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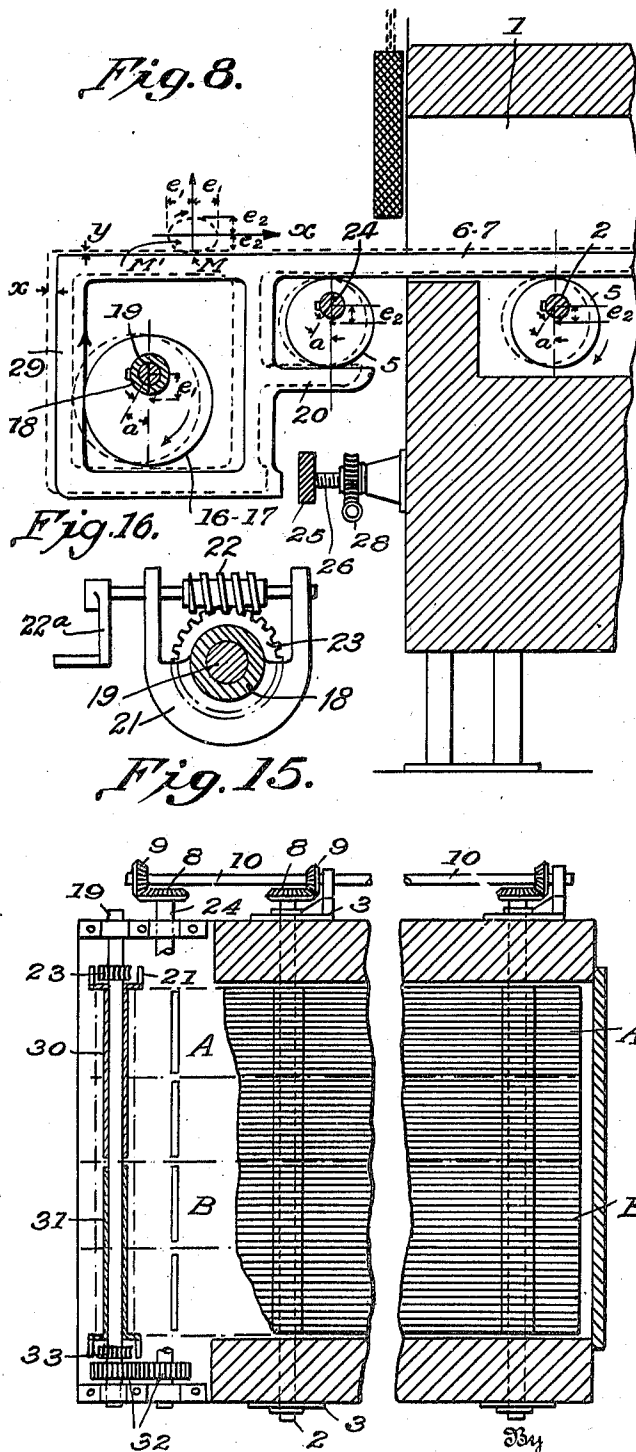
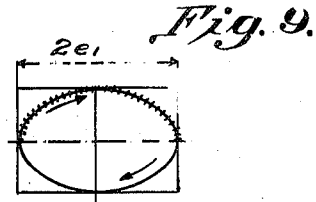
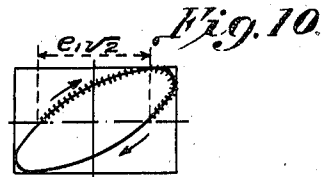
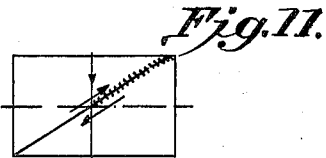
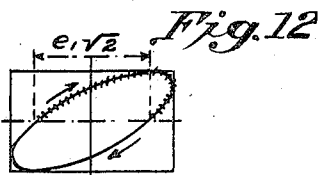
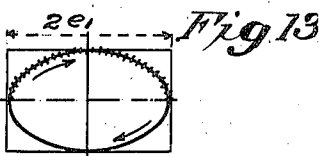
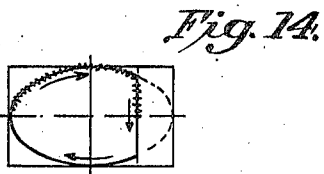
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2,122,200

APPARATUS FOR CONVEYING OBJECTS TREATED IN CONTINUOUSLY OPERATING FURNACES

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APPARATUS FOR CONVEYING OBJECTS
TREATED IN CONTINUOUSLY OPERATING
FURNACES

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16 Claims. (Cl. 198-219)

This invention relates to apparatus for conveying objects being treated in continuously operating furnaces.

