Aug. 31, 1943. E. P. BULLARD, 3D 2,328,050

CONVEYER

Filed April 20, 1940 3 Sheets-Sheet 1

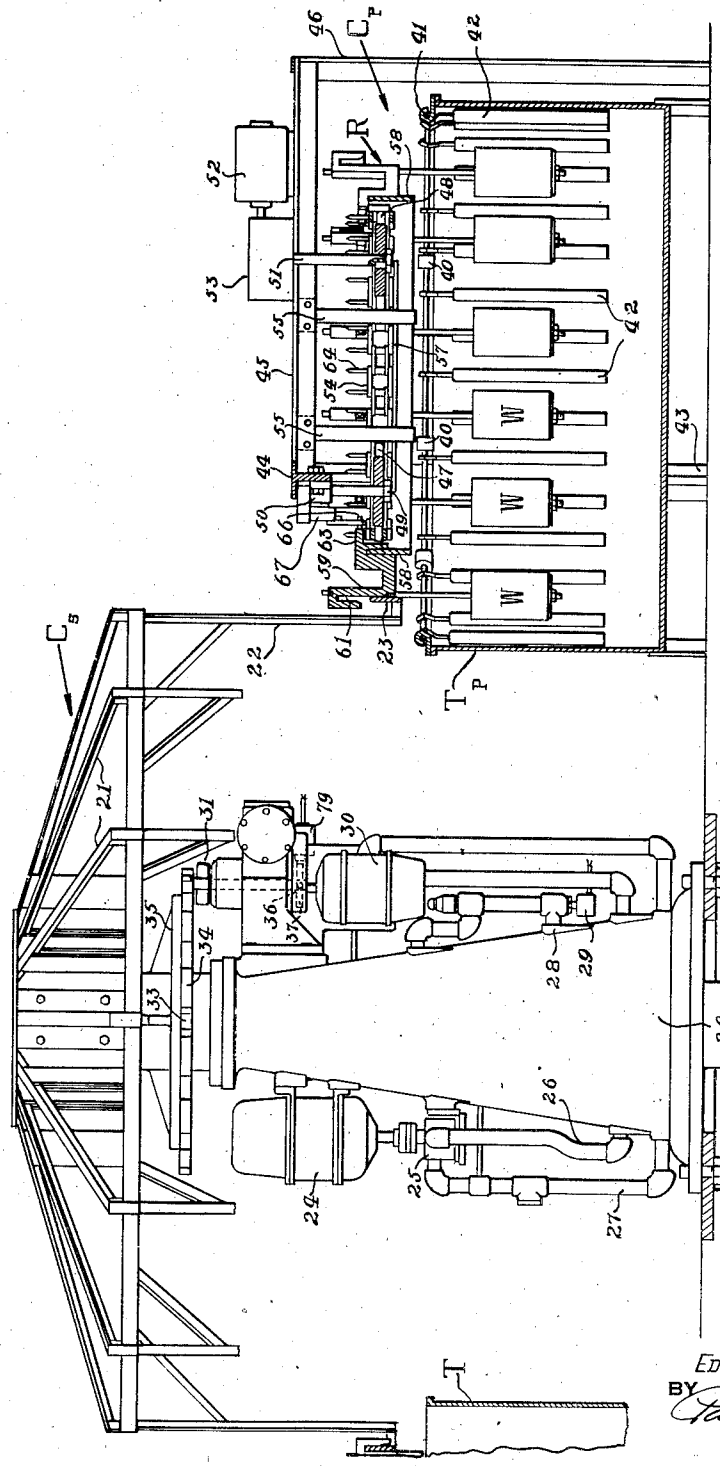

Fig 1

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CONVEYER

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Fig. 3

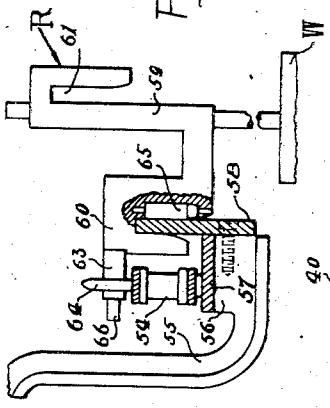

Fig. 2

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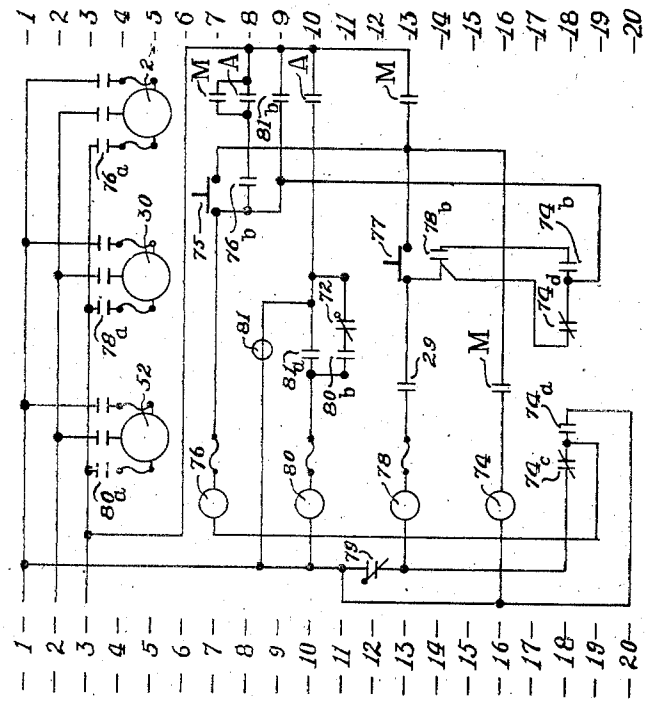

Fig. 5

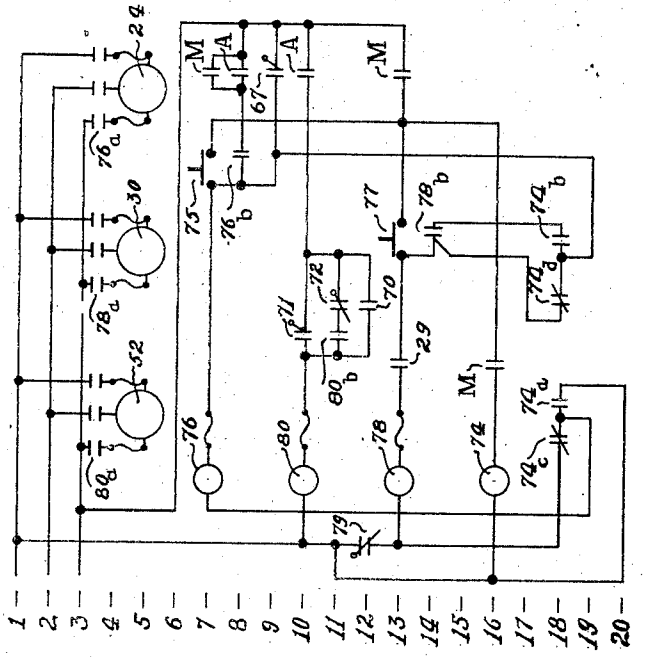

Fig. 4

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Patented Aug. 31, 1943

2,328,050

UNITED STATES PATENT OFFICE

2,328,050

CONVEYER

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Application April 20, 1940, Serial No. 330,687

23 Claims. (Cl. 198—103)

This invention relates to conveyers, and particularly to a combination of two conveyers having separate cycles of operation, and to a method of, and apparatus for transferring articles from one of said conveyers to the other in response to the operation of one of said conveyers.

Although the principles of the invention may be applied to conveyers in general, they will be illustrated and described in connection with an electro-cleaning and plating process.

A cleaning and plating process usually includes subjecting the work to a plurality of cleaning steps of relatively short time duration, a relatively long plating step, and finally one or more rinsing steps of short time duration.

An object of this invention is to provide one conveyer for handling work during a plurality of steps of relatively short time duration and another conveyer conjointly operable with the first for handling the work during at least one step of substantially long time duration.

