

April 4, 1961

A. W. FRANK

2,978,237

HEAT TREATING APPARATUS

Filed Sept. 20, 1956

2 Sheets-Sheet 1

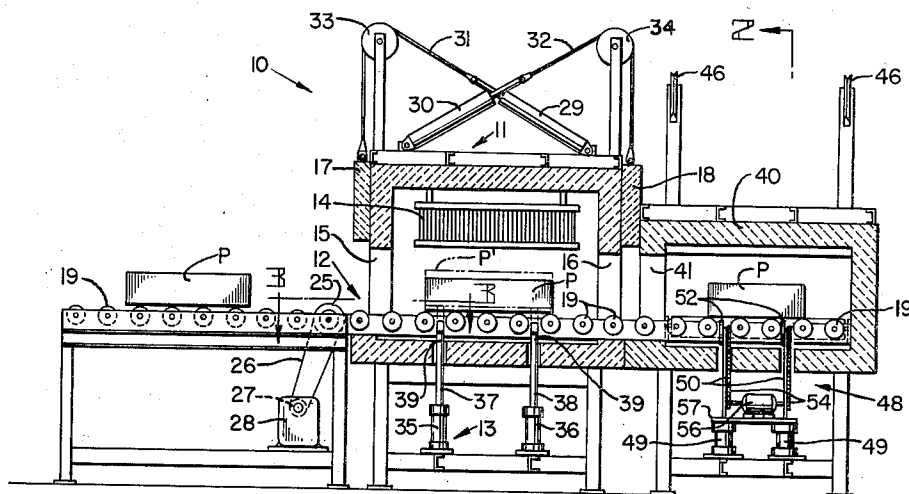


FIG. 1

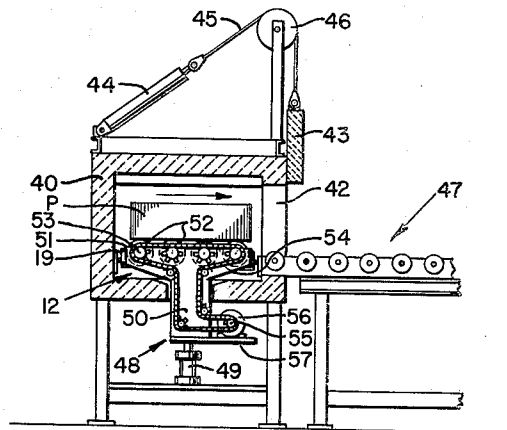


FIG. 2

INVENTOR.
ARTHUR W. FRANK
BY

Pellard Johnston Smyth & Robertson
ATTORNEYS.