In order to circulate objects intended to undergo heat treatment in continuously operating furnaces it has been proposed to provide so-called rail conveyors therein, these being formed of two groups of bars or plates animated with a combined vertical and horizontal movement, such that the advance movement of one group of bars, located in the elevated position and supporting at this moment the objects being treated, takes place at the same time as the return of the other group which is then in the low position, without contact with the objects being treated.

In existing furnaces all the mechanism is located exterior of the furnace or at least outside of the hot parts, so as to be inspected, maintained and lubricated, and each bar of a group is affixed by transverse cast shoulders to an outer frame directly actuated by the mechanism. These shoulders or transverse members require for their passage slots or openings in the furnace walls, these latter admitting air and interfering with the heating of the furnace. If the number of bars is multiplied to permit the transportation of small objects the number of such openings will naturally be multiplied, thus resulting in complicated and delicate mechanism. These defects, notwithstanding the advantages offered, make rail furnaces useless for delicate tempering operations.

The method of the present invention, which overcomes these defects, consists in subjecting the conveyor bars or plates, on which the objects intended to be treated in the furnace are placed, to a tractional force the resultant of which is exerted solely at one of their ends, while the lifting forces exerted by eccentrics and distributed over the entire length of said plates or bars are suitably directed opposite each other, so as to produce a partial or total equilibrium of said plates or bars, in order to advance or move the materials treated, with a minimum of force and with a single resultant producing the constant operation of said bars under tension.

This application is an improvement over my prior filed application, Serial No. 679,439, filed July 7, 1933, now Patent No. 2,008,696, issued July 23, 1935.

An exemplary embodiment of a conveyor constructed in accordance with the invention is illustrated on the accompanying drawings as applied to a continuously operating furnace.

Fig. 2 is a horizontal section of the furnace at the level of the transporting platform (conveyor table), on II-III of Fig. 1.

Fig. 3 is a cross section of the furnace on III-III of Fig. 1.

Fig. 4 is a partial perspective view on enlarged scale showing the two sets of plates forming the conveyor platform.

Figs. 5 and 6 are sections of transverse shafts supporting the plates of the platform, showing the 180° displacement of two successive eccentrics supporting the plates.

Fig. 7 is a partial cross section of the platform, showing the conveyor plates in the high and low position.

Fig. 8 is a section on enlarged scale showing details of Fig. 1, and the mechanism positioned in the insertion or charging side of the furnace.

Figs. 9 to 14 show paths which can be realized for any point of the conveyor platform.

Fig. 15 is a plan view of an example of the invention for a furnace having four zones of independent speeds.

Fig. 16 is a detail view illustrating an arrangement for adjusting the sleeve 18, which carries the actuating cams 16, 17, angularly in respect to the shaft 19.

The continuously operating furnace 1 (Figs. 1 and 2) comprises the transverse shafts 2, of any number desired mounted in any suitable manner in the bearings 3 (Fig. 2) exterior of the furnace; each of these shafts carries eccentric pulleys or cams 4, 5, all having the same eccentricity, but two successive pulleys are relatively displaced or staggered 180°, as shown on Figs. 5 and 6, the result being that for a given position of shaft 2 the pulleys 4 (for example those of the even row) are in the upper position and the pulleys 5 (odd row) are in the lower position as shown on Figs. 5, 6 and 7; Fig. 4 is a perspective view of the corresponding relative position of plates 6, 7 carried by these pulleys.

Each shaft 2 carries at its free end, outside the furnace, a bevel pinion 8 (Figs. 2 and 3), meshing with a similar pinion 9 keyed on a longitudinal shaft 10 actuated by a motor 11 through a suitable variable speed mechanism 12 and a speed reducer 13, in order to assure the transverse shafts such as 2 a continuous and uniform movement, at regulable speed.

The eccentrics, such as 4 and 5, are separated by the jaws 14, of suitable form, for guiding the plates laterally.

The bar or plate assemblage is subdivided into two groups: some, the plates or bars 6 for ex-

Fig. 1 is a longitudinal section of the furnace.

ample, bearing on the eccentrics 4 which are in the upper position at a given moment (Fig. 6), the plates 7 then resting on the eccentrics 5 which are in the lower position (Fig. 5).

According to the invention the horizontal movement of plates 6, 7, is realized by a mechanism outside the furnace, at the charging or removal side.