Other objects of the invention include, the provision of apparatus including a plurality of conveyers each having a separate cycle of operation and intercontrol means for actuating one of the conveyers in response to the operation of another; the provision of apparatus including a plurality of conveyers having separate cycles of operation so inter-controlled that the cycle of operation of one may be changed independently of the cycle of operation of another, without disturbing the phase relation between the two; the provision of apparatus including a plurality of conveyers having separate cycles of operation, and in which work is adapted to be transferred from one to the other and vice versa by the normal operation of one of the conveyers; the provision of apparatus including an intermittently operable conveyer that is adapted to be controlled by a continuously operable conveyer; the provision of apparatus including an intermittently operable conveyer that is adapted to control the intermittent operation of another conveyer; and the method of transferring work between two conveyers having different cycles of operation while maintaining said cycles in definite phase relation.

The above, as well as other objects and novel features of the invention will become apparent from the following specification and the accompanying drawings, in which:

Figure 1 is an elevational view of two conveyers embodying the principles of the invention;

Figure 2 is a plan view of the conveyers of Figure 1;

Figure 3 is an enlarged sectional elevational view taken substantially along line 3—3 of Fig. 2; and

Figures 4 and 5 are electrical circuit diagrams for several embodiments of the controls for the conveyers shown in Figures 1 and 2.