April 4, 1961

A. W. FRANK
HEAT TREATING APPARATUS

2,978,237

Filed Sept. 20, 1956

2 Sheets-Sheet 2

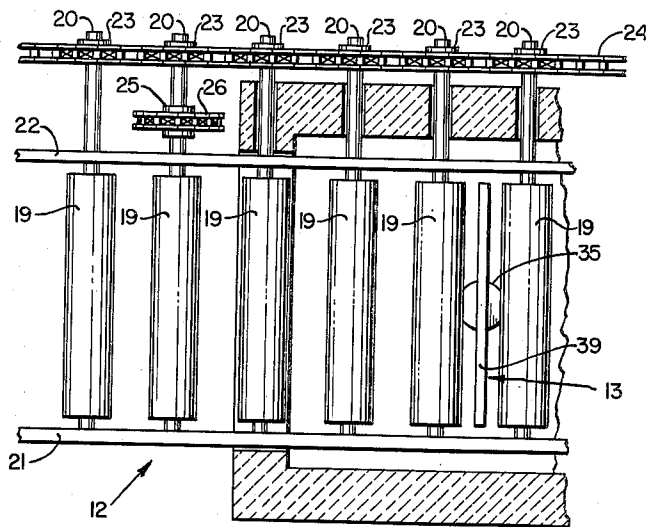


FIG. 3

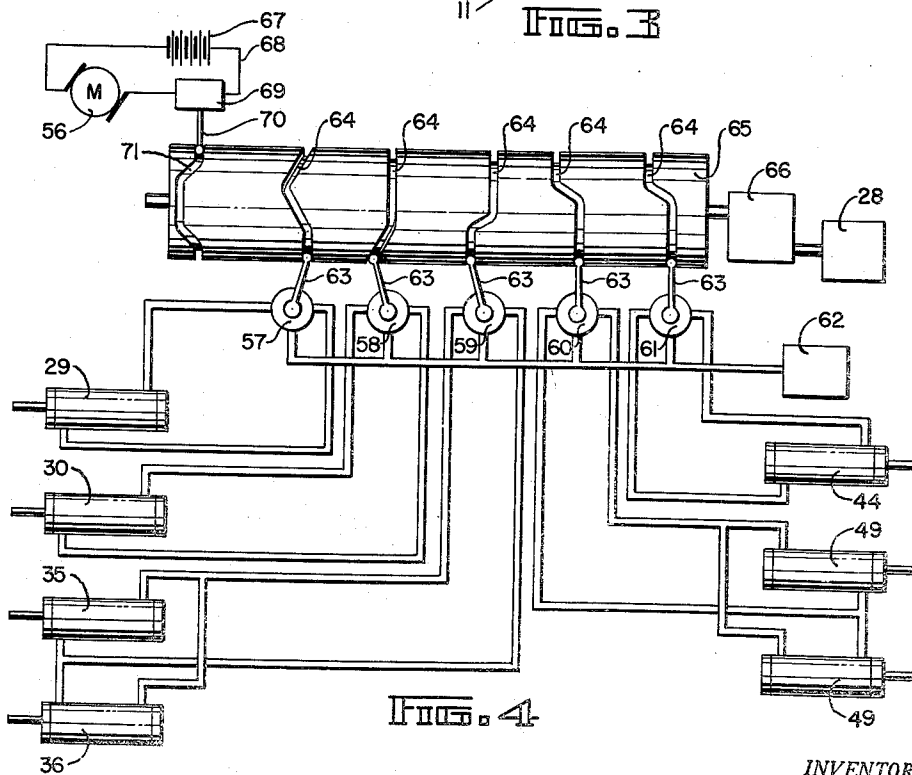


FIG. 4

INVENTOR.
ARTHUR W. FRANK
BY
Pollard Johnston Smythe & Robertson
ATTORNEYS.

1

2,978,237

HEAT TREATING APPARATUS

Arthur W. Frank, Delafield, Wis., assignor, by mesne assignments, to Basic Products Corporation, Milwaukee, Wis., a corporation of Wisconsin

Filed Sept. 20, 1956, Ser. No. 611,037

4 Claims. (Cl. 263—6)

The present invention relates generally to apparatus for treating articles in a chamber having specified conditions for treatment present therein, and more particularly is directed to improvements in heat treating apparatus.

In order to provide maximum physical properties in the final product, present day heat treating specifications are becoming increasingly stringent with respect to time, temperature and controlled atmosphere requirements. While the heat treating specifications have become more restrictive, the demand has been growing for automatic furnace equipment capable of performing the necessary heat treating operations and endowed with a high degree of operational flexibility and reliability so that the requirements of widely different specifications may be met with a standardized apparatus.

The method or means employed for conveying the parts to be treated through the treating chamber or chambers strongly influences the satisfaction of the above demands in apparatus of the described character, since the movement of the parts through the treating chamber or chambers determines the durations of the various stages of the treatment and is an important factor to be considered in obtaining automatic and flexible operation of the treating apparatus. For example, if the parts are to be exposed to various treatments in a succession of related treating chambers and are continuously conveyed through the latter, the relative times or durations of the several treatments, or stages thereof, cannot be altered except by the obviously unacceptable expedient of changing the lengths of the treating chambers in the direction of the conveyor movement so that the apparatus must be designed to meet the requirements of a particular treating specification and does not have the desired operational flexibility. Further, it is usually desirable to effect the relatively rapid movement of the parts to be treated into and out of the treating chamber so that the doors of the latter need be open only for a short time to permit the entry and removal of the parts, thereby minimizing the escape of the treating atmosphere from the chamber. However, if the conveyor continuously carrying the parts through the treating chamber moves at a sufficient speed to effect rapid movement of the parts into and out of the treating chamber, it is apparent that the parts can be exposed to the atmosphere within the treating chamber for a long period only by providing a correspondingly long chamber. The costs involved in constructing and maintaining such long treating chambers will inherently be greater than those encountered with relatively short chambers. Further, a conveyor carrying parts through a long treating chamber will be longer, and hence more difficult to drive, than a conveyor for carrying the parts through a relatively short treating chamber, so that substantial power savings and other economies will be realized if the length of the treating chamber can be made independent of the time of treatment.

