CONVEYER SYSTEM FOR HEAT TREATMENT

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This invention relates to conveyer systems especially applicable in connection with installation for the continuous heat treatment of lightweight metal articles, such as wire, light strip, metal strip, and the like.

A broad object of the invention is the provision of an improved conveyer system. Another object of the invention is to provide an improved heat treatment system specially advantageous for high-temperature treatment of metal articles having a relatively low heat capacity. Another object is to provide such a system wherein heat losses due to the conveyer part of the system will be greatly reduced. A more specific object is to provide a continuous conveyer means for putting a plurality of articles through a heating zone, wherein a predetermined section of the conveyer will remain permanently within the heating zone so that the same portion of the conveyer will remain directly exposed to heat throughout the process, thereby to eliminate substantially all heat losses from said zone other than the heat losses due to the thermal conductivity of the conveyer. Further objects will appear as the disclosure proceeds.

According to one aspect of the invention an improved conveyer system comprises at least two sets of longitudinal bar elements supported with the bars of the sets in an intersecting relation, means for imparting to the sets separate cyclic motions whereby all the bars in each set describe bodily displacements along generally elliptical paths in the vertical longitudinal planes of the bars, the cyclic displacements imparted to the respective sets being relatively displaced in time, so as to "walk" articles deposited on the supporting surface defined by the bars, over said surface.

In one embodiment the bars in each of two sets are all made to reciprocate longitudinally to provide a horizontal component for said elliptical displacement, and means are further provided for guiding the bars along a vertical component of said displacement, in such a manner that at the start of each reciprocation one set of bars is brought to a highermost position while the other set is brought to a lowest position of its vertical displacement component. That set of bars which is uppermost during the forward portion of a displacement cycle serves to advance the articles to be treated while the other set of bars is accomplishing its return movement in a lowestmost position below the level of the supporting surface. Thereafter the second set of bars assumes an uppermost portion while the first set is lowered, and the articles are now taken up by the second set and advanced a further step, and so on repeatedly. The articles are alternately advanced by the two sets of bars and progress smoothly at a substantially uniform rate without being subjected to shocks.

Preferably the operating mechanism including such components as linkages, cams, rollers and the like, is entirely positioned outside of the heating zone of the installation. The bars in each set may be straight or they may be made arcuate, if it be desired for example that the input and output stations for the articles should be provided at elevations lower than the heating enclosure. In this latter case the conveyer may be surrounded by a tunnel having its ends dipping into water tanks, in order to seal the atmosphere within the heating zone or furnace and thereby make it possible to control said atmosphere.

An embodiment of the invention will now be described as applied by way of example to an installation for annealing steel wire. Figs. 1 and 2 of the accompanying drawings illustrate the system in elevation and in overhead plan view respectively.

By way of further example the system is shown as combined with the improved wire handling system disclosed in my copending patent application Serial No. 702,644, filed December 13, 1957, to which reference may consequently be made for a fuller disclosure of the means shown herefor for feeding the wire in displaced overlapping loops at the input end and for lifting the loops off the conveyer at the output end thereof.

Referring to the accompanying drawings, wire 1 to be annealed is continuously fed at a high rate to a feedout head 2 which casts off the wire at its base in successive circular loops. The loops are described upon the surface of a conveyer 3 comprising three belts stretched across sheaves 4. The conveyer 3 is immersed in a water tank 5. The array 6 of overlapping loops is then transferred from the conveyer 3 to the surface of a conveyer generally designated 7 and constructed in accordance with the present invention as will be more fully described hereinafter. The array of loops 6 is advanced over the conveyer 7 through an annealing furnace 8 and is then fed downward into another water tank 9. A tunnel 10 is connected to each end of the furnace and its ends sections are immersed in the respective water tanks 5 and 9 to seal the interior of the furnace from the outer atmosphere and permit the furnace atmosphere to be controlled as to its chemical composition and pressure conditions. The wire 6 is transferred within tank 9 to another conveyer 11 comprising three belts applied against a sheave 12 by pressure pulleys 13. A belt 14 is further trained between the sheaves 12 and a guide pulley 15. In this way the wire 6 is gripped between the belts 11 and 14 and turned upside down without the overlapping loops of wire being disturbed. The wire is then taken up by being lifted off the belt 14, a conventional taker casing 16 being provided to prevent the wire from "ballooning" out, and a retarding or tensioning device 17 is provided. The wire may be finally delivered into cylinders 18 rotated at the same speed as the feedout head 2, the rotations being synchronized through the belt drive 19.

The novel conveyer 7 essentially comprises two sets of bars 20 and 21 in the form of vertical, upwardly-convex circular arcs, the bars in each set being secured to one another in transversely spaced relation in any suitable manner, and the two sets being arranged so that the respective bars thereof alternate. All the bars extend through the annealing furnace shown at 8 which surrounds substantially an apical portion of the arcs. The bars have their opposite end portions projecting downwardly into the water tanks 5 and 11 and into the spaces between the transversely spaced belts of each conveyer 11 and 12 respectively. All the bars of set 20 are interconnected at their respective ends by cross members 22 and all the bars 21 are similarly interconnected at their ends by cross members 23. A cross member 22 extends through apertures formed in the bars of set 21 and a cross member 23 extends through apertures in the bars of set 20. Corresponding ends of the pair of cross members 23 are interconnected by raillike members 24 which are
formed with the same curvature in a vertical plane as the bars, but extend alongside the furnace outwardly thereof instead of passing through the furnace. The rail members 22 are supported in their intermediate portions each by a pair of spaced rollers 25. In the same way the corresponding ends of cross members 23 are interconnected by arcuate rail members 25 extending alongside the furnace and supported by the spaced rollers 27. The rollers 25 and 27 are journaled on vertically reciprocable supports to be presently described.