Each of the bars or plates terminates at one end of the furnace in a frame 15 (Figs. 1 and 8) in which are seated the eccentrics or cams 16, 17, relatively displaced or staggered 180°, intended to control the longitudinal movement of the different plates or bars and suitably brace each other as well as a common sleeve 18 mounted for adjustment on a shaft 19 (Fig. 8) which receives its movement from the main shaft 10 through any suitable drive, gear train or other device.

Disposed on the inner standard of frame 15 is a slide 20 which comes into position under the corresponding end eccentric pulley 4 or 5, as shown on Fig. 8, so as to prevent the plates or plate jaws from rising when cams 16, 17 rotate in the direction indicated by the arrow on Fig. 8. The sleeve 18, integral with the different eccentrics 16, 17, is integral with a shackle 21, the free arms of which carry a worm 22 in mesh with a helicoidal gear 23 (Fig. 15) keyed on shaft 19. Rotation of the worm 22 by a wrench or crank 22a will produce an angular variation such may be desired of the keying of the sleeve 18 and thus of the eccentrics 16, 17 relative to this shaft 19. The pinions 8, which drive or control the different transverse shafts 2 mounted at the interior of the furnace, are keyed invariably with respect to their drive shaft, and it is thus possible to vary the relative keying of the advance eccentrics 16, 17 with respect to the lifting eccentrics 4, 5.

The relative displacement of the cams 16—17 and eccentrics 4—5 can also be effected by displacing the eccentrics 4—5 on their shafts, by mechanism similar to that employed in adjusting the cams 16—17.

As shown particularly on Fig. 8, the eccentrics 16, 17 are arranged at a level lower than eccentrics 4, 5 and more particularly to the group of these eccentrics 4, 5 located outside the furnace, on a shaft 24.

A movable stop 25 is formed by a crossbar supported by threaded arms 26 screwed in fixed nuts, each having on its periphery teeth meshing with a worm 28, through which the position of the crossbar stop 25 can be regulated at each instant.

According to the invention and as shown on Fig. 1 a certain number of shafts 2 are animated with a rotational movement in the direction of the arrows F, a component of the movement of these eccentrics resulting in the lifting or raising of the bars or plates 6, 7, while another component is passed in the direction of the arrow G on Fig. 1. This component results in constantly assuring the contact of the standard 29 of each frame 15 with a corresponding eccentric 16 or 17.

In order to avoid excessive forces from being exerted on eccentrics 16, 17 the pinions 8 of certain transverse shafts 2 are driven in a diametrically opposite direction, as indicated for example at 9 on Fig. 2, thus causing the corresponding shafts 2 to rotate in the direction of the arrows H, opposite that of arrows F.

By reason of this arrangement the plates or bars 6, 7 constantly operate under tension, the advantage being that each bar or plate being constantly tensed, it can expand with all freedom

and it may be given a slight cross section without danger of bending or sagging, which would take place if the plate operated under compression, at any movement.

This feature makes it possible to construct conveyor platforms for very small objects, the bars or plates being thinner, up to 2 mm.

Each shaft 2, rotating in the direction of the arrow H is, of course, preferably arranged between two shafts rotating in the direction of the arrow F, thus assuring constant tension of each bar or plate, at any point thereof.

The function of the slide 20 (Fig. 8) which engages under the eccentrics mounted on the transverse shaft 24 exterior of the furnace is to prevent the raising of the frames 15 and the corresponding bars or plates 6, 7 as a result of the tangential friction which is exerted between the eccentrics 16, 17 and the vertical standard 29 of the frame 15.

The operation is as follows:

Assuming (Fig. 8) that by reason of the relative position of sleeve 18 on its shaft 19, the eccentric 16 has, on said shaft 19, the same keying as the eccentrics 5 on their respective shafts 2, that is, as shown on Fig. 8, eccentric 16 is at its lowest point while all the eccentrics 5 are likewise at their lowest point.

The motor 11 being set in operation it actuates the different shafts through the transmission indicated on Fig. 2, the different eccentrics assume the position indicated in broken lines on Fig. 8 from that shown in full lines, the bar or plate 6 having under a horizontal displacement or movement represented by x and a vertical movement represented by y , the various eccentrics being turned for an angle a . Any point of the plate or bar has come to M' . The figure shows that:

$$X = e_1 \sin a \quad y = e_2 (1 - \cos a) \quad 40$$

The immediate deduction is that the path of the point M will be an ellipse the horizontal axis of which will be equal to $2e^1$ and the vertical axis equal to $2e^2$.