Accordingly, it is an object of the present invention to provide treating apparatus of the described character wherein the parts to be treated are conveyed through one

2

or more treating chambers and the period of residence of the parts in each chamber is made independent of the speed of movement of the conveyor carrying the parts and of the length of the chamber so that relatively short chambers and conveyors can be employed while affording a high degree of operational flexibility.

Another object is to provide treating apparatus of the described character which is compact and which is inherently economical and relatively trouble-free in operation.

In accordance with an aspect of the invention, the treating of parts or articles in a chamber is achieved with an apparatus that includes conveying means for carrying the parts through the treating chamber, and lifting means operative to raise the parts off the conveying means within the treating chamber and then to return the parts to the conveying means so that the time during which the parts to be treated remain within the treating chamber is determined by the period of operation of the lifting means rather than by the length of the treating chamber or the speed of movement of the conveying means. Thus, relatively short treating chambers and conveyors, with the advantages inherent therein, can be employed even when the treatment specifications require long periods of exposure to the atmosphere within the chambers. Further, since the load of the parts being treated is removed from the conveyor during at least a substantial part of the treating period, it is apparent that the wear on the conveyor and the necessity for maintenance of the latter are correspondingly reduced.

The above, and other objects, features and advantages of the invention, will be apparent in the following detailed description of an illustrative embodiment thereof which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

Fig. 1 is a longitudinal sectional view of a treating apparatus embodying the present invention;

Fig. 2 is a transverse sectional view taken along the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary horizontal sectional view taken along the line 3—3 of Fig. 1; and

Fig. 4 is a schematic view of a system that may be used to automatically control the operation of the treating apparatus of Figs. 1, 2 and 3.

Referring to the drawings in detail, and initially to Fig. 1 thereof, it will be seen that an apparatus embodying the present invention, and there generally identified by the reference numeral 10, includes a chamber 11 in which the desired treatment is effected, a conveyor 12 for carrying the parts or articles P to be treated through the chamber 11, and a lifting device which is generally identified by the reference numeral 13 and is operative to raise or lift the parts or articles off the conveyor 12 within the chamber 11 and then to return the articles to the conveyor for movement, by the latter, out of the treating chamber 11.

With the above general arrangement, it is apparent that the conveyor 12 may be continuously operated at a speed effective to rapidly move the parts or articles P into and out of the treating chamber 11 when the parts rest upon the conveyor, and that the successive parts can be retained within the treating chamber for a relatively long period of treatment, notwithstanding the rapid movement of the conveyor 12 or the relatively short length of the treating chamber, merely by suitably controlling the operative periods of the lifting device 13.

Although the above described arrangement is capable of being advantageously employed in any apparatus wherein parts or articles are treated in a chamber having a controlled atmosphere therein, the apparatus 10, which has been illustrated only as a specific example of the application of the invention, is intended for the purpose of effecting the heat treatment of metal parts or articles,

In order to serve that purpose, the treating chamber 11 of the apparatus 10 is formed by a furnace which is suitably heated, for example, by electric heating elements 14.

The furnace 11 has an opening 15, at one end, to admit the parts to be treated into the interior of the furnace chamber and an opening 16, at the opposite end, through which the treated parts may be discharged. Vertically movable doors 17 and 18 are provided at the opposite ends of the furnace 11 and are displaceable between the illustrated raised positions, uncovering the openings 15 and 16, and lowered positions where the doors 17 and 18 substantially close the openings 15 and 16, respectively.

