

Oct. 4, 1932.

F. A. FAHRENWALD

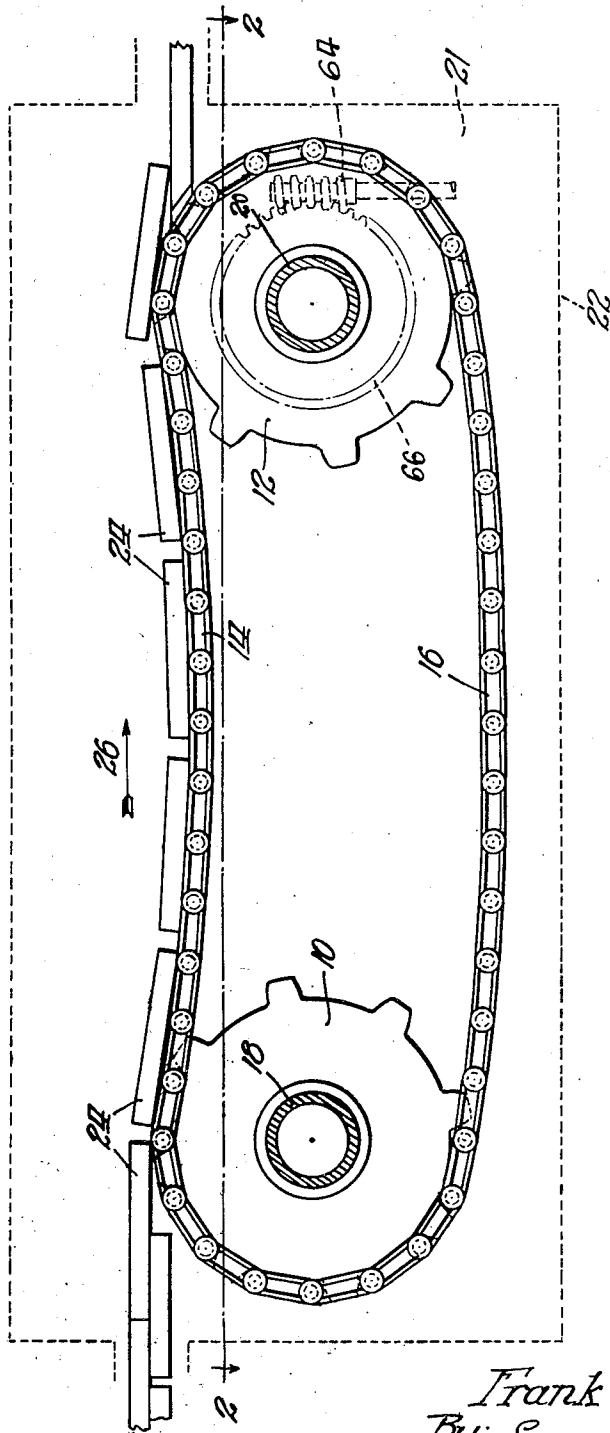
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FURNACE

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4 Sheets-Sheet 1

Fig. 1



Inventor
Frank A. Fahrenwald
By: Smith and Freeman
Attys.

Oct. 4, 1932.