If the movement of the point M is related to the two axes OX and OY, passing through the centre of the ellipse described by this point, the equation of the movement of point M will be given by:

$$X = e^1 \sin a \quad 50$$

by having e^1 represent the eccentricity of the eccentric pulley 16, while:

$$Y = e^2 (1 - \cos a) \quad 55$$

e^2 representing the eccentricity of the eccentric pulleys 5.

The immediate deduction is that the path of any point of plate 6 will be an ellipse the horizontal axis of which is equal to $2e^1$ and the vertical axis equal to $2e^2$. If this movement of any point of plate 6 is related to two perpendicular axes passing through the centre of the ellipse described by this point, the equation of the movement of this point will be given by:

$$X = e^1 \sin a \text{ and } Y = e^2 (1 - \cos a) \quad 65$$

Practically, the horizontal course of an object placed on a set of plates such as those shown on Figs. 1 and 2 will be equal to $2e^1$.

If, now, the keying of eccentric 16 is varied by advancing it, for example, relatively to eccentrics 5, the vertical movement of any given point of plate 6 will always be given by the following equation:

$$Y=e^2(1-\cos a)$$

while the horizontal trajectory (path) will be given by the product of the eccentricity e^1 of eccentric 16 multiplied by the sine of the new angle. If b represents the advance angle of the eccentric 16 over eccentrics 5 the equation of the horizontal path will be given by:

$$X=e^1 \sin (a+b)$$

The angular coefficient or slope of the tangent at any point of the path is equal to:

$$\frac{-e^2 \sin a}{e^1 \cos (a+b)}$$

The path of the involved point of the plate or bar 6 is still an ellipse, but the large axis thereof is inclined to the horizontal.

The horizontal course of an object placed on the bar is given by the formula

$$\text{horizontal course} = 2e \cos b$$

The vertical course always remains equal to $2e^2$ and is independent of b . The following is the result: By varying the relative staggering of eccentric 16 the course of the object, that is, the rate of passage through the furnace, is varied.

Fig. 10 designates the trajectory of the involved point when the staggering is equal to $\frac{1}{4}$ of the circumference ($b=45^\circ$).

The course is then $e^1\sqrt{2}$ and the object circulates from left to right.

Fig. 11 designates the trajectory obtained when the staggering is equal to $\frac{1}{4}$ of the circumference ($b=90^\circ$).

The trajectory is a straight line whose inclination over the horizontal is equal to

$$\frac{e^2}{e^1}$$

the course is zero; the objects no longer advance in the furnace.

Fig. 12 indicates the path (trajectory) obtained when the staggering is equal to $\frac{3}{4}$ of the circumference ($b=135^\circ$).

The horizontal course of travel is equal to $e^1\sqrt{2}$, but the horizontal displacement of an object placed on the bar takes place for the upper part of the trajectory, from right to left instead of from left to right as in the preceding figures.

In other words, by giving the staggering b a value greater than $\frac{1}{4}$ of the circumference the circulating direction of the objects is reversed in the furnace.

Fig. 13 designates a trajectory obtained when the staggering is equal to a half circumference ($b=180^\circ$). The trajectory coincides with that of Fig. 9, but the direction of travel is reversed. It is understood, of course, that other trajectories may be obtained.

It is to be understood that as there are two sets of bars 6 and 7 the trajectory of an object placed on the platform will be limited to the portion of the curve above the horizontal passing through the centre of the ellipse (this trajectory is accentuated on Figs. 9 to 14 by the small transverse lines). The result is that for a complete revolution of shafts 2 the advance of the objects in the furnace is equal to twice the above indicated course.

It is thus apparent that, by varying the staggering angle of eccentrics or cams 16 and 17, mounted on the shaft 19, it is possible to vary the rate of passage in the furnace of the objects to be treated and to reverse at will the direction in which these objects circulate, by giving the

angle b (difference of staggering eccentrics 16 and 5) a value greater than 90° .

The course of the objects may also be modified by varying the position of the stop crossbar 25 through action on the worm 28. This stop, in fact, forms a check of the course or travel of the frames 15 integral with the bars. By giving the slot provided in frame 15 a length, horizontally, greater than the space covered by the eccentric 16 the course of the plates may be restricted, as shown on Fig. 14, and it is even possible completely to check the horizontal course of the platform.

It is to be noted that with the described arrangement the tension effort on the plates ceases as soon as the rotation ceases, thus making maintenance, inspection and repairs easily possible.