The conveyor 12 may be of the kind employing a belt, chains, pushers, walking beams or rotated rollers, as shown, for the purpose of carrying the parts to be treated through the furnace chamber. The roller conveyor 12 of the illustrated embodiment includes a series of rollers 19 which are supported by parallel, laterally extending axles 20. The axles 20 are rotatably journaled in suitable side supports 21 and 22 (Fig. 3). In order to provide for the simultaneous rotation of the rollers 19 in the direction causing advancement of the parts P supported thereon through the furnace chamber, each axle 20 has a sprocket 23 fixed on one end portion thereof and engaged by a continuous chain 24 (Fig. 3), and one of the shafts or axles 20 carries an additional sprocket 25 which is engaged by a continuous chain 26 driven by a sprocket 27 on the shaft of drive unit 28 (Fig. 1) which may include an electric motor and a speed-change mechanism. Under some circumstances, it may be desirable to momentarily stop or slow down the conveyor 12 in order to ease lifting up the load.

The doors 17 and 18 may be actuated by pressure fluid operated, double-acting cylinders 29 and 30, respectively, which are suitably mounted on top of the furnace 11 and have their plungers or rams connected to cables 31 and 32 which pass over pulleys or sheaves 33 and 34 and are attached to the respective doors (Fig. 1). It is apparent that the doors 17 and 18 can be raised and lowered, as desired, by suitably controlling the supplying of pressure fluid to the related cylinders 29 and 30.

The lifting device 13 of the illustrated embodiment of the invention may also be pressure fluid operated and includes vertical, double-acting cylinders 35 and 36 disposed under the furnace 11 and having their rams or plungers 37 and 38 passing upwardly through suitable openings in the bottom of the furnace. The cylinders 35 and 36 are located in relation to the conveyor 12 so that the plungers 37 and 38 can pass between successive rollers 19 of the conveyor when the plungers are raised by pressure fluid admitted to the related cylinders. If desired, a cross-member 39 may be mounted on the upper end of each of the plungers 37 and 38 and is adapted to pass between the side supports 21 and 22 (Fig. 3) when the related plunger is raised.

Normally, the plungers 37 and 38 are in the lowered positions of Fig. 1 so that the cross-members 39 are disposed below the level of the top surface portions of the conveyor rollers 19, thereby permitting a part P disposed within the furnace chamber to rest upon the rotated conveyor rollers and be advanced by the latter. However, when the plungers 37 and 38 are simultaneously moved upwardly to dispose their cross-members 39 in the broken-line positions of Fig. 1, where the top surfaces of the cross-members are disposed above the level of the top surface portions of the conveyor rollers 19, the part P disposed within the furnace chamber is lifted off the conveyor rollers to the broken-line position P' and is thereby retained within the furnace chamber until the plungers 37 and 38 are again lowered to return the treated part to the conveyor 12 for continued movement by the latter out of the chamber 11 through the discharge opening 16.

Although the lifting device 13 is pressure fluid operated in the illustrated embodiment of the invention, it is to

be understood that other means, for example, screw-jack operated means, may be employed for lifting the article and then returning the latter to the conveyor 12.

The illustrated apparatus 10 embodying the present invention further may include an additional chamber 40 adapted to receive parts treated in the chamber 11 and to further treat such parts under controlled conditions. When the chamber 11 is a furnace in which the parts are heated, as described, the additional chamber 40 may be an annealing chamber in which the previously heated parts are cooled in a controlled atmosphere. The chamber 40 has an opening 41 at one end and is arranged with that end adjacent to the end of the furnace chamber 11 having the discharge opening 16 therein so that the door 18 can serve as the closure for both of the openings 16 and 41. In order to carry the treated parts from the furnace chamber 11 into the annealing chamber 40, the conveyor 12 may be extended through the openings 16 and 41 into the chamber 40.

In order to minimize the length of the space required for installation of the apparatus 10, the fully treated parts may be discharged from the latter through an opening 42 formed in a side of the annealing chamber 40 (Fig. 2) and adapted to be closed by a vertically movable door 43. As in the case of the doors 17 and 18, the door 43 may be raised and lowered by a pressure fluid operated mechanism that includes at least one double-acting cylinder 44 suitably mounted on top of the chamber 40 and having its ram or plunger connected to a cable 45 passing over a related pulley or sheave 46 and attached to the door 43, so that the position of the latter can be determined by suitably regulating the supplying of pressure fluid to the cylinder 44. A laterally extending discharge conveyor 47 (Fig. 2) may extend from the opening 42 of chamber 40 to receive the treated parts discharged from the latter.

