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