The foregoing assemblance thus permits of numerous practical combinations according to the thermal problems to be solved.

Thus, for a furnace of predetermined width, the stop bar 25 may be made of a plurality of elements, with independent regulation of the advance and return movement; it is hence possible to provide in the furnace a certain number of longitudinal sections of different speeds; in the simplest case it is possible to have two sections, one at high speed on which, for example, light objects are placed, the other at slower speed on which heavier objects requiring a longer period of treatment are placed. It is thus easy, in a furnace thus constructed, to vary the number and width of the sections operating at different speeds by acting on the number and length of the stop bars, such as 25.

Fig. 15 shows, by way of example, an application of the invention, in which, for clarity, the frames such as 15 are not shown, and shaft 24 shown only partially. The head shaft 19 carries two sleeves 30 and 31 which are independent of each other and which may be of equal or of different length. Shaft 19 is actuated from horizontal shaft 10 through bevel gears 8, 9 of shaft 24 and straight gears 32. The mechanism thus realized is such that shaft 19 rotates with the same speed as shafts 2.

The keying or adjustment of the sleeves 30 and 31 relative to drive shaft 19 may be regulated for any value so as to vary the course of the circulating direction of the objects; for this purpose shaft 19 has keyed on it two gear wheels 23 and 33 which mesh respectively with two independent tangent screws, such as 22 (Fig. 16).

It is apparent that, by manipulating the worm it is possible to give the displacing or staggering angle the desired angle. The bars which form the conveyor platform are thus subdivided into two groups, accordingly as the frame, such as 15 which drive them, are actuated by eccentrics keyed either on sleeve 30 or on sleeve 31. The furnace is thus subdivided into two longitudinal sections, independent of each other, and capable of conveying the objects at variable speed and direction of circulation.

Different thermal cycles may be obtained with the same furnace thus constructed: assuming that the hot point of the furnace is at the right side on Fig. 15, the object may be placed on the section A, from which they pass to A', there to reach the desired temperature; having arrived at A', the objects are placed at B' and they return to B cooling progressively and giving off their heat units to objects which advance in the opposite direction on the section AA'. If the hot part of the furnace is at the centre thereof the

cold objects may be charged or inserted at A and B', thus forming two rows of objects AA' and B'B, which advance in opposite directions and which, in their respective cooling zones, give off their heat units to the adjacent row which, circulating in the opposite direction, are being heated. In order to realize the foregoing thermal cycles it is sufficient to stagger sleeves 30 and 31 relatively for 180°. The sections AA' and BB' may be divided into sub-sections, each with its own rate of speed. For this purpose it is sufficient to provide stop bars, such as 25, which limit the travel of the frame such as 15 and permitting different and variable speeds on the sections. This simple example shows how the invention is capable of multiple combinations which can be instantly modified according to the thermal cycle to be produced.

It is, of course, possible to subdivide the platform into any desired number of sections, extending over the entire length of the furnace or only a portion thereof. The various elements may be of any desired materials and of any dimensions.

The arrangement for modifying the displacing or staggering of the eccentrics may be of any type suited to the specific case, and it is obviously possible, in each case, to modify the staggering of one or the other group of eccentrics by action either on the staggering proper of these eccentrics or on the shafts which support them, or on transmission gears.

The invention is applied to conveying through continuously operating furnaces objects intended to undergo heat treatment, said objects being of any dimension or constitution. What is claimed is:

1. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars, means for inducing longitudinal movement of said bars, a plurality of shafts extending transversely of said bars and below the same, means associated with said shafts and bars for inducing vertical movement of said bars and means for rotating one or more of said shafts in a direction opposite to the rotation of other of said shafts whereby to keep said bars under tension.

2. In a furnace for the thermal conditioning of articles the combination of a plurality of bars, each provided with an actuating arm adjacent one end thereof, a cam operating said actuating arm, a plurality of transverse shafts, each carrying cams and engaging said bars, and means for actuating said transverse shafts in a direction to cause said last named cams to maintain said actuating arm in working relation to the surface of the first named cam.

3. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars, each provided with an actuating arm adjacent one end thereof, a plurality of cams, each operatively arranged to move the actuating arm, a sleeve to which each cam is keyed, a shaft within the sleeve, means interconnecting the sleeve and shaft whereby the sleeve and cams may be advanced or retarded angularly in respect to said shaft, and means for driving said shaft.