In order to remove the treated parts from the conveyor 12 within chamber 40 for lateral discharge through the opening 42 onto the conveyor 47 and also in order to permit the residence of the parts in the annealing chamber 40 for a treating period that is independent of the speed of movement of conveyor 12 and of the length of the chamber 40, a lifting device 48 is associated with the chamber 40 and is operative to raise a part P off the conveyor 12 within the annealing chamber, so that the raised part can remain in the latter while the conveyor 12 continues to operate, and then to laterally move the raised part through the opening 42 onto the discharge conveyor 47.

Fig. 2 of the drawings illustrates, merely by way of example, a structural arrangement of the lifting device 48 that can perform the above functions and that includes double-acting, pressure-fluid operated cylinders 49 mounted vertically below the chamber 40 and having their rams or plungers 50 passing upwardly through openings in the bottom of the chamber. The cylinders 49 are located relative to the conveyor 12 so that the plungers 50 can pass through the spaces between successive rollers 19 of the conveyor during vertical movement of the plungers. Laterally extending channel members 51 are fixed on the upper ends of the plungers 50 and have conveyor discs 52 rotatably mounted therein to engage and support a part P within the chamber 40 when the plungers 50 are moved upwardly from the normal, relatively low positions of Fig. 1 to the raised positions of Fig. 2 in which the upper surface portions of the discs 52 project upwardly above the level of the upper surface portions of the adjacent conveyor rollers 19.

In order to move a part P supported by the conveyor discs 52 through the opening 42 onto the discharge conveyor 47, the conveyor discs 52 may be simultaneously rotated in the clockwise direction, as viewed in Fig. 2, that is, in the direction causing movement of the top surface portions of the discs 52 laterally toward the opening 42 of chamber 40. Such simultaneous rotation

of the conveyor discs 52 may be effected by providing each of the latter with a sprocket 53 rotatable therewith and engaged by a continuous drive chain 54 that is trained over suitable idler sprockets and led by the latter out of the chamber 40 for engagement with a drive sprocket 55 on the shaft of an electric motor 56 mounted on a platform 57 movable vertically with the plungers 50 below the chamber 40.

The motor 56 may be continuously energized so that, when the plungers 50 are raised and the conveyor discs 52 lift a part P off the conveyor 12 within the chamber 40, the lifted part will be immediately discharged laterally from the chamber through the side opening 42 of the latter, or the energization of the motor 56 may be controlled so that the motor is inoperative when the plungers 50 are raised to lift the part P off the conveyor 12 within the chamber 40, thereby to retain the part within the latter for a predetermined period, and so that the motor 56 becomes operative to drive the conveyor discs 52 only after termination of the predetermined treating period at which time the fully treated part is discharged onto the conveyor 47.

It is apparent that the operation of the doors 17, 18 and 43 is synchronized with the operation of the lifting devices 13 and 48 and with the rate at which the conveyor 12 carries parts P to be treated to and through the chamber 11 into the chamber 40, and that the operative periods of the lifting devices 13 and 48 are predetermined in order to provide for the presence of the parts being treated in the chambers 11 and 40 for the periods required by the relevant treating specification.

Any type of suitable control apparatus can be used for controlling a given cycle such as mechanical, electronic, or electrical relays.

As an example, Fig. 4 schematically represents an arrangement that may be employed for controlling the operation of the doors 17, 18 and 43 and of the lifting devices 13 and 48. In such arrangement, a series of two-way valves 57, 58, 59, 60 and 61 are provided to control the feeding of pressure fluid through a system of ducting from a suitable source 62 to the opposite ends of the cylinder 29, the cylinder 30, the cylinders 35 and 36, the cylinders 49, and the cylinder 44, respectively. Thus, valve 57 controls the raising and lowering of door 17; valve 58 controls the position of door 18; valve 59 controls the raising and lowering of the rams 37 and 38 of the lifting device 13 and hence determines the operative periods of the latter; valve 60 controls the raising and lowering of the rams 50 of the lifting device 48; and valve 61 controls the raising and lowering of the door 43.

