June 13, 1944. C. E. HAHN 2,351,262

LEHR

Filed Feb. 10, 1941 3 Sheets-Sheet 1

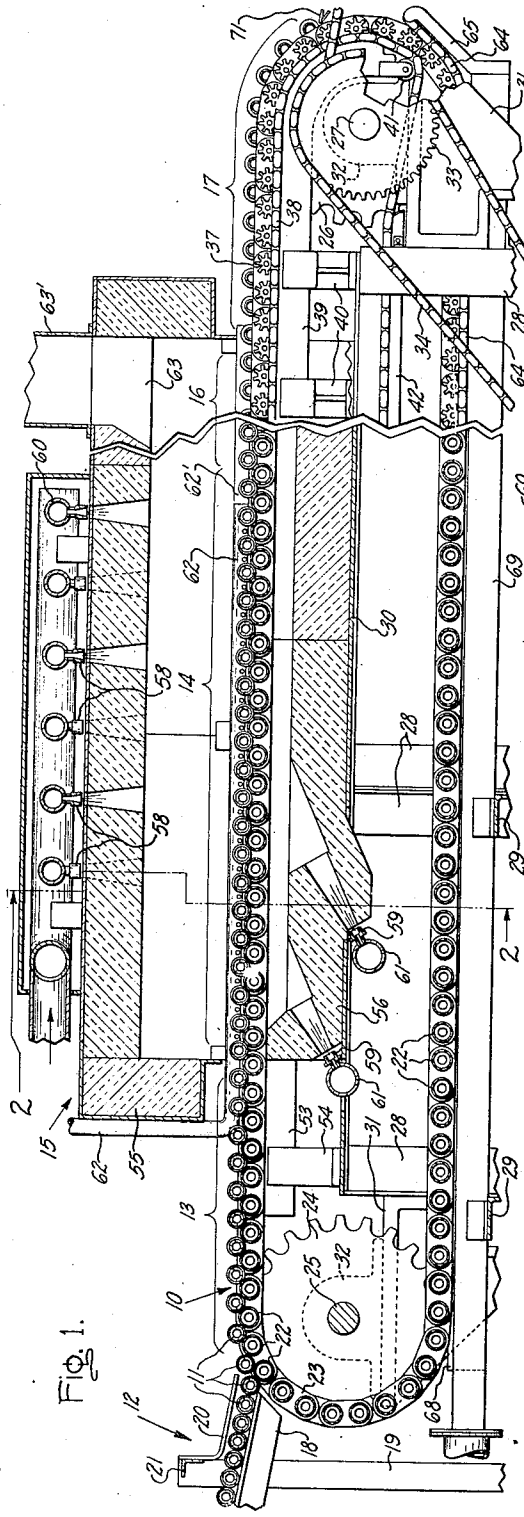


Fig. 1.