4. In a furnace for the thermal conditioning of articles the combination of a series of sections, each consisting of a plurality of bars, means for imparting longitudinal movement to the bars of each section including a shaft, a plurality of spaced sleeves carried by said shaft, a plurality of cams fast to each sleeve and engaging said bars, means connecting each sleeve and

shaft for adjusting the angular relation of the same, whereby the bars of one section may be moved longitudinally to move articles through the furnace in a direction opposite to the movement of the articles occasioned by another section.

5. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same arranged at intervals throughout the length of the bars for imparting vertical motion thereto, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to said bars, and means for varying relatively the timed relation between said first and second named means and thereby vary the rate of progression of articles through the furnace.

6. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same arranged at intervals throughout the length of the bars for imparting vertical motion thereto, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to said bars and means for adjusting the second named means to vary the timed relation between the first and second named means and thereby vary the rate of progression of articles through the furnace.

7. In a furnace for the thermal conditioning of articles the combination of a plurality of bars free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same arranged at intervals throughout the length of the bars for imparting vertical motion thereto, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to said bars, and means for adjusting the first named means to vary the timed relation between the first and second named means and thereby vary the rate of progression of articles through the furnace.

8. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same, arranged at intervals throughout the length of the bars for imparting vertical motion thereto, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to said bars, and means for adjusting the first and second named means to vary the timed relation between said first and second named means and thereby vary the rate of progression of articles through the furnace.

9. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same arranged at intervals throughout the length of the bars for imparting vertical motion thereto, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to said

bars, and means for adjusting the second named means so constructed and arranged as to vary the initiation of the horizontal movement in respect to the vertical movement occasioned by the first named means and thereby vary the rate of progression of articles through the furnace.

10. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars arranged side by side in spaced relation and free at one end, means associated with shafts extending transversely of the bars and frictionally engaging the same arranged at intervals throughout the length of the bars for imparting vertical motion to alternate bars in succession, means connected to the bars at a point remote from their free ends and operable in timed relation with the first named means for imparting horizontal movement to alternate bars in succession, and means for varying relatively the timed relation between said first and second named means and thereby vary the rate of progression of articles through the furnace.

11. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars having one end free, mechanism for inducing longitudinal movement of said bars positively in one direction, means for imparting a vertical movement to the articles and means frictionally engaging said bars at intervals throughout their length and tending to move them in the opposite direction.

12. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars having one end free, mechanism for inducing longitudinal movement of said bars positively in one direction located at a point remote from the free ends of said bars, means for imparting a vertical movement to the articles, means frictionally engaging said bars at intervals throughout their length tending to move said bars in the same direction, and means frictionally engaging said bars at intervals throughout their length tending to move them in an opposite direction, thereby maintaining said bars in a state of substantially uniform tension throughout their length.

13. In a furnace for the thermal conditioning of articles, the combination of a plurality of bars having one end free, mechanism for inducing longitudinal movement of said bars positively in one direction located at a point remote from the free ends of said bars, means frictionally engaging said bars at intervals throughout their length for moving the bars in a vertical direction, certain

of said last named means tending to move said bars in the above named direction and other said means tending to move said bars in an opposite direction, thereby maintaining said bars in a state of substantially uniform tension throughout their length independently of thermal conditions within the furnace.

14. In a furnace for the thermal conditioning of articles, the combination of a plurality of sections, each section comprising a series of bars, means associated with shafts extending transversely of the bars of each section and frictionally engaging the same arranged at intervals throughout the length of the bars to impart vertical movement thereto, driving means common to the bars of each section for imparting horizontal movement thereto, and means associated with the last named means and operable in timed relation to the first named means for moving the bars comprising each section at different speeds.

15. In a furnace for the thermal conditioning of articles, the combination of a plurality of sections, each section comprising a series of bars, means associated with shafts extending transversely of the bars of each section and frictionally engaging the same arranged at intervals throughout the length of the bars to impart vertical movement thereto, driving means common to the bars of each section for imparting horizontal movement thereto, and adjustable means permanently associated with the last named means and operable in timed relation to the first named means for selectively moving the bars comprising said sections in the same or different directions.

16. In a furnace for the thermal conditioning of articles, the combination of a plurality of sections, each section comprising a series of bars, means associated with shafts extending transversely of the bars of each section and frictionally engaging the same arranged at intervals throughout the length of the bars to impart vertical movement thereto, driving means common to the bars of both sections for imparting horizontal movement thereto, and means associated with the last named means for varying relatively the time of occurrence of the vertical and horizontal movements of the bars comprising each section and thereby vary the rate of progression of articles on the bars of each section through the furnace.

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