In order to actuate the several valves 57, 58, 59, 60 and 61 in a predetermined order so that such valves send pressure fluid first to one end, and then to the other end, of the related cylinders, each valve may have an actuating arm 63 extending radially from the related valve body and engaging in a corresponding groove 64 extending circumferentially in a drum-type cam 65 and having a suitable contour to obtain the desired actuation of the related valve. In order to relate the operation of the doors 17, 18 and 43 and of the lifting devices 13 and 48 to the rate at which the conveyor 12 advances parts to be treated to and through chamber 11 into chamber 40, the drum-type cam 65 may be rotatably driven by the drive unit 28 of the conveyor through an additional speed changing unit 66. Further, in the case where the motor 56 for rotating the conveyor discs 52 of the lifting device 48 is energized only when a treated part is to be discharged from the chamber 40, the circuit for energizing the motor 56 may include a source 67 of electric current conductors 68 leading from that source to the motor, and a switch 69 interposed in the conductors 68 in series with the motor 56 and having an actuating arm 70 engaging in a circumferential groove 71 of the drum-type cam 65 so that the switch 69 causes energization and deenergization of the motor 56 in synchronism

with the operation of the door 43 and the lifting device 48.

It will be understood that the several grooves of the drum-type cam 65 are shaped so that, initially, all of the doors 17, 18 and 43 are lowered or closed and the lifting devices 13 and 48 are in their lowered or inoperative positions with the motor 56 being deenergized. When a part to be treated approaches the chamber 11 on the conveyor 12, valve 57 is actuated to cause raising of door 17 so that the part P can enter the interior of chamber 11 through the opening 15 and, thereafter, valve 57 is again actuated to close door 17. When the part P on the conveyor 12 within chamber 11 arrives above the lifting device 13, valve 59 is actuated to cause upward movement of the plungers or rams 37 and 38 of cylinders 35 and 36 so that the lifting device 13 is then operative to lift the part to be treated off the conveyor 12. The device 13 remains operative for as long as the treatment within chamber 11 is to continue. At the conclusion of the predetermined period of treatment in chamber 11, valve 59 is again actuated to lower the rams 37 and 38, whereupon, the device 13 becomes inoperative and the treated part is returned to the conveyor 12 for movement by the latter out of the opening 16 of chamber 11 and into the chamber 40 through opening 41 of the latter. In order to permit the transfer of the treated part from one chamber to the other, the valve 58 is then actuated to raise or open the door 18 and, when the treated part is disposed within the chamber 40, the valve 58 is again actuated to close the door 18. When the part within chamber 40 has arrived over the lifting device 48, valve 60 is actuated to raise the plungers or rams 50 so that the conveyor discs 52 then become operative to lift the treated part off the conveyor 12. Upon the conclusion of the period of treatment of the part in chamber 40, valve 61 and switch 69 are actuated to open the door 43 and to cause energization of the motor 56, respectively, so that the discs 52 are then rotated to discharge the lifted part through the opening 42 onto the discharge conveyor. Finally, when the treated part is safely out of the chamber 40, valves 60 and 61 and switch 69 are again actuated to return the lifting device 48 to its lowered inoperative position, to close the door 43 and to interrupt operation of the motor 56, respectively.

It will be apparent that the durations of the treating periods may be varied in accordance with different treatment specifications merely by replacing the drum-type cam 65 with a cam having grooves therein corresponding in shape to the requirements of the treatment specification. Further, it is apparent that the parts to be treated load the conveyor 12 only for relatively brief periods, that is, only when the conveyor is actually carrying the parts into and out of the treating chambers, whereby the wear on the continuously operated conveyor is substantially reduced. It is also to be noted that a relatively short treating chamber and conveyor can be employed even when treatment for a long period is required. Thus, the initial cost and the maintenance costs for the treating chamber and conveyor are relatively low, and the power required for driving the relatively short conveyor is also minimized.