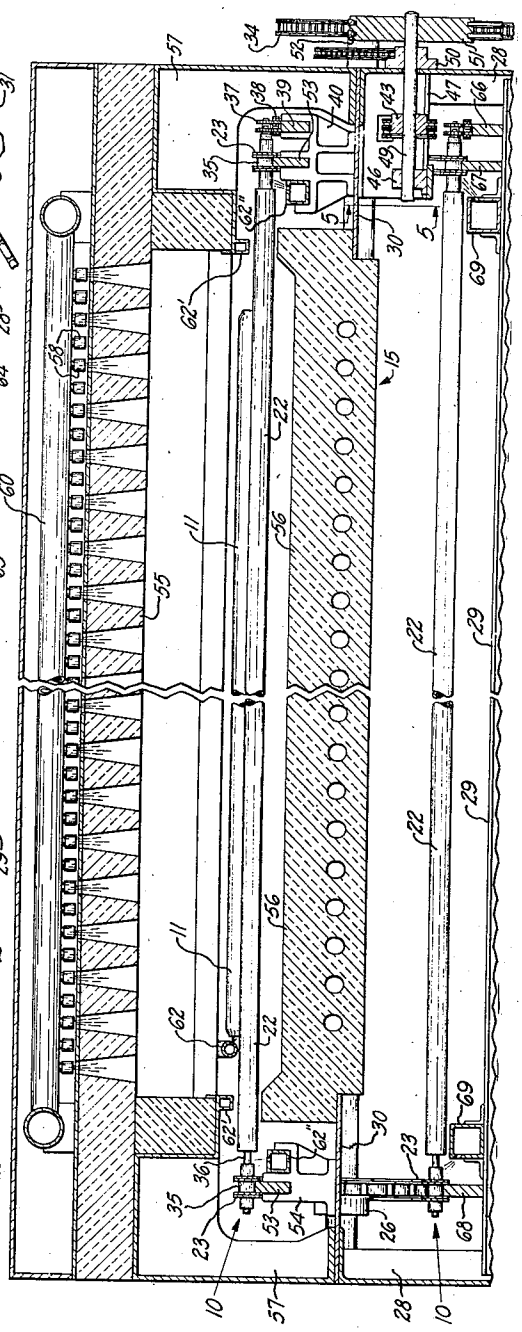


Fig. 2.

Inventor:
Clarence E. Hahn,
by John H. Anderson
His Attorney.

June 13, 1944. C. E. HAHN 2,351,262

LEHR

Filed Feb. 10, 1941 3 Sheets-Sheet 2

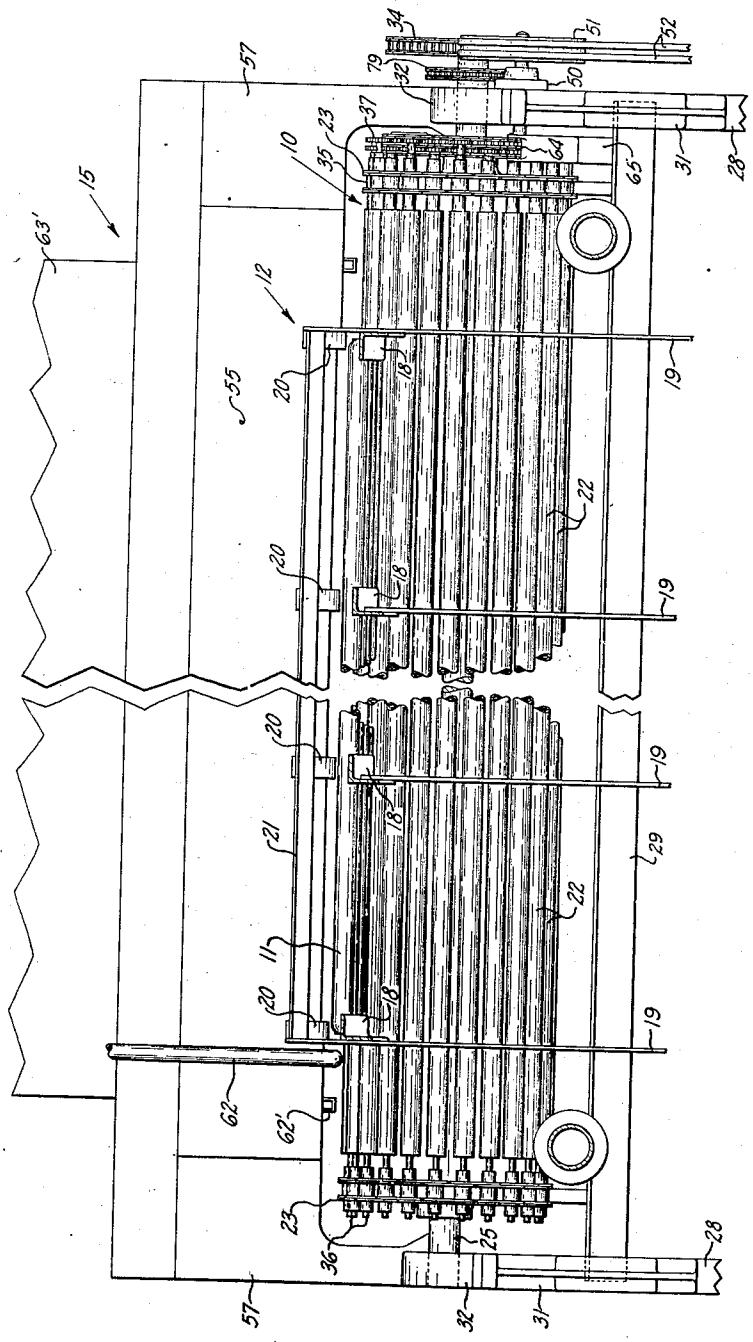


Fig. 3.