Referring to the drawings, the invention is shown as applied to apparatus including a station-type conveyer C_s having an intermittently operable cycle whereby its work-supporting portion may be raised, indexed and lowered to position work pieces W successively within tanks T forming stations numbered 1 to 10, 12 and 13 about the conveyer; and another conveyer C_p including an endless chain that is adapted to be driven about a closed path. The closed path of the conveyer C_p may take any form, so long as one portion of the path can be conveniently substituted for one of the tanks T at one station of the conveyer C_s.

A plurality of work-supporting racks R are adapted to be readily engaged by and removed from the rack-supporting portions of either of the conveyers C_s and C_p. The work W on the racks R is adapted to be subjected to treatments of relatively short time duration at each of the stations 1 to 10 inclusive. The work is adapted to be transferred from the conveyer C_s at its station 11 to the endless chain of the conveyer C_p at a point X. The chain of the conveyer C_p draws the racks R throughout its closed path at a relatively slow speed, and returns each rack R to the point X thereby subjecting the work to a treatment of relatively long time duration. As a rack R again reaches the point X after it has passed throughout the closed path of conveyer C_p, it is picked up by the conveyer C_s, moved to station 12, and simultaneously, another rack R from station 10 is deposited on the endless chain of the conveyer C_p to take the place of the one just removed. Accordingly, by varying the number of racks and their spacing on the endless chain of the conveyer C_p, as well as the speed at which said conveyer is operated, the time duration of the treatment the work is subjected to while it is mounted on the conveyer C_p may be changed within limits without changing the cycle of operation of the conveyer C_s. Additionally, the cycle of operation of the conveyer C_s may be varied within limits without changing the cycle of the conveyer C_p by varying the spacing of the racks R on the conveyer C_p.

The conveyer C_s is substantially the same as that disclosed in Patent 2,129,463, granted September 6, 1938, to E. P. Bullard III. It comprises a vertically disposed column **20** within which a rotatable plunger P (Fig. 2) is adapted to be moved vertically upwardly by fluid under pressure that is drawn from a reservoir also included within the column **20**. A work-supporting frame including a plurality of radially-disposed arms **21** is mounted on the upper end of the plunger P. Hangers **22** are located near the outer ends of arms **21** and support work bars **23** which carry racks R.

A motor **24** is mounted on the side of the column **20** and is coupled to a pump **25** that withdraws fluid from the reservoir within the column **20** through a pipe **26** and forces the fluid under pressure through a pipe **27** to a chamber beneath the vertically reciprocable plunger P. As the plunger rises, and arrives at a predetermined elevation, its lower end opens a port **28** admitting the fluid under pressure to a pressure-operated switch **29** that closes the circuit of an indexing motor **30**.

The indexing mechanism comprises a rotatable crank **31** having two rollers **32** (Fig. 2) thereon. The rollers **32** are adapted successively to cooperate with slots **33** formed between a plurality of plates **34** that are mounted on a disc **35** (Fig. 1). The disc **35** is fixed against vertical movement but splined to the vertically reciprocable plunger P. The number of plates **34** is equal to the number of treatment stations to which the work is subjected. In the embodiment disclosed, fourteen plates **34** are employed. As the crank **31** rotates through a half revolution, the work-supporting arms **21** are indexed together with the plunger P through $\frac{1}{14}$ of a revolution. Upon completion of the indexing movement, a dog **36** on a cam plate **37** fixed to the shaft on which crank **31** is mounted trips a normally closed limit switch that stops both motors **24** and **30**. When motor **24** is stopped, the plunger P and work-supporting arms **21** gravitate to their lower position where they encounter a shock absorbing device, all as more fully described in Patent 2,129,463.

The tanks T are located in a circle, the radius of which is substantially equal to the length of arms **21**. Tanks T are located at stations **1** to **10** inclusive, **12** and **13** (Fig. 2), each containing liquids employed in the treatment of the work. Station **14** is the work-loading station, and a portion of the closed path of conveyer C_p occupies station **11**. Intermittent closing of the circuit of motor **24** will initiate the operation of the conveyer C_s to cause it to raise the work W out of one tank and to lower it into the next succeeding tank.

In the present embodiment of the invention, the conveyer C_p is shown as applied to a plating tank T_p. A series of insulated brackets **40** are mounted on the top edge of tank T_p for supporting a current carrying bar **41** from which numerous anodes **42** are suspended.

A pair of uprights **43** on the outside of tank T_p are adapted to support a beam **44** that extends transversely over the top of the tank. A longitudinally extending beam **45** is connected to the beam **44** midway of the ends of the latter, and its end opposite to that which is connected to beam **44** is supported by an additional upright **46**. The beams **44** and **45** are adapted to support the conveyer C_p and its driving mechanism.