Each of the rails 24 and 25 has secured to a point thereof intermediate the rails 26 or 37, a generally radial arm 28 or 29 which extends downwardly and has journaled to its lower end a follower roller 30 and 31; both rollers 20 associated with rails 24 cooperate with the periphery of a cam 22 and both rollers 31 associated with rails 25 cooperate with a cam 23. Springs 34 act on the lower extremities of the arms 28 and 29 to press the rollers carried thereby into firm engagement with the surfaces of the respective cams.

The rollers 26 supporting the rails 24 are journaled on vertical plates 36 which are mounted for vertical sliding reciprocation relatively to stationary guide structure mounted on each side of the furnace 7 and including guide rollers 38 engaging the vertical edges of the plates 36. Similarly the rollers 27 supporting the rails 25 are journaled on vertical plates 36 which reciprocate vertically in engagement with guide rollers 39, as will be apparent from the drawings. Rollers 40 and 41 journaled at the lower ends of arms projecting downwardly from the plates 36 and 37 cooperate with the peripheries of respective cams 42 and 43 secured coaxially with the cams 32 and 33 previously mentioned, upon a vertically extending rotatable drive shaft 44, driven in rotation from any suitable source.

It will be readily appreciated that the two cams 32 and 42, or 33 and 43, which respectively relate to each set of bars can be so shaped that continuous rotation of the shaft 44 will impart to the rail members and associated set of bars a cyclic, generally elliptical movement in a vertical plane, the horizontal longitudinal component of such displacement being imparted by the cam 33 or 34 acting on the radial arm 28 or 29, and the vertical component of the displacement being imparted by the cam 42 or 43 acting on the vertical plate 36 or 37. Thus, any given point of a particular bar of either set will describe a small generally elliptical path of travel in a vertical plane, as indicated by way of example in dotted lines for the trajectory described by the cross member 23 at the left side of Fig. 1.

Furthermore, the relative setting between the cams 32 and 42 imparting motion to the bar structure 20 and the cams 33 and 43 imparting motion to the bar structure 21, is such that the cycles of displacement of the two bar structures are time-displaced by one half a complete cycle. In this way it will be understood that the array 6 of loops of wire as deposited from the input conveyor belts 3 upon the inlet end of the bar conveyor within tank 5, will be advanced by the alternate "walking" motion of the two sets of bars into and through the annealing furnace 7 and out again into water tank 9. There the annealed wire is transferred on to belt conveyor 14 and passed around the sheave 12 to the flat upper leaf of said belt conveyor 14, whence the wire is taken up in a manner already described.

An important advantage of this invention is that the intermediate portion of the bar conveyor remains at all times within the furnace so that no heat is withdrawn from the furnace during an annealing operation by movement of the conveyor out of the furnace, as would be the case with any of the various forms of conventional conveyors currently used in installations of the kind described and wherein the conveyor itself must necessarily pass through the furnace together with the parts carried thereby, and thus continually carries away valuable heat units as it passes out of the furnace. This waste of high-temperature energy is completely eliminated by the invention, and it is further noted that the intermediate section of the conveyor within the furnace preferably is insulated thermally from the outer sections.

The rate of advance imparted by the conveyor is readily adjustable e.g. by action on the cams.

Among the many modifications conceivable within the scope of the invention, there may be mentioned that wherein there are provided more than two, e.g. three, sets of intersected bars and the cyclic displacements imparted to the respective sets being displaced in time by a corresponding fraction, e.g. ⅔ of a cycle.

What I claim is:

1. In a heat treating system in combination, at least two bar assemblies each comprising a set of transversely spaced bars having an arcuate configuration in a vertical plane with the apex of the arc directed upward, means supporting said assemblies in parallel interconnected relation whereby all the bars define a generally part-cylindrical supporting surface having a substantially flat apical portion intermediate the ends of the assemblies and end portions drooping downwardly from said flat apical portion towards the ends of the assemblies, liquid container means into which said drooping end portions project, tunnel-like extensions projecting from the ends of said enclosure into said container means in surrounding relation with said bar assemblies whereby to define a sealed space within said enclosure and tunnel extensions, a charging station at an input end of said assemblies for placing articles to be treated on said supporting surface, means imparting to the respective assemblies time-displaced generally elliptical cyclic motions in a vertical plane to advance said articles over said surface through said enclosure, and a discharging station at the opposite end of the assemblies for removing the treated articles.

2. In a system as claimed in claim 1, guide rail means of generally similar arcuate configuration as said bars interconnecting the opposite ends of each of said bar assemblies and extending alongside said enclosure and tunnel-like extensions externally thereof, rollers supporting said guide rail means in intermediate portions thereof, vertically reciprocable supports on which said rollers are journaled, and cam means for reciprocating said supports and for simultaneously imparting to said guide rail means longitudinal reciprocations relatively to said rollers.

3. In a system as claimed in claim 1, an input belt conveyor in interconnected relation with the bar assemblies at an input end of said system arranged to transfer articles placed on said input conveyor to said supporting surface, and an output belt conveyor in interconnected relation with the bar assemblies at the output end of the system arranged for transfer of treated articles from said supporting surface to said output conveyor.

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