Inventor:
Clarence E. Hahn,
by John H. Anderson
His Attorney.

June 13, 1944. C. E. HAHN 2,351,262

LEHR

Filed Feb. 10, 1941 3 Sheets-Sheet 3

Fig. 4.

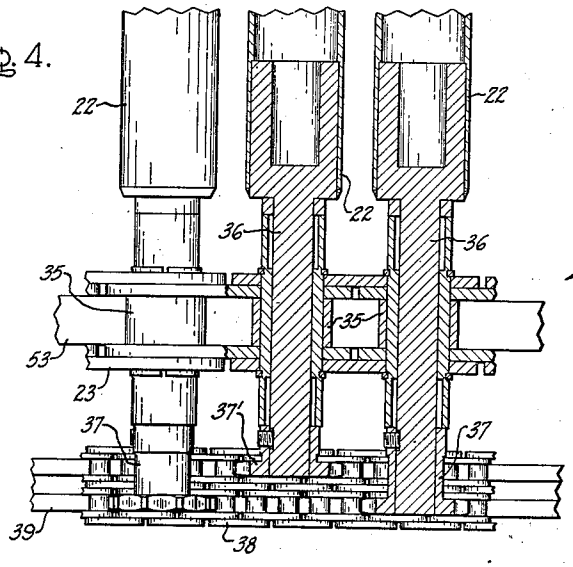


Fig. 5.

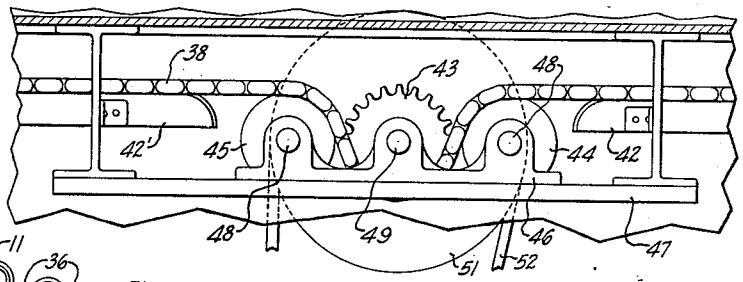
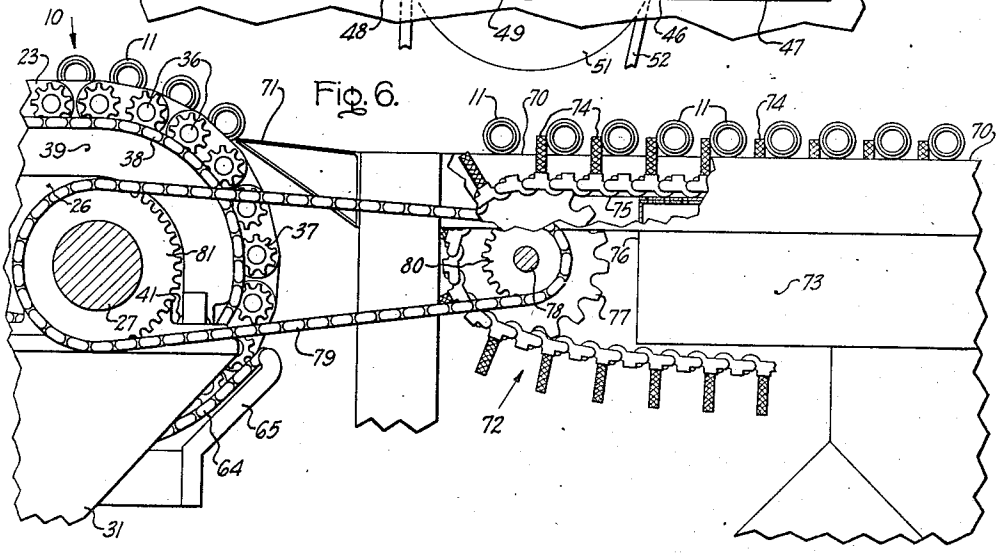


Fig. 6.