A pair of sprockets **47** and **48** are adapted to be supported in a common horizontal plane. The sprocket **47** is fixed to a vertical shaft **49** that is journaled in a bearing **50** mounted on the under side of beam **44**. The sprocket **48** is fixed to a shaft **51** that is driven from a motor **52** through a variable-speed transmission **53**. The motor **52** and transmission **53** are supported on the top of the beam **45**. An endless chain **54** is in driving engagement with the sprockets **47** and **48** and in the preferred embodiment of the invention is adapted to be driven at any one of a plurality of speeds by adjusting the variable-speed transmission **53**.

A plurality of insulated brackets **55** extend downwardly from the beam **45** and provide supports **56** (Fig. 3) for track elements **57** that extend between the sprockets **47** and **48** on each side thereof, and upon which the chain **54** is adapted to rest. A current-carrying rail **58** is adapted to be connected to the outside of the supports **56** forming a closed path entirely surrounding the chain **54** and about which the work-supporting racks R are adapted to be moved. The elevation of the rail **58** is such that a rack R supported thereon clears the bar **23** of the conveyer C_s when the latter is in its lowest position. See Fig. 1.

The racks R are adapted readily to be connected to, and disconnected from the rack-supporting portions of both of the conveyers C_s and C_p. The racks R may take any desired form, and it is apparent that a wide choice of constructions may be employed. The form of rack R shown in the accompanying drawings is merely an example of one construction that will fulfill the requirements of the apparatus.

Referring to Fig. 3, a rack R comprises an irregularly shaped member **59** having two spaced hook portions **60** and **61**. The hook portion **61** is adapted to cooperate with the work bars **23** on the conveyer C_s. The hook portion **60** is adapted to cooperate with, and slide along the rail **58**. It is provided with an extension **63** that passes between adjacent extended pintle pins **64** of the chain **54**. The work W is suspended from the member **59** so that it will clear the supports **56** and rail **58** when the conveyor C_s lifts the work and member **59** from the chain **54** of conveyer C_p. This limitation on the construction of the member **59** provides a substantial turning moment tending to cause the hook portion **60** to seize and bind the rail **58**. Antifriction means may be provided between the cooperating surfaces of the hook **60** and the rail **58**, such for example as the roller **65** journaled within a relieved portion of the hook **60**.

Each of the racks R is provided with a lug **66** that is adapted to trip a switch **67** to close the circuit of the motor **24** whenever a rack arrives at the transfer point X after passing around the closed path **58**.

The preferred method of operating the two conveyers will be described in connection with the continuous operation of conveyer C_p and a hypothetical set of facts. Assume that the work W is to be treated for 1½ minutes in each of the tanks T; the time for raising, indexing and lowering the racks R by the conveyer C_s requires ½ a minute; and the plating time, or the time the work is to remain in the tank T_p is 26 minutes. The transmission **53** is adjusted to drive the chain **54** at a speed whereby a rack R, placed on it at the point X, will be returned to that point in 26 minutes. Thirteen racks R are substantially equally spaced about the chain **54** (two minutes apart in relation to time), and a rack

R is likewise placed on each of the bars 23 at stations 1 to 10 inclusive of the conveyer C_s.

With the apparatus in the position shown in Figure 2, the conveyer C_s has just completed an operation in which a rack R, that has completed a cycle on the conveyer C_p, has been transferred from point X to the tank T at station 12. At the same time, conveyer C_s has also transferred a rack R from the tank T at station 10 to the point X on the conveyer C_p. It will be noted that the next rack R_1 on conveyer C_p to arrive at point X is only 1½ minutes therefrom when the apparatus is in the position of Fig. 2 because the chain 54 continuously moves during the ½ minute consumed in transferring the work from station 10 of conveyer C_s to point X of conveyer C_p. As a rack R on conveyer C_p arrives at point X, its lug 66 trips the switch 67 to initiate a cycle of operation of conveyer C_s. From the foregoing it is evident that the intermittent operation of the conveyer C_s is controlled by the position of the racks R on the conveyer C_p, and that the two conveyers C_s and C_p have separate cycles of operation that are so intercontrolled that neither can get out of phase with the other.

The ramifications of the apparatus may include changing the treatment time within the tanks T without affecting the plating time within the tank T_p and conversely, changing the plating time within tank T_p without changing the treating time within tanks T.

