing the remainder of the furnace cycle. Another object is to increase the output of such furnaces without increasing the use of heat.

These objects are accomplished as stated in the claims and in the specification and drawings hereof. In this invention defective resistances or other damage can be repaired quickly, without cooling the furnace, and the furnace can be returned to operation at once following the repairs. As a consequence, the yield of such furnaces is materially increased.

These furnaces have separate banks of heating resistances separately mounted and separately and readily removable for repair. They also have means for sealing off the areas which are still at operating temperature to keep them at equilibrium. The following description is of a preferred example of a furnace constructed according to this invention, in which the vault is constructed of a series of independent sections arranged in longitudinal juxtaposition, suspended movably from an exterior frame and constituted of resistance carriers between two uprights. It is also characterized by the fact that the resistance carriers are spaced from one another sufficiently to permit the introduction of insulating screens across the furnace to seal off the rest of the furnace from the space occupied by the section undergoing repair. Maintenance of the other sections of the furnace at operating temperature while one section is being repaired results in the loss of only a relatively small quantity of energy, a rapid replacement of defective parts, and prevents any substantial reduction in the output of the furnace.

In normal operation the spaces left between the sections of the vault, are closed by removable insulating means which seal the openings and complete the enclosure of the furnace. They are normally provided with lifting means to facilitate handling.

The sections have been referred to above as sections of the vault but they can also be considered as plates for supporting the resistances surmounted by insulating means, but in either case they are to be provided with means for lifting them and handling them readily. In our specific example they are supported solely by an exterior frame and have no effect on the durability of the masonry of the furnace, contrary to usual furnace practice.

The above and further objects and novel features of the present invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings. It is to be expressly understood, however, that the drawings are for the purpose of illustration only and are not intended as a definition of the limits of the invention.

In the drawings, wherein like reference characters refer to like parts throughout the several views,

FIG. 1 is a vertical cross section of the furnace on the line I—I of FIG. 2; and

FIG. 2 is, at the left, a partial longitudinal section on line II—II of FIG. 1, the remainder of FIG. 2 being in elevation illustrating the construction and operation of the furnace.

Referring to FIG. 1, each section of the vault of the furnace is composed, across its axis, of three, resistance-carrying plates 1, 2, 3 each of which is constituted by a cast silica box 4 which, because of its nature, has a very low coefficient of expansion, which is important for ease of movement at hot temperatures. These boxes are filled with thermal insulation 5 and on their lower faces they have flanged ribs 4a parallel to the furnace axis upon the shoulders of which pins 4b rest and support the resistance ribbons 6, the ends of which are projected as at 7 (FIG. 2 left) for attachment to a convenient source of current. These resistances are suspended in loops, being flexible, and their replacement is the work of only a few minutes once the supporting box is raised.

The boxes of each section are each supported by four hangers 8 from a rectangular frame formed, for each three-box section, by two beams 9b perpendicular to the furnace axis and two others 9a parallel to the axis and affixed to those beams 9b. The hangers support the boxes and allow them to be regulated in vertical position by means of the nuts 10 on screw threaded upper ends of the hangers. The frame 9*a* 9*b* is provided at each corner with a bracket 11, affixed to one of the beams 9*b* at one end thereof. The bracket has a sleeve 11*a* affixed thereto to receive a removable pin 13, passing through an aperture through the beam 12 and through a short tube 13*a* affixed to the beam 12. The beams 12 are supported from the floor by columns and extend the full length of the furnace. The boxes, that is to say the vault, is wholly suspended and its weight is not borne by the masonry of the furnace. To change a vault section, a crane, not shown, runs on tracks 14 affixed to the upper surface of the beams 12 to a position above the box. Hooks are lowered to engage the brackets 11, the pins 13 are withdrawn, and (after prelimi-

nary steps disengaging the side wall pieces of the section as described below) the section is raised to a position of repair. At the right of FIG. 2 is shown a box in raised position, together with some additional features of the invention.

It will be seen in FIG. 2 that the sections of the vault do not touch, longitudinally of the furnace, but have a slot 15 between them at the bottom of a gap formed by their spaced ends. This slot extends completely across the furnace and is closed by a refractory insulating plug 16 provided with straps 17 for lifting it into and out of position.