Inventor:
Clarence E. Hahn,
by John H. Anderson
His Attorney.

Patented June 13, 1944 2,351,262

UNITED STATES PATENT OFFICE

2,351,262

LEHR

Clarence E. Hahn, Euclid, Ohio, assignor to General Electric Company, a corporation of New York

Application February 10, 1941, Serial No. 378,182

6 Claims. (Cl. 49—47)

My invention relates to a lehr for heat treating and straightening lengths of vitreous tubing and more particularly relates to a lehr for heat treating and straightening comparatively large sizes of vitreous tubing such as those used for the envelopes of incandescent and discharge lamps.

In the manufacture of lamps it becomes necessary to heat treat tubing for several reasons, the most important of which are to relieve the strains therein, bake and otherwise treat colored and fluorescent coatings applied thereto and permit the tubing to be straightened. In such instances, the operations involve the handling of comparatively straight lengths of tubing up to 60 inches in length and 2½ inches in diameter although the operations are not necessarily limited to tubing of such lengths or sizes.

One object of my invention is to provide a lehr for heating lengths of tubing uniformly from end to end on such a scale as to be applicable to commercial use.

Another object of my invention is to provide a lehr for heat treating lengths of tubing more quickly and to higher temperatures than has been possible on a commercial scale heretofore. The ability of the lehr to introduce heat units into the tubing allows high temperatures to be applied thereto and increases the speed and reduces the cost of said operation.

Another object of my invention is to provide apparatus for correcting the alignment and avoiding distortion and injury to lengths of vitreous tubing during the heating thereof.

Still other objects and advantages of my invention will be apparent from the detailed description which follows of the species thereof shown in the attached drawings.

In the drawings, Fig. 1 is a side elevation of a lehr comprising my invention having the forward part of the apparatus in section and a mid-portion removed so that the details of said lehr can be shown more clearly; Fig. 2 is a vertical section through said lehr along line 2—2 of Fig. 1; Fig. 3 is an end view of the lehr; Fig. 4 is a plan view of one end of several conveyor rolls and associated apparatus having two of the roll ends in section; Fig. 5 is a vertical section through a portion of the apparatus along line 5—5 of Fig. 2 showing drive means for the roll rotating chain; and Fig. 6 is a side elevation of the end of heating apparatus and the adjacent end of cooling apparatus associated therewith.

The lehr in the drawings is considerably longer than can be shown and is comprised essentially of an endless conveyor 10 extending from the front end thereof, at the left of Fig. 1, to the back end thereof, at the right of said figure. The conveyor 10 functions as the means of carrying the vitreous tubes 11 through the various heat zones in said lehr and extends substantially the full width of the lehr as shown in Figs. 2 and 3 so as to provide a support for the full length of the tubes 11 during the heat treatment. In the usual course of events the vitreous tubes 11 are fed to the conveyor 10 automatically by the apparatus 12 at the front end of the lehr and are carried through a relatively short idle zone 13, the heating zone 14 within the furnace 15, a combination heating and cooling zone 16 (only partially shown) of substantially the same length as the heating zone 14 and a cooling zone 17 by said conveyor 10. It is also preferred that a cooling conveyor be attached to the back end of the lehr to receive the tubes 11 discharged therefrom.