Although a particular embodiment of the invention has been described in detail herein and shown in the accompanying drawings, merely by way of example, it is to be understood that the invention is not limited to that particular embodiment, and that various changes and modifications may be effected in the latter without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. In apparatus for the treatment of articles; the combination including a treating chamber having conditions therein for effecting the desired treatment of the articles, single conveying means for transporting the articles

through said treating chamber at a fixed elevation, means for continuously moving said conveying means in said chamber, and lifting means independent of said conveying means normally disposed underlying said conveying means and intermittently projected above the latter to lift the articles off said conveying means so that the articles are then maintained substantially immobile within said chamber for a predetermined treating period, said lifting means being lowered to its normal disposition below said level of the conveying means at the conclusion of said treating period to return the articles to said continuously operating conveying means for further transport by the latter.

2. In apparatus for the treatment of articles; the combination including a treating chamber having conditions therein for effecting the desired treatment of the articles, single conveyor means for the articles extending into, through and out of said treating chamber and having a series of laterally extending, parallel, spaced-apart rollers rotated to advance articles resting thereon, means continuously rotating said rollers while an article is in said chamber, lifting members independent of said conveying means and extending into said chamber from below and movable through the spaces between adjacent rollers of said conveyor means within the chamber between normal inoperative positions, where said lifting members are disposed below said rollers, and operative positions, where said lifting members project above said rollers, and actuating means for said lifting members moving the latter to said operative positions when said rotated rollers have advanced an article to a location within said chamber above said lifting members, so that the latter raise the article off said rotated rollers to retain the article within the chamber for a predetermined treating period, and, at the conclusion of said period, returning said lifting members to said normal inoperative positions, so that the treated article then rests on said conveyor means and is further advanced by said rotated rollers for movement out of said treating chamber.

3. In apparatus for the treatment of articles; the combination including at least first and second treating chambers arranged in succession and having conditions therein for performing related phases of a treatment on articles residing therein, single continuous conveyor means for the articles extending successively through said treating chambers to advance the articles to be treated through said first chamber and then through said second chamber at a fixed elevation, means for continuously moving said conveyor means in said chambers, and lifting means independent of said conveying means and extending into each of said chambers and operative periodically to remove articles from said conveyor means within the re-

lated chamber, thereby to retain the removed article within the related chamber for the period of operation of the lifting means, and then to return the removed article to said conveyor means for further advancement by the latter.

4. In apparatus for the treatment of articles; the combination including at least first and second treating chambers arranged longitudinally in succession and having conditions therein for performing related phases of a treatment on articles residing therein, said first chamber having openings at the opposite ends thereof to respectively receive and discharge articles, said second chamber having an opening at the end thereof adjacent said first chamber to receive articles from said discharge opening of the latter and a discharge opening at one side, continuous conveyor means extending longitudinally through said first and second chambers for advancing articles through the latter, means for continuously moving said conveyor means in said chambers, first lifting means extending into said first chamber and operative periodically to remove articles from said conveyor means within said first chamber for a predetermined period of treatment in the latter and then to return the articles to said conveyor at the conclusion of said period for further advancement by the latter out of said first chamber and into said second chamber, second lifting means extending into said second chamber and operative periodically to lift articles from said conveyor means within said second chamber and to laterally discharge the lifted articles from the latter through said discharge opening in the side of said second chamber, doors normally closing said openings of the first and second chambers, and coordinated control means for said first and second lifting means and for said doors operating in synchronism with said conveyor means to operate said lifting means when articles have been advanced over the latter by said conveyor means and to move said doors away from the related openings when articles on the conveyor means are disposed for movement by the latter through said openings.

References Cited in the file of this patent

UNITED STATES PATENTS

1,205,690	Wetcke	Nov. 21, 1916
1,761,199	Drake	June 3, 1930
1,969,708	Betke	Aug. 7, 1934
2,010,295	Dreffein	Aug. 6, 1935
2,622,861	Talley	Dec. 23, 1952
2,713,480	Ruckstahl	July 19, 1955
2,875,995	Trogione	Mar. 3, 1959

FOREIGN PATENTS

493,184	Great Britain	Oct. 4, 1938
---------	---------------	--------------