Referring to FIG. 1, above the sole of the furnace, not shown, is a gang of parallel horizontal rollers 20 which extend across the furnace and transport the glass plates through it. The sides of the vault are made up of side pieces generally indicated at 18. Each of these comprises two parts 18*a* and 18*b* made of refractory material. The parts 18*a* and 18*b* of each side piece 18 are suspended by screw type, adjustable hangers 19 (FIG. 2) from beams 9a. Each of the side pieces 18 corresponds to the length of a vault section and is subdivided into two trapezoidal parts 18*a* and 18*b* (see right-hand portion of FIG. 2). When the two parts 18*a* and 18*b* of a side piece 18 are at the same height, the side piece 18 so formed fills the entire space lengthwise of the furnace between the adjacent upstream and downstream side pieces 18, and the inclined faces 23, 24 are also tightly engaged, so that all the side pieces form a continuous wall. When an element or section of the vault, comprising the three plates 1, 2 and 3 and the two appurtenant side pieces 18, is to be withdrawn for repairs, longitudinal strip plugs 25 which close the gap between the side pieces and the rollers 20 are removed from below the side pieces 18 of that section at the two sides of the furnace. In each of those side pieces 18, the part 18*b* is then lowered by adjustment of the nuts 119 on the hangers 19 of that part 18*b* until a gap of perhaps a few centimeters appears between that part 18*b* and its mating part 18*a*. Then by loosening the nuts 120 on the hangers 19 of the mating part 18*a*, that part 18*a* can be shipted lengthwise of the furnace to create a clearance between the section 18 comprising the parts 18*a* and 18*b* so moved and the side pieces 18 upstream and downstream thereof. It is then possible to raise the entire section at its frame 9*a*–9*b*, lifting with that frame the plates 1, 2 and 3 and their appurtenant side pieces 18. A section so raised for repairs is shown at the right in FIG. 2. Thereafter, the plugs 16 at the upstream and downstream ends of the section being also removed, screens 26, 27 (FIG. 2) are lowered into position across the furnace, through slots 15, sealing the upstream and downstream sections against loss of heat. Thus the section of the furnace between the screens 26, 27 is isolated and the resistance ribbons 6 can be replaced rapidly and without cooling the remainder of the furnace.

The elevated section of the vault can be wholly replaced immediately, by maintaining a spare section, and the whole furnace restored to full operation in the time required to make the change, leaving the repair of the section withdrawn to await the convenience of the repair crew or until it has cooled to comfortable temperature. Once the new or repaired section has been lowered into operating position the strip plugs 16 are put in place, and the insulating screens 26, 27 are withdrawn, the procedure being the reverse of that used in removing it. The heating of the new section is very rapid, beginning if desired by activating the resistances as soon as repairs have been made (in cases where a spare section is not kept in readiness) so that heating proceeds as the section is being emplaced, while the removal of the screens 26, 27 floods the section with heat from the contiguous sections, allowing production to proceed promptly.

The amount of heat and power saved by this apparatus is very large and the idle time of the furnace occasioned by repairs is reduced to a small fraction of that which was previously necessary. The result is that the output of the furnace becomes a multiple of that which was previously possible with a unitary furnace of similar size and heating characteristics.

The construction of the furnace below the rollers 20 has not been shown but it can be presumed to be of cast refractory, or of refractory blocks, constructed according to proper engineering principles and resting on the floor of the factory. Driving means for the rollers is also not shown, being conventional. The furnace is thus comprised of a fixed base surmounted by a sectional vault, the sections of which are suspended and individually removable for repair or replacement. The lower ends of hangers 8 may be secured to the longitudinal vertical ribs or flanges of boxes 4 in any suitable manner, such as by means of depending metal strips 8′ and bolts 8*a*. The lower ends of hangers 19 may be similarly secured, as by strips 19′ and bolts 19*a*, to the upper reduced edges of blocks 18*a*, 18*b*. The boxes 4 may be provided with cover plates P which extend transversely between hangers 8, 8′ and the upper ends of insulating plugs 16.

As many apparently widely different embodiments of the present invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments.

What is claimed is:

1. A thermally and electrically insulative tunnel furnace comprising conveyor means to transport objects longitudinally of the tunnel of the furnace and a refractory vault positioned over the conveyor means and forming the ceiling of the furnace, said vault comprising a plurality of separate sections placed in end-to-end relation lengthwise of the furnace, each said section including generally horizontal plate means, electrical resistance heating means arranged on said plate means, and a generally vertical side wall piece adjacent each longitudinal edge of said plate means, the side wall pieces of adjacent sections being in close end-to-end relation to form substantially continuous side walls longitudinally of the vault, said vault further comprising for each section a supporting frame and means for individually suspending the plate means and each of the side wall pieces of such section in operative assembly from said frame, each said side wall piece being divided into two parts individually suspended from said frame for vertical adjustment relative to each other in a manner to selectively increase or diminish the effective extent thereof longitudinally of the vault.

2. The combination comprising a tunnel furnace as defined in claim 1, track means extending longitudinally of the furnace, and a crane operable on said track means and operable to engage any of said supporting frames for lifting a section vertically from the vault and

transporting the same above and longitudinally of the vault.

3. A tunnel furnace as defined in claim 1 wherein the plate means of adjacent sections of the vault are longitudinally spaced, said furnace further comprising means for closing the spaces between adjacent ones of said plate means.

4. A tunnel furnace as defined in claim 3 wherein said space closing means are readily removable and replaceable when the sections are in assembled relation.

5. A tunnel furnace according to claim 1 wherein the two parts of each of said side pieces are of generally trapezoidal shape in elevation and are divided along a line inclined to the vertical extending from top to bottom of each said side piece.

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