The operation of feeding the tubes 11 to the conveyor 10 is provided for by the apparatus 12 which is comprised of a plurality of inclined rails 18 (Figs. 1 and 3) distributed at desirable intervals across the entire front end of the machine. The rails 18 are supported by upwardly extending arms 19 of the frame (not shown) of the machine and provide an inclined surface which causes the tubes 11 placed on an extending portion thereof to roll down to the conveyor 10. The tube 11 must escape from the feeding apparatus separately in order to be fed properly to the conveyor 10 and accordingly must pass below a series of fingers 20 mounted at intervals along the cross bar 21 which keep said tubes 11 from climbing over each other and which only allow single tubes 11 properly placed on the conveyor 10 to move out from behind the feeding apparatus. In the instance shown, the tubes 11 extend the full width of the lehr and but one tube 11 can be accommodated crosswise thereof, but in other instances, shorter tubes are provided and multiples thereof can be accommodated if they can be arranged in end to end relation. In the latter instance the tubes 11 are placed on the rails 18 of the feeding apparatus in the desired arrangement and pass to the conveyor 10 in exactly the same manner as the longer tubes 11.

The conveyor 10 forms an endless belt type of conveying means in that it is comprised of closely arranged rolls 22 held in place by endless chains 23 attached to the opposite ends thereof. The chains 23 extend about sprockets 24 on the shaft 25 at the front end of the lehr and corresponding sprockets 26 (only one of which is

shown) on shaft 27 at the back end of the lehr and follow a path of movement carrying them to opposite sides of the heated portion of the furnace 15 whereas the rolls 22 pass directly through said furnace 15. The frame of the lehr is the supporting means for the conveyor 10, although it is not directly connected thereto, and is comprised of a basic unit under the center section of said lehr built up from a series of vertically disposed legs 28 at intervals along each side thereof of structural angle bars, the cross members 29 and the lengthwise disposed members 30. To each corner leg 28 at both ends of this structural unit is attached a bracket 31 which supports a bearing block 32 for an end portion of either shaft 25 or 27. The brackets 31 and bearing blocks 32 are located just beyond the limits of the conveyor 10 and are completely hidden by the legs 28 in Fig. 2. Motion is imparted to the conveyor through the shaft 27 and the sprockets 26 thereon as said shaft 27 extends beyond the bearing block 32 at the near side (Fig. 1) of the back end of the lehr to another sprocket 33 and chain 34 which serve to connect it to an electric motor and speed reducer (not shown), the main driving means of the lehr.

The rolls 22 of the conveyor 10 are spaced from each other so as to provide a trench or furrow in which the tube 11 will remain during the course of travel thereof and correspond in number to the rollers 35 of the chains 23 to which they are attached. The spaced relation of the rolls 22 is therefore established by the links of the chains 23 and is such that all sizes of tubes 11 which can be accommodated by the lehr will nest securely therebetween. The connection between the ends of the rolls 22 which are hollow and the chains 23 is made through studs 36 which have an enlarged portion (Fig. 4) within the end of said rolls 22 and a portion extending endward of said rolls 22 journaled within the rollers 35 of the chains 23.

The heating cycle of the lehr starts at the time the tubes 11 come to rest on the conveyor 10 as the rolls 22 of said conveyor 10 already contain some of the heat they have absorbed during their preceding cycle of operation. This residual heat is relatively small but means are provided for rotating the rolls 22 so that they will transfer heat to the full periphery of the tubes 11 and will not in themselves tend to sag or warp. The means of rotating the rolls 22 engages portions of the ends of the studs 36 attached to the ends of the rolls 22 at the near side of the lehr in Fig. 1 and at the right side of the lehr in Figs. 2 and 3, which portions extend beyond the chain 23 as shown in detail in Fig. 4. These studs 36 support the sprockets 37 and 37' and are of unequal length so that sprocket 37 on alternate studs 36 engages one section of the chain 38 and the sprockets 37' on the remaining studs 36 engage the other section of said chain 38. Both sections of the chain 38 rest on a ridge on a rail 39 lying parallel to the major portion of the path of travel of the conveyor 10 and are moved along said rail 39 in a direction and at such a speed as to cause the rolls 22 and the tubes 11 to be rotated at a fairly rapid rate (50 to 150 R. P. M.). The rail 39 is supported by brackets 40 at intervals along its length and is straight except for its end portions (only one of which is shown) which follow the curvature of the sprockets 24 and 26 at opposite ends of the lehr. The chain 38 engages a roller 41 held by the end portions of the rail 39 in passing to and from said bar 39 and is driven by the means shown in Fig. 5 which is mounted on the frame midway between the ends of the lehr and which engages the return loop of said chain 38 extending between ends of the rail 39. The return loop of said chain 38 is kept to its path of movement by the guide rails 42 and 42' on opposite sides of the driving means and is caused to loop down around the double sprocket 43 by the idler rolls 44 and 45 which are located on opposite sides thereof. A common bracket 46 mounted on a suspended hanger 47 of the frame provides the means of supporting one end of the shafts 48 holding the idler rolls 44 and 45 and the shaft 49 supporting the driven sprocket 43 whereas a second bracket 50 (Fig. 2) attached to a side member of the frame provides the means of holding opposite ends of the shafts 48 and 49. The driving sprocket 43 and shaft 49 are actuated separately from the other parts of the machine in order that the speed of rotation of the conveyor rolls 22 can be controlled more easily and are connected to said means, which is preferably an electric motor and speed reducer, through the sheave 51 and belts 52.