Referring to Figure 4, wherein an electrical control circuit is shown, switch 70 line 12 is manually closed thereby shunting switch 71 line 10 and switches 72 and 80_b line 11. Closing the switches M lines 7, 13 and 16 energizes the relay 74 line 16, which closes normally-open switches 74_a and 74_b and opens normally-closed switches 74_c and 74_d line 18. Closing the push-button switch 75 line 7 causes energization of relay 76 line 7 which in turn closes switches 76_a line 4 and switch 76_b line 8. Closing switches 76_a line 4 starts motor 24 and causes plunger P to rise. The circuit is maintained upon release of the push-button switch 75 line 7 by the closing of switch 76_b line 8. With plunger P in its elevated position, pressure switch 29 line 13 closes whereupon the conveyer C_s may be indexed by closing the push-button switch 77 line 13. Closing switch 77 causes relay 78 line 13 to become energized which closes switches 78_a line 4 of the index motor 30, and also closes switch 78_b line 14. This circuit is maintained upon release of push-button switch 77 line 13 since switch 78_b line 14 is closed—the current passing through switch M line 7, switch 76_b line 8, switch 74_b line 18, switch 78_b line 14, switch 29 line 13 and limit switch 79 line 12. Upon completion of the index, the dog 36 on cam plate 37 trips the limit switch 79 line 12, thereby opening the circuit for index motor 30 without, however, disturbing the circuit for pump motor 24. Successive indexing of the conveyer C_s may be effected when desired by closing push-button switch 77 line 13. This indexing of the conveyer C_s independently of the pump motor 24 facilitates loading the conveyer C_s with empty racks for automatic operation.

When both conveyers are loaded with empty racks, and automatic operation is to begin, the switch 70 line 12 remains closed, switches M lines 7, 13 and 16 are opened, and switches A lines 8 and 10 are closed. Closing switches A lines 8 and 10, energizes relay 80 line 10 thereupon switches 80_a line 4 are closed and the plating conveyer motor 52 is started. As a rack R on the chain of the plating conveyer C_p arrives at the transfer point X, normally-open limit switch 67 line 9 is closed causing current to flow through the relay 76 line 7 thereby energizing it, whereupon switches 76_a line 4 are closed starting the pump motor 24 and causing the plunger P of the station type conveyer C_s to be elevated. Energization of relay 76 line 7 also closes holding switch 76_b line 8 so that upon the re-opening of limit switch 67 line 9, relay 76 line 7 remains energized. The circuit including switch 76_b line 8 also includes normally-closed switch 74_d line 18, normally-open pressure switch 29 line 13 and relay 78 line 13. When the plunger P reaches a predetermined elevation, pressure switch 29 line 13 is closed causing relay 78 line 13 to become energized whereupon switches 78_a line 4 are closed and the index motor 30 causes indexing of the station-type conveyer. Upon completion of the indexing, the dog 36 on the cam plate 37 opens normally-closed limit switch 79 line 12 thereby interrupting the circuit through relays 78 line 13 and 76 line 7 whereupon switches 78_a and 76_a line 4 open, stopping the index and pump motors 30 and 24. The plunger of the station-type conveyer then descends and a new rack R is deposited on the chain 54 of the conveyer C_p. As the next succeeding rack R arrives at the point of removal from the plating chain, its lug 66 trips switch 67 line 9 closing it, thereby initiating another cycle of operation of the station-type conveyer C_s.

In another embodiment of the invention, the conveyer C_p stops when a rack R thereon arrives at the transfer point X, and simultaneously therewith, the conveyer C_s starts to operate. As the plunger P descends during the operation of conveyer C_s, a switch is actuated to re-start conveyer C_p.

Referring again to Figure 4, the diagram of which also covers the present embodiment, switch 70 line 12 is manually opened. Manual operation of the conveyer C_s is accomplished in the same manner as in the previously-described embodiment. With both conveyors loaded with empty racks, automatic operation is begun by closing switches A lines 8 and 10. With plunger P at its lowest position, normally open switch 71 line 10 will close completing the circuit through relay 80 line 10, whereupon switches 80_a line 4 close, starting the plating conveyer motor 52. Energization of relay 80 line 10 also closes switch 80_b line 11 which maintains relay 80 energized after the re-opening of switch 71 line 10, to thereby effect continued operation of conveyer C_p. As a rack R on conveyer C_p arrives at the transfer point X, switches 67 and 72 lines 9 and 11 are simultaneously closed and opened respectively, whereupon the relay 80 becomes de-energized thus stopping conveyer C_p. At the same time, closing switch 67 line 9 energizes relay 76 line 7, closing switches 76_a line 4 thus starting pump motor 24 to cause the plunger P to rise. Likewise, switch 76_b line 8 is closed so that when switch 67 line 9 re-opens, relay 76 is maintained energized. When the plunger P arrives at a predetermined elevation, pressure switch 29 line 13 closes causing relay 78 line 13 to become energized through a circuit including switches A and 76_b line 8, normally closed switch 74_d line 18, switch 29 line 13, relay 78 line 13 and switch 79 line 12. Energization of relay 78 line 13 closes switches 78_a line 4 starting index motor 30. Upon completion of the indexing of con-

veyer C_s, the dog 36 on the cam plate 37 opens normally-closed limit switch 79 line 12 whereupon motors 24 and 30 stop and the plunger P descends to deposit a new rack R on the conveyer C_p. As the plunger nears its low position, normally-open limit switch 71 line 10 is closed. Closing switch 71 line 10 re-energizes relay 80 line 10 thereby starting the motor 52 and restarting conveyer C_p. As another rack R on conveyer C_p arrives at the transfer point X, simultaneous opening and closing of switches 72 and 67 lines 11 and 9, respectively, is effected, whereupon another cycle of operation of the conveyer C_s is initiated.