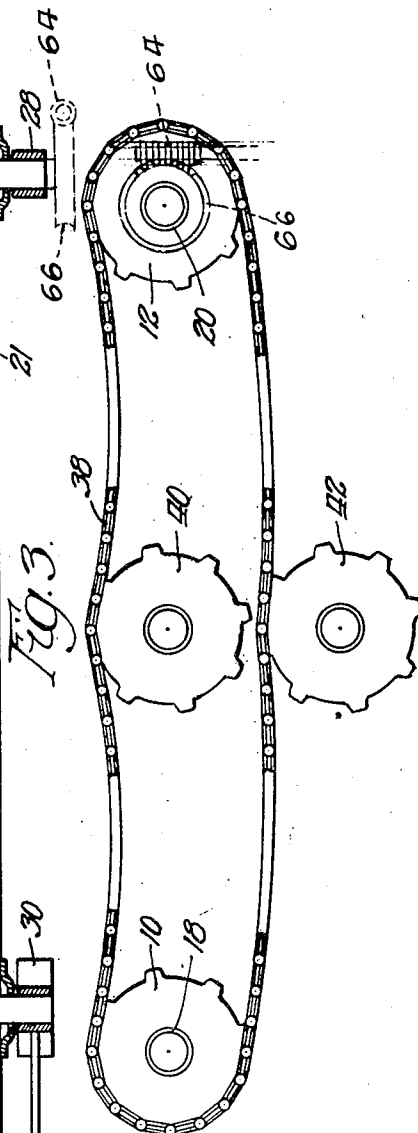
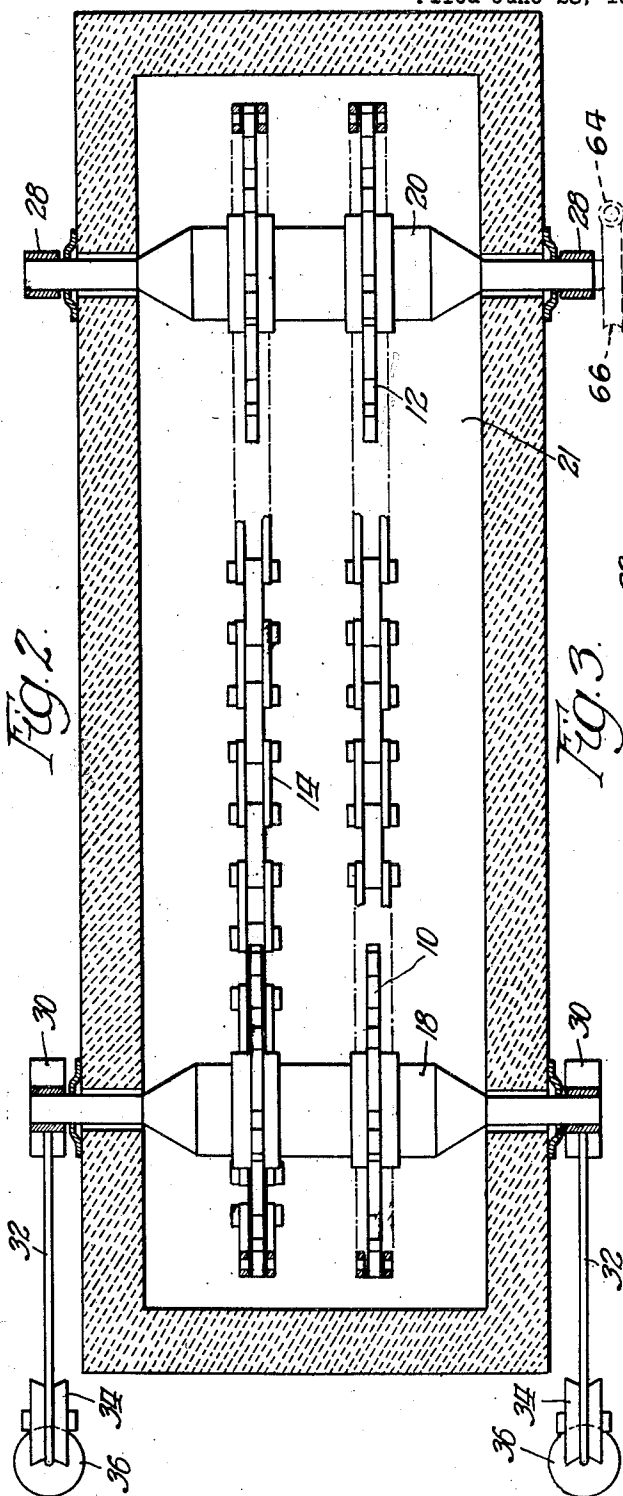
F. A. FAHRENWALD

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Inventor
Frank A. Fahrenwald
By: Smith and Freeman
Attys.