The tubes 11 are fed to a portion of the conveyor 10 held by a section of the chains 23 riding on the sprockets 24 at the front end of the machine but the movement of said conveyor 10 soon carries it over the highest part of said sprocket 24 and onto the guide rails 53. The guide rails 53 which extend along the path of movement of the chains 23 support said chains 23 until they are about to pass onto the sprockets 26 at the back end of the lehr and are mounted on one side of lehr on brackets 40 and on the other side on brackets 54.

During the first interval of movement of the tube 11, it receives only a small portion of the residual heat in the rolls 22 and passes through the idle zone 13 but, following this, it passes into the furnace 15 and into the high temperature zone 14 thereof. The mouth of the furnace 15 is at the forward edge of a separation between independent upper and lower sections 55 and 56 thereof which have less width than the conveyor 10 and only surround the portion of the rolls 22 carrying the tubing 11. The ends of the rolls 22, the chains 23 and the roll rotating means of the conveyor 10 extend sideward beyond the limits of the furnace 15 and are therefore protected from the high internal heat thereof. The lower section 56 of the furnace 15 is made of blocks of a refractory material which are suspended between the side members 30 of the frame, whereas the upper section 55 of said furnace 15 is supported by the side frames 57 which extend sideward over the ends of the rolls 22, the chains 23 and the roll rotating means of the conveyor 10 and downward to said side members 30.

The object of the furnace 15 is to introduce heat in the tubes 11 as rapidly as said tubes 11 will absorb it without being injured and accordingly must heat the full periphery thereof as uniformly as possible. The furnace 15 is, therefore, heated by means consisting of a plurality of burners 58 located in a plurality of rows above ports in the upper section 55 thereof and by means consisting of a plurality of burners 59 located below two rows of ports in the lower section 56 thereof. In both instances the flames from the burners 58 and 59 do not touch the tubes 11 or the rolls 22 but cause a steady stream of very hot gases to be directed thereagainst. The success of the high speed heat cycle depends on the ability of the furnace 15 to heat the full

periphery of the tube 11 uniformly from end to end and, in every instance, the burners 58 and 59 are arranged very close to each other in the rows so that said tubes 11 are heated in this manner. The burners 58 and 59 are attached directly to the manifolds 60 and 61 respectively which are, in turn, connected to means for supplying the combustible gaseous mixture and are preferably controlled automatically by means varying the supply so that the temperature to which the tubes 11 are treated can be as near the maximum limit as possible. The temperature of the treatment can be higher than normally thought possible, partially because the rolls 22 have relatively thin walls and are made of stainless steel which resists sticking to the vitreous material of the tube 11. In fact, the tubes 11 can be heated above the softening temperature of the vitreous material without danger of collapsing and are normally heated to a point where they are straightened by their contact with the rolls 22. In instances when the tubes 11 are being heated to condition a coating on the inner surface thereof, it is preferred that a current of air be directed through said tubes 11 to cause the gaseous products of the heat cycle to be blown out. The air is blown into one end of the tubes 11 while they are in the high temperature zone 14 and passes to the tubes 11 from a series of openings in the side of a pipe 62 mounted just above one end of the rolls 22 as shown. The pipe 62 extends through the open mouth of the furnace 15 from a source of air (not shown) and is heated by the furnace 15 so that the air discharged into the tube 11 is at a fairly high temperature. Along the upper edge of the separation at each side of the furnace 15 is mounted a square tube 62' which helps to seal said opening. Air is blown through the square tube 62' from one end to the other to keep it cool. The air ducts 62'' provide the means of directing jets of air onto the chains 23 to cool them.