An additional embodiment of the invention comprises initiating the operation of the conveyer C_s by a time-cycle controller that also controls the operation of the conveyer C_p.

Referring to Figure 5, the manual operation of the conveyer C_s is effected in a similar manner to that described in connection with Figure 4. The conveyers C_p and C_s are loaded with empty racks as previously described and the switches A lines 8 and 10 are closed to initiate an automatic cycle of operation of the apparatus by energizing the relay 81 line 8 for the time-cycle controller. The controller is of conventional design in which means is provided for energizing two circuits at different time intervals. When the time-cycle controller closes switch 81_a line 10 the relay 80 line 10 becomes energized. Energization of relay 80 closes switch 80_a line 4 starting the plating conveyer C_p, and closes switch 80_b line 11 to hold the circuit after switch 81_a line 10 re-opens. As a rack R on conveyer C_p arrives at the transfer point X, it opens a normally-closed limit switch 72 line 11 thereby de-energizing relay 80 line 10 and stopping the conveyer C_p. When the time-cycle controller closes switch 81_b line 9, relay 76 line 7 becomes energized, whereupon switches 76_a line 4 close, starting the pump motor 24. At the same time switch 76_b line 8 closes thereby holding the circuit for motor 24 after switch 81_b line 9 re-opens. As the plunger P rises, it permits pressure switch 29 line 13 to close thereby energizing relay 78 line 13 through a circuit including switches A and 76_b line 8, switch 74_d line 18, pressure switch 29 line 13 and limit switch 79 line 12. Energization of relay 78 line 13 closes switches 78_a line 4 whereupon the index motor 30 is started. Upon completion of the index, the dog 36 on the cam plate 37 opens limit switch 79 line 12 thereby stopping motors 30 and 24, whereupon the plunger P descends and deposits a new rack R on the conveyer C_p. After a predetermined time interval, the time-cycle controller re-closes switch 81_a line 10 to restart another cycle of operation of the apparatus. Of course, an additional limit switch may be employed with a time-cycle controller having a single circuit for the conveyer C_s instead of the time-cycle controller described. The additional limit switch may be operated to re-start the conveyer C_p on the downward movement of the plunger P as described in connection with Figure 4.

In this last embodiment, the variable-speed transmission 53 must be adjusted to drive the chain 54 of the conveyer C_p fast enough to deliver a rack R to the transfer point X before the time-cycle controller initiates the operation of the conveyer C_s.

Although the various features of the apparatus have been shown and described in detail to fully disclose several embodiments of this invention, it will be evident that numerous changes may be made in such details, and certain features may be used without others, without departing from the principles of the invention.

What is claimed is:

1. Apparatus comprising in combination, two separate conveyers; separate means for driving each of said conveyers; work-supporting racks adapted to be transferred from each of said conveyers to the other; the construction and arrangement of said conveyers being such that said racks are transferred from each conveyer to the other in response to the operation of one of said conveyers; and means for maintaining the cycles of operation of said conveyers in definite phase relation including means rendered effective by the normal operation of one of said conveyers for effecting the normal operation of the other.

2. Apparatus comprising in combination, two separate conveyers each of which is adapted to be intermittently advanced from one position to another; separate means for driving each of said conveyers; article-supporting racks adapted to be transferred from each of said conveyers to the other; the construction and arrangement of said conveyers being such that said racks are transferred from each conveyer to the other in response to the intermittent advancement of one of said conveyers; and means for maintaining the cycles of operation of said conveyers in definite phase relation including means rendered effective by one of said conveyers for stopping only one of said conveyers.

3. Apparatus comprising in combination, a conveyer including a work-supporting member adapted to be raised, indexed, and lowered; means for raising and indexing said member; another conveyer in cooperative position relative to said first conveyer and including means forming an endless path about which work-supporting racks are adapted to be moved; means for moving said racks about said endless path; means for starting said rack-moving means; and means on said racks for controlling one of said conveyers when a rack arrives substantially at a common point between said conveyers.

4. Apparatus comprising in combination, a conveyer including a work-supporting member adapted to be raised, indexed, and lowered; means for raising and indexing said member; another conveyer in cooperative position relative to said first conveyer and including means forming an endless path about which work-supporting racks are adapted to be moved; means for starting said rack-moving means; means on said racks for starting the means for raising said member when said racks arrive at said cooperative position; means associated with said member for starting the indexing means when said member arrives at a pre-determined elevation; and means for stopping said raising and indexing means after an indexing movement of said member has been completed.

5. Apparatus comprising in combination, a conveyer including a work-supporting member adapted to be raised, indexed, and lowered; means for raising and indexing said member; another conveyer in cooperative position relative to said first conveyer and including means forming an endless path about which work-supporting racks are adapted to be moved; means for moving said racks about said endless path; means for starting said rack-moving means; means on said racks for simultaneously stopping the rack-mov-

ing means when a rack arrives at a common point between said conveyers and for starting the means for raising said member; means associated with said member for starting the indexing means when said member arrives at a predetermined elevation; means for stopping said raising and indexing means after an indexing movement of said member has been completed; and means for re-starting said rack-moving means when said member arrives at a point in its descent.

6. Apparatus comprising in combination, a conveyer including a work-supporting member adapted to be raised, indexed, and lowered; means for raising and indexing said member; another conveyer in cooperative position relative to said first conveyer and including means forming and endless path about which work-supporting racks are adapted to be moved; means for moving said racks about said endless path; a time-cycle controller including means for starting said rack-moving means; means on said racks for stopping said rack-moving means when a rack arrives at a common point between said conveyers; means within said time-cycle controller for starting the means for raising said member after a rack has been stopped at the common point between said conveyers; means associated with said member for starting the indexing means when said member arrives at a predetermined elevation; and means for stopping said raising and indexing means after an indexing movement of said member has been completed.

7. Apparatus comprising in combination, a treatment tank; a conveyer for moving articles about a closed path within said treatment tank; a plurality of work-supporting racks equally spaced about said conveyer; a plurality of tanks adjacent said treatment tank and arranged in such manner that at least a portion of said treatment tank is in aligned relation with said plurality of tanks; and means for simultaneously transferring work-supporting racks from said treatment tank to one of said tanks and from another of said tanks to said treatment tank.

8. Apparatus comprising in combination, two conveyers having different cycles of operation; separate means for driving each of said conveyers; work-supporting racks adapted to be transferred from each of said conveyers to the other; and means for maintaining the cycles of operation of said conveyers in definite phase relation including means rendered effective by the normal operation of one of said conveyers for effecting the normal operation of the other.

9. Apparatus comprising in combination, two conveyers having different cycles of operation; work-supporting racks adapted to be transferred from each of said conveyers to the other; means for changing the cycles of either of said conveyers without affecting the other; and means for maintaining the cycles of said conveyers in definite phase relation including means rendered effective by the normal operation of one of said conveyers for effecting the normal operation of the other.

10. Apparatus comprising in combination, two conveyers having separate cycles of operation; work-supporting racks adapted to be transferred from each of said conveyers to the other; separate sources of power for each of said conveyers; and means for maintaining the cycles of both of said conveyers in fixed phase relation including means associated with one of said power sources for rendering the other power source effective.

11. Apparatus comprising in combination, two conveyers having separate cycles of operation; means for adjusting the cycle of one independently of the cycle of the other; work-supporting racks adapted to be transferred from each of said conveyers to the other; separate sources of power for each of said conveyers; and means for maintaining the cycles of both of said conveyers in fixed phase relation including means associated with one of said power sources for rendering the other power source effective.

12. Apparatus comprising in combination, a rotary station-type conveyer including a plurality of radially-disposed arms; an endless chain-type conveyer; separate means for driving each of said conveyers; work-supporting racks adapted to be transferred from each of said conveyers to the other; the construction and arrangement of said conveyers being such that upon successively indexing said station-type conveyer, said work-supporting racks are transferred from each of said conveyers to the other; and means for maintaining the operation of each of said conveyers in definite phase with respect to the other including means rendered effective by the normal operation of one of said conveyers for effecting the normal operation of the other.

13. Apparatus comprising in combination, a rotary station-type conveyer; an endless chain-type conveyer; separate means for driving each of said conveyers; work-supporting racks adapted to be transferred from each of said conveyers to the other; means for adjusting the cycle of operation of each of said conveyers independently of the other; and means for maintaining the operation of each of said conveyers in definite phase with respect to the other including means rendered effective by the normal operation of one of said conveyers for effecting the normal operation of the other.

14. Apparatus comprising in combination, a rotatable vertically reciprocable member; a plurality of circumferentially-disposed arms extending radially from said member; means for reciprocating, and for intermittently indexing said member successively through a pre-determined number of degrees about its axis of rotation; an endless chain member mounted in cooperative position relative to said reciprocable member; separate means for driving said endless chain member; a plurality of racks; the construction and arrangement of said conveyers being such that the racks are adapted to be transferred from said arms into cooperative position relatively to said endless chain member and from said cooperative position relative to said chain member to the arms of said reciprocable member in response to the operation of one of said members; and means for maintaining the operation of said conveyers in definite phase relation.

15. Apparatus comprising in combination, a rotatable vertically reciprocable member; a plurality of circumferentially-disposed arms extending radially from said member; means for reciprocating, and for intermittently indexing said member through a pre-determined number of degrees about its axis of rotation; an endless chain member mounted in cooperative position relative to said reciprocable member; separate means for continuously driving said endless chain member; and a plurality of racks; said conveyers being constructed and arranged such that said racks are transferred from said arms into cooperative position relatively to said endless chain member and from said cooperative position relatively to said chain member to the arms of said recipro-

cable member, said transferring being controlled by the operation of one of said members, and incident to the operation of the other member.

16. Apparatus comprising in combination a rotary station-type conveyer including a plurality of circumferentially-disposed radially-extending arms; an endless chain-type conveyer located in cooperative position relatively to said station-type conveyer; a plurality of work-supporting racks adapted to be readily mounted on and removed from supporting means on each of said conveyers; and means for raising, indexing and lowering the arms of said station-type conveyer to present successive arms to the cooperative position between said conveyers, whereby said work-supporting racks are transferred from each of said conveyers to the other.

17. Apparatus comprising in combination, a rotary station-type conveyer including a plurality of circumferentially-disposed radially-extending arms; an endless chain-type conveyer located in cooperative position relatively to said station-type conveyer; a guide rail adjacent said endless chain-type conveyer; a plurality of work-supporting racks removably mounted on said rail and adapted to be moved about said rail by the endless chain-type conveyer; a plurality of said racks removably mounted on said station-type conveyer; means for actuating said station-type conveyer to present successive arms to the cooperative position between said conveyers, whereby said work-supporting racks are transferred from each of said conveyers to the other; and means actuated by said racks during their travel about said rail for initiating the operation of said station-type conveyer.

18. Apparatus comprising in combination, a conveyer including rack-supporting means adapted to be intermittently indexed to a plurality of stations; another conveyer in cooperating position relative to said intermittently indexed conveyer including rack-supporting means associated with rack-conveying means that is adapted to be continuously moved about an endless path; a plurality of work-supporting racks adapted readily to be connected to and disconnected from the rack-supporting means of both said conveyers, certain of said racks being located at predetermined intervals about the closed path of said continuously movable conveyer and engageable by the rack-supporting means of said intermittently indexed conveyer; and means for raising and lowering said indexical conveyer between successive indexing movements whereby the work-supporting racks are transferred from one of said conveyers to the other in response to the operation of one of said conveyers.

19. Apparatus comprising in combination, a conveyer adapted to be indexed from station to station including a plurality of circumferentially-disposed radially-extending rack-supporting means; another conveyer including a rack-supporting member and a rack-conveying means therefor adapted to be moved about an endless path, a portion of which path is located in a cooperating position relative to said indexical conveyer; cycle-operating means for raising, indexing and lowering said rack-supporting means to present them successively to said cooperating position; a plurality of work-supporting racks adapted to be readily engaged by and disengaged from both said rack-supporting means and rack-supporting member; and means on said work-supporting racks for starting said cycle-operating means when a work-supporting rack on said member arrives at said cooperating position, whereby said racks are transferred from each of said conveyers to the other.

20. Conveying apparatus comprising in combination, means including a central column to which a plurality of circumferentially-disposed radial arms are attached; intermittent cycle-operating means for raising, indexing and lowering said column to move said arms to a plurality of successive stations; an endless chain; continuous cycle-operating means for driving said chain; work-supporting means adapted to be transferred from said radial arms to means associated with said chain and vice versa; inter-control means for actuating said intermittent cycle-operating means in timed relation with the actuation of said continuous cycle-operating means; and means for varying either the intermittent or continuous cycle-operating means independently of the other.

21. Apparatus comprising in combination, two conveyers having separate cycles of operation; separate means for driving each of said conveyers; and work-supporting racks adapted to be transferred from each of said conveyers to the other, the time of said transfer being controlled by the operation of one of said conveyers and incident to the operation of the other conveyer.

22. Apparatus comprising in combination, a conveyer adapted intermittently to raise, index and lower work to move it to a plurality of stations; another conveyer including an endless chain adapted to be moved about a closed path; means for driving each of said conveyers independently of the other; and work-supporting racks adapted to be transferred from each of said conveyers to the other, said transfer being controlled by the operation of said endless chain conveyer and incident to the operation of said intermittently operable conveyer.

23. Apparatus comprising in combination, means within which treatments may be performed; a conveyer for moving articles about a closed path within said treatment means; a plurality of work-supporting racks equally spaced about said conveyer; a plurality of means adjacent said treatment means and arranged in such manner that at least a portion of said treatment means is in aligned relation with said plurality of means; and means for simultaneously transferring work-supporting racks from said treatment means to one of said plurality of means and from another of said plurality of means to said treatment means.

EDWARD P. BULLARD III.