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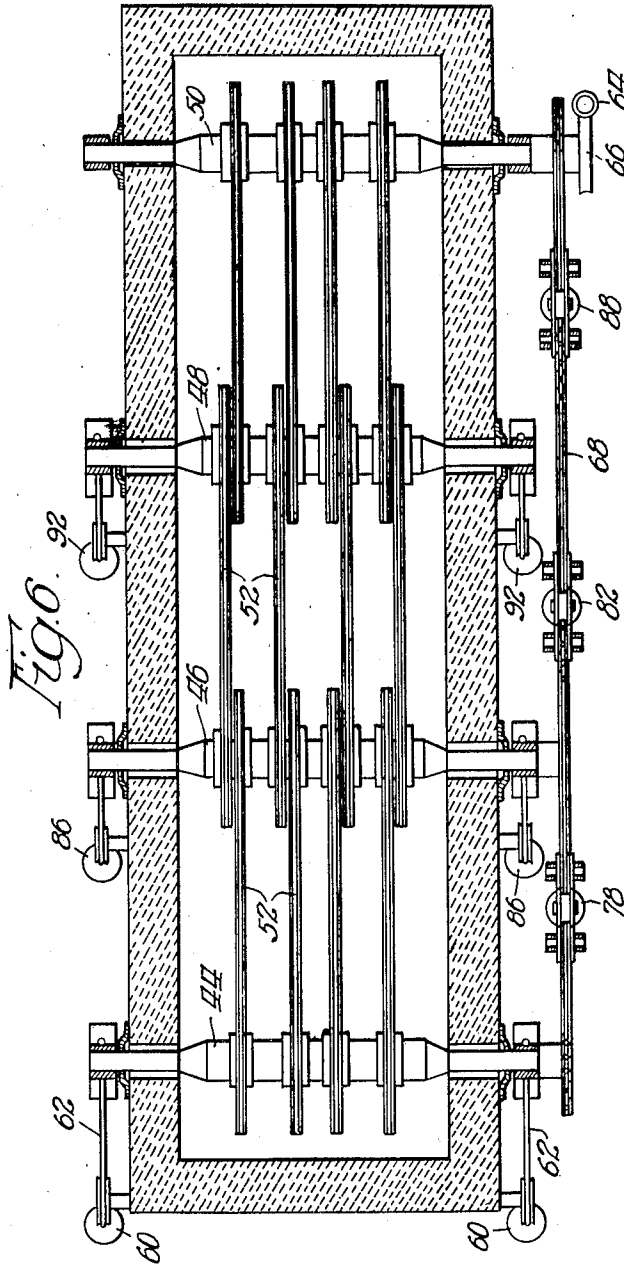
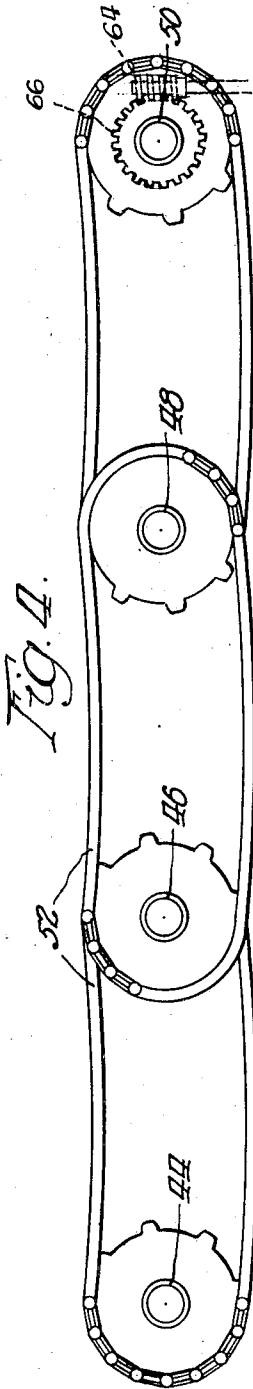
F. A. FAHRENWALD

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Inventor
Frank A. Fahrenwald
By: Smith and Freeman Attys.

Oct. 4, 1932.

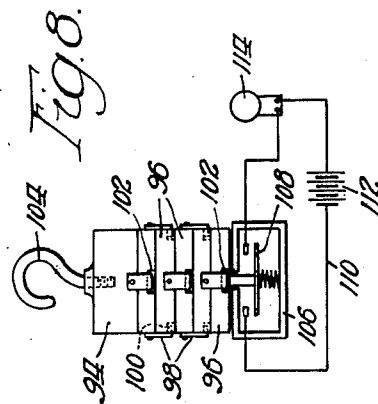
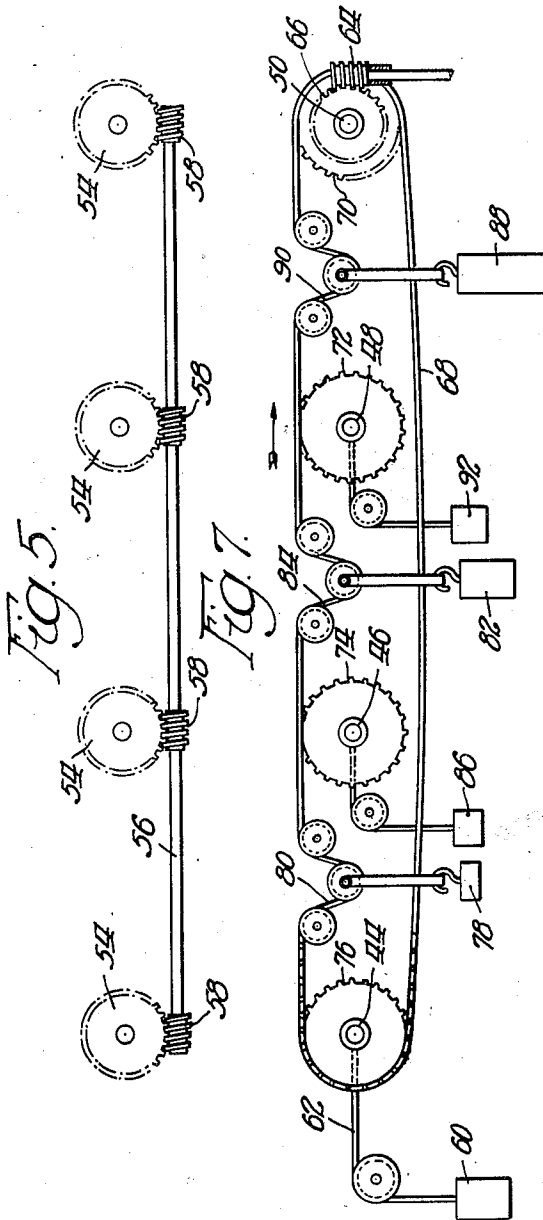
F. A. FAHRENWALD

1,880,954

FURNACE

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Inventor
Frank A. Fahrenwald
By: Smith and Freeman Attys.

UNITED STATES PATENT OFFICE

FRANK A. FAHRENWALD, OF CHICAGO, ILLINOIS

FURNACE

Application filed June 28, 1929. Serial No. 374,311.

My invention relates to high temperature equipment, and more specifically to the continuous conveyor equipment employed for the heat treatment of metals at temperatures such that ordinary steel and cast iron are useless on account of insufficient mechanical strength or chemical reaction with other materials, or both. However, I am aware that this type of equipment is suitable for the heating of materials other than metals, such as ceramic articles. It includes among its objects and advantages a decrease in maintenance and operating cost, and an increase in speed and reliability in equipment of this type.

One widely used and most successful furnace of the continuous type is that described in my Patent 1,623,469. However, the rollers of such a furnace cannot handle small articles, such as bolts, nuts, forgings, and cylindrical pieces of rods, tubes, or bars, which must all have a continuous supporting surface to carry them through the furnace.

One particular construction of continuous conveyor now in use for this work employs one or more strands of chain operating over sprockets outside the ends of the hot chamber, with the load-carrying reach of the strand sliding upon the hearth or in channels laid through the chamber. Such procedure has several drawbacks, including:

(1) Excessive heat losses by carrying the hot conveying strand out of the chamber to the cold exterior;

(2) Slower production for a given size furnace, because the conveying strand as well as the material, has to be heated up;

(3) Excessive power required to drag the loaded strand across the hearth because the coefficient of sliding friction becomes very large at high temperatures;

(4) Excessive abrasion and rapid wearing out of the conveyor strand, due to heavy friction at high temperatures;

(5) Excessive tensile stress localized in the conveyor strand where it leaves the hearth;

(6) Rapid deterioration and disintegration of the strand parts by repeated contraction and expansion due to temperature fluctuation;

(7) Rapid wear on the supporting members over which the strand is dragged;

(8) Complicated furnace construction required to take care of the return reach of such a strand.

In the accompanying drawings,

Figure 1 is a partly diagrammatic vertical central section through a small unit according to the invention;

Figure 2 is a section on line 2-2 of Figure 1;

Figure 3 is a diagram indicating the arrangement for supporting a longer conveyor strand;

Figure 4 is a similar diagram for a conveyor system of indefinite length;

Figure 5 is a side elevation of the driving connections for such a conveyor system as that of Figure 4;

Figure 6 is a plan view indicating the arrangement of the sets of conveyors in a conveyor system of indefinite length;

Figure 7 is a side elevation of a constant tension drive system; and

Figure 8 is a detail of a tension compensator.

In the embodiment of the invention selected for illustration in Figures 1 and 2, the conveyor employs an endless flexible chain or strand of heavy rugged construction, and passes over a supporting rotary sheave or sprocket 10 at one end, and a similar member 12 at the other end, being supported on said members, with a catenary load carrying reach 14, and a catenary return reach 16. The members 10 and 12 may be supported on shafts 18 and 20 similar to those disclosed in my above mentioned patent, which shafts extend out through the walls of the chamber 21 as clearly indicated in Figure 2.

In such a system the only friction load inside the furnace is the slight flexing of the chain, or the movement of the chain parts into and out of contact with the teeth of the sprockets. On account of the high temperatures and high friction coefficients at such high temperatures, this flexing of the chain may constitute a substantial portion of the power load. The gravity load is car-

ried on the bearings outside, which bearings operate at relatively low temperatures and can be designed for good efficiency, so far as friction is concerned.

6 I have indicated the boundaries of the hot chamber at 22 in Figure 1, and a series of billets, or pieces of material at 24 resting on the strand and passing through the furnace in the direction of the arrow 26.

10 The bearings 28 for the shaft 20 are fixed and immovable, but the bearings for the shaft 18 are mounted on small carriages 30 slidable longitudinally of the conveyor and resiliently pulled away from the bearings 28 by suitable means, such as tension cords 32 passing over pulleys 34 and attached to weights 36. Such a mounting guarantees a substantially uniform and constant tension for the conveyor strand. When the strand is heavily loaded, the bearings for the shaft 18 will slide and permit the strand to sag a little more so as to carry the increased load without any increase in tension.

Referring now to Figure 3, I have indicated a conveyor strand 38, of somewhat greater length than can be safely supported in a single catenary span at the high temperatures prevailing. To reduce the tension in the strand necessary to carry the weight of the strand and its load, I may provide a central idler 40. In many instances, especially at high temperatures, the major portion of the mechanical load on the system is the weight of the strand, as the strand weighs more per unit length than the load placed upon it. In such cases I provide a lower idler 42 for giving the return reach of the strand the same support given the load carrying reach by the idler 40. These idlers 40 and 42 are of identical construction with the shafts 20 and sprocket 12.

To make up a furnace of indefinite length without dragging the conveyor strand, I may continue the system of Figure 3 or I may employ the system of Figures 4 and 6. I have indicated four transverse shafts 44, 46, 48 and 50. The end shafts 44 and 50 each carry four rotary members, and the intermediate shafts 46 and 48 each carry eight rotary members.

Each span is bridged by four conveyor strands 52, the strands in successive spans being laterally offset enough to provide room for mounting the additional rotary members on the intermediate shafts. When such a series of shafts has outside bearings, the shafts may be driven in unison by mounting worm wheels 54 on the ends of the shafts and driving all the shafts from a line shaft 56 through worms 58 as shown in Figure 5. In such an installation, the sag of each catenary span depends on the temperature at which the furnace is operating.

65 In such a drive, I prefer to provide all the

shafts with longitudinally adjustable bearings, so that the spacing of the shafts may be adjusted to let the conveyors sag the proper amount, and avoid an overload on any strand or span.

The conveyor strands of Figures 4 and 6 may also be driven from outside as illustrated in Figure 6, by the floating drive system of Figure 7, in which case the same constancy of tension will obtain in these multiple units as in the small unit of Figures 1 and 2.

For this purpose the shaft 50 is mounted on fixed bearings, and shafts 44, 46 and 48 are supported by bearings slidable longitudinally of the furnace. If the tension in each reach of each strand is T , the force between each pair of shafts tending to draw them together will be $8T$.

Weights 60 attached to the tensioning cords 62 for the shaft 44, each equal to $4T$, will tension the entire system, as the longitudinal forces acting on intermediate shafts 46 and 48 are balanced.

To turn the shafts without interfering with the tensioning of the strands, I drive the shaft 50 through a worm 64 and worm wheel 66, and run a cold chain 68 over sprockets 70, 72, 74 and 76 on the shafts 50, 48, 46 and 44, respectively. I may now apply a load or torque to each shaft to turn it. These loads will be approximately but not exactly twice as great for shafts 46 and 48 as for shafts 44 and 50, because there are twice as many strands being curled up and straightened out around the shafts 46 and 48 as there are around the shafts 44 and 50.

Thus, I apply a tensioning weight 78 pulling on a bight 80 in the reach of the cold chain 68 between shafts 44 and 46. The amount of this weight I have designated as P and to hold the sprocket end of shaft 44 in place it is accordingly necessary to add the same amount of weight at 60, making the total weight applied there $4T + P$. Similarly I increase the tension by another tensioning weight 82 pulling on a bight 84 between shafts 72 and 74. Approximating the torque load of shaft 46 at twice that on shaft 44, the weight 82 should weight $3P$, and the sprocket end of shaft 46 will need to be held in place by a counter weight 86 equal to $2P$. Between shafts 50 and 48 it will similarly be necessary to employ a tensioning weight 88 equal to $5P$ pulling on the bight 90, and to counter-balance the sprocket end of shaft 48 with a counter weight 92 equal to $2P$.

It will be obvious that in practice these weights will be adjusted when the furnace is first set up and that the 1:3:5 ratio enumerated is merely an approximation, the weights in practice being adjusted to the amounts that will secure a proper balance.

To provide a slight change in tensioning in case of displacements I may arrange the sides of the bights 80, 84 and 90 to diverge

slightly as indicated in Figure 7. When such an arrangement is employed, any slight shifting, lifting any one of the tension weights, will slightly increase the tension developed by said weight and there will be a mild tendency to come back to the equilibrium position. This reduces the sensitivity of the system to slight changes in load.

An alternative and much more adaptable variable tensioning means is that illustrated in Figure 8. Any one of the tensioning or counter balancing weights of Figure 7, and preferably all of them, may be made up of a top weight 94 and a plurality of auxiliary weights 96 connected in series under the top weight by clips 98, each pair of clips mounted on the weight above, and having toes 100 fitting loosely in sockets 102 in the weight below. Thus, every displacement of the shaft or sheave to which the weight is attached by the hook 104 will pick up an additional auxiliary weight, each time the displacement amounts to the play in one socket. In this way the rate at which restoring forces are generated by any displacement may be varied in any arbitrary way to suit the conditions of service.

In some installations where certain displacements might become critical, I may provide a support 106 in the form of a housing for a spring pressed electric switch 108 so that the lifting of the lowermost weight 96 will complete a circuit through a wire 110, a source of electromotive force 112, and a bell or some equivalent alarm means 114.

Without further elaboration the foregoing will so fully explain the gist of my invention that others may, by applying knowledge current at the time of application, readily adapt the same for use under various conditions of service.

I claim:

1. Equipment for conveying materials at high temperatures comprising a chamber, an endless conveyor strand, the load carrying reach of said strand being located in said chamber and suspended as a catenary span, rotating members for supporting said span, said rotating members and the return reach of said strand being located inside said chamber, shafts carrying said members, a power drive for rotating the shaft at the discharge end of the strand, and gravity actuated means acting on said other shaft for maintaining constant tension in said strand.

2. Equipment for conveying materials at high temperatures comprising a chamber, an endless conveyor strand, the load carrying reach of said strand being located in said chamber and suspended as a catenary span, rotating members for supporting said span, said rotating members and the return reach of said strand being located inside said chamber, a power drive for moving said strand,

and means for maintaining constant tension in said strand.

3. Equipment for conveying materials at temperatures above 1400° F., comprising a chamber, an endless conveyor strand, the load carrying reach of said strand being located in said chamber and suspended as a catenary span, rotating members for supporting said span, said members and the return reach of said strand being located inside said chamber, shafts carrying said members and extending transversely outside the furnace, bearings outside the furnace for the ends of said shafts, a power drive for rotating the shaft at the discharge end of the strand, the bearings for the shaft at the other end being longitudinally slidable, and gravity actuated means acting on said slidable bearings for maintaining constant tension in said strand.

4. Equipment for conveying materials at temperatures above 1400° F., comprising a chamber, a plurality of sets of endless flexible conveyor strands in said chamber, each set longitudinally offset from adjacent sets, the individual members of each set being laterally offset from the individual members of adjacent sets, the adjacent ends of adjacent sets being looped around a common axis, a plurality of transverse shafts for supporting said strands by catenary suspension, and power transmission to turn all said shafts.

5. Equipment for conveying materials at high temperatures, comprising a chamber, a plurality of sets of flexible endless conveyor strands in said chamber, each set longitudinally offset from adjacent sets, the individual members of each set being laterally offset from the individual members of adjacent sets, the adjacent ends of adjacent sets being looped around a common axis, a plurality of transverse shafts for supporting said conveyors by catenary suspension, and power transmission to turn all said shafts.

6. Equipment for conveying materials at high temperatures comprising a chamber, flexible conveyor strand means in said chamber suspended in a plurality of catenary spans, supporting members at the ends of each span, transverse shafts carrying said supporting members, tension means for maintaining constant tension in all said spans, and means for transmitting power to each shaft independent of the operation of said tension maintaining means.

7. Equipment for conveying materials at high temperatures comprising a chamber, flexible conveyor strand means in said chamber suspended in a plurality of catenary spans, supporting members at the ends of each span, transverse shafts carrying said supporting members, tension means for maintaining constant tension in all said

spans, and a power drive for turning said shafts.

8. Equipment for conveying materials at high temperatures comprising a chamber, flexible conveyor strand means in said chamber suspended in a plurality of catenary spans, supporting members at the ends of each span, transverse shafts carrying said supporting members, a power drive acting on the ends of said shafts, and tension means for maintaining the tension in all said spans substantially equal and substantially constant.

9. Equipment for conveying materials at high temperatures comprising a chamber, flexible conveyor strand means in said chamber suspended in a plurality of catenary spans, supporting members at the ends of each span, transverse shafts carrying said supporting members, sprockets on the ends of said shafts outside the chamber, a cold chain passing over all said sprockets, and tensioning means in each load carrying reach of said cold chain adjustable for maintaining a predetermined tension in said reach.

10. High temperature conveying equipment comprising a catenary conveyor strand, a weight, and connections between said weight and strand for automatically maintaining the tension in all parts of said strand substantially the same when loaded as when unloaded.

11. The combination with a chamber maintained at 1400° F. or more, of a catenary conveyor in said chamber, transverse supporting shafts for the ends of said conveyor, and means operating by displacing said shafts toward and away from each other for automatically varying the slackness of said catenary as a function of the load thereon.

12. The combination with a chamber maintained at 1400° F. or more, of a catenary conveyor in said chamber, transverse supporting shafts for the ends of said conveyor, and means operating by displacing said shafts toward and away from each other for varying the slackness of said catenary to compensate for variations in the load thereon.

13. The combination with a chamber maintained at 1400° F. or more, of a catenary conveyor in said chamber, transverse supporting shafts for the ends of said conveyor, said shafts having ends extending outside said chamber, and means engaging the ends of said shafts and operating by displacing said shafts toward and away from each other for automatically varying the slackness of said catenary as a function of the load thereon.

14. Equipment for conveying materials at high temperatures comprising a chamber, flexible conveyor strand means in said chamber suspended in a plurality of catenary spans, supporting members at the ends of each span, transverse shafts carrying said supporting members, sprockets on the ends

of said shafts outside the chamber, a cold chain passing over all said sprockets, tensioning means in each load carrying reach of said cold chain adjustable for maintaining a predetermined tension in said reach, said tension means being of progressively increasing capacity toward one end, and a power input connection at said end for driving the entire system.

15. The combination with a chamber maintained at high temperature, of a catenary conveyor in said chamber, transverse supporting shafts for the ends of said conveyor, and means operating by displacing said shafts toward and away from each other for automatically varying the slackness of said catenary as a function of the load thereon.

In testimony whereof I hereunto affix my signature.

FRANK A. FAHRENWALD.

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