Following the high temperature zone 14 in the furnace 15 is a second slightly longer zone 16 which is heated by the flow of gases from zone 14. The temperature gradient in this latter zone 16 is lower as the gases flowing from zone 14 are gradually relieved of their heat as they pass from the forward end thereof to the exhaust opening 63 along the back edge of the roof of the furnace 15. This movement of the gases is preferably produced by an exhaust fan (not shown) connected to the vent pipe 63' attached to the opening 63 in that the leakage of heat from the openings in the furnace 15 will then be less, and more accurate control of the apparatus will then be afforded. The rate at which the tubes 11 are cooled within zone 16 is of course very slow but sufficient cooling occurs to bring said tubes 11 below their strain point before they pass from the furnace 15. In the zones 14 and 16 the tube 11 is heated so rapidly and to such a high temperature that the strains within the tube 11 would ordinarily cause it to crack and in some cases burst if it were conducted through the furnace 15 in the ordinary manner. The apparatus is very effective in relieving strains within the tube 11, correcting linear alignment thereof and heat treating fluorescent material placed on the inner surface thereof.

In their course of travel beyond the furnace 15, the tubes 11 are in the open air and continue to cool to a point where they are not injured when discharged therefrom. In this interval the tubes 11 receive only the treatment that results from the continued rotation of the rolls 22.

At this time the conveyor 10 has completed the effective portion of its cycle of operation and the portion thereof conducting the tubes 11 to the cooling conveyor has but to return to the feeding apparatus 12 to start the next cycle. In the course of the return movement while the chains 23 are still supported by the sprockets 26, the roll rotating sprockets 37 and 37' pass from the chain 38 and move into engagement with a double stationary chain 64 which follows the path of movement thereof until they are again engaged by the chain 38. The chain 64 has opposite ends attached to corresponding arms 65 at opposite ends of the frame of the lehr and causes the rolls 22 of the conveyor 10 to rotate at a slow rate due to the rolling motion given to the sprockets 37 and 37'. This final rotative movement of the rolls 22 keeps them from sagging and warping out of alignment during the major portion of the inactive portion of the cycle of operation. Support is provided for the straight section of the chain 64 by the guide rail 66 which is attached directly to the frame. During this last interval the chains 23 of the conveyor 10 ride on the guide rails 67 and 68 respectively and are cooled by the air blown from the holes in manifold 69. The guide rails 66, 67 and 68 and manifold 69 are mounted directly on the frame of the lehr.

The tubes 11 are still too hot upon leaving the lehr to be handled and it is preferred that they be transferred to a cooling conveyor connected to the end of the lehr. The cooling conveyor can consist, as shown in Fig. 6, of a stationary table 70 having a lip 71 extending therefrom which takes the tubes 11 from the conveyor 10 as it starts to pass down around the sprocket 26 and preferably includes means 72 of moving the tubes 11 along the surface of said table 70 and means 73 of directing a cooling air stream against said tubes 11. The lip 71 is inclined toward the table 70 so that the tubes 11 roll over onto said table 70 by their own weight where they engage the first upright fingers 74 of the moving means 72 of the cooling conveyor. The surface of the table 70 on which the tube 11 rests consists of a series of longitudinally disposed strips in that it must allow the moving means 72 which consists of a plurality of parallel disposed chains 75 having fingers 74 at regular intervals therealong to gain access to the tubes 11 and must allow the free flow of air from the air duct 76 of the cooling means 73 below said surface to the tubes 11. The different chains 75 of the moving means each extend about a sprocket 77 on the shaft 78 which is held by the cooling conveyor and which is driven through the chain 79 and sprockets 80 and 81 by the lehr. This manner of operation causes the fingers 74 on the chains 75 to swing up through the surface of the table 70 behind each tube 11 as rapidly as they are received from the lehr and causes the tubes 11 to be pushed along the surface of said table 70 by the movement of the fingers 74. The tubes 11 actually roll along said surface so that the full periphery thereof are subjected to the flow of air from the cooling means 73. The length of said conveyor is preferably such that the tubes 11 are cooled to a point where there they can be handled conveniently when discharged therefrom.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A lehr for heat treating vitreous tubes comprising a furnace adapted to produce heat treating temperatures above the softening temperature of the tubes, and a conveyor extending through said furnace comprising a series of uniformly spaced rolls disposed in a substantially horizontal position and adapted to support the full length of each of a plurality of tubes placed longitudinally between successive rolls, means for carrying said rolls through the furnace at a desired rate of speed to soften the tubes, and means for rotating said rolls during said movement to cause the tubes to be rotated during the heat treatment so that distorted tubes are straightened by their contact with the rolls.

2. A lehr for heat treating vitreous tubes comprising a furnace adapted to produce heat treating temperatures above the softening temperature of the tubes, and a conveyor extending through said furnace comprising a series of uniformly spaced hollow rolls disposed in a substantially horizontal position and adapted to support the full length of each of a plurality of tubes placed longitudinally between successive rolls, means for keeping the rolls in alignment with each other and carrying said rolls through the furnace at a desired rate of speed to soften the tubes, and means for rotating said rolls during said movement to cause the tubes to be rotated during the heat treatment so that distorted tubes are straightened by their contact with the rolls.

3. In a lehr for heat-treating vitreous tubing, an endless conveyor, a furnace through which said conveyor travels adapted to heat the tubes above their softening point, said conveyor comprising a series of uniformly spaced rolls of hollow sheet metal tubing arranged to support the full length of each of a plurality of vitreous tubes placed longitudinally between successive rolls, means for moving said rolls through said furnace, and means for rotating said rolls about their axes at a comparatively slow speed during the period of their travel outside said furnace and means for rotating said rolls at a higher speed during the period of their travel within the furnace whereby distorted tubes are straightened within the furnace by their contact with the rolls and the rolls are prevented from warping during their period of travel outside the furnace.

4. A lehr for heat-treating vitreous tubes comprising a furnace adapted to heat the tubes above their softening point, and a conveyor extending through said furnace comprising a series of spaced rolls arranged to support the full length of each of a plurality of tubes placed longitudinally between successive rolls, means for rotating said rolls about their axes to cause the tubes to be rotated during the heat treatment so that distorted tubes are straightened by their contact with the rolls, and means, independent of the said rotation of said rolls, for moving said tubes through the furnace.

5. A lehr comprising a furnace, and a conveyor for carrying vitreous tubes through the furnace comprising an endless chain mechanism carrying a series of uniformly spaced horizontal rolls arranged to support tubes placed horizontally between adjacent rolls, means operable upon those rolls which at a given time are located within the furnace for rotating said rolls about their own axes independently of any such rotation which might be effected only by movement of the conveyor, and means operable upon those rolls located outside the furnace for rotating said rolls at a lower speed.

6. A lehr comprising a furnace, and a conveyor for carrying vitreous tubes through the furnace comprising an endless chain mechanism carrying a series of uniformly spaced horizontal rolls arranged to support tubes placed horizontally between adjacent rolls, said rolls having sprockets at an end thereof, a second chain mechanism engaging the sprockets of those rolls which at a given time are located within the furnace, means for moving said second chain mechanism independently of the movement of the first-mentioned chain mechanism to rotate said rolls about their own axes, and a third chain arranged to engage the sprockets of those rolls located outside the furnace to rotate said rolls at a lower speed.

CLARENCE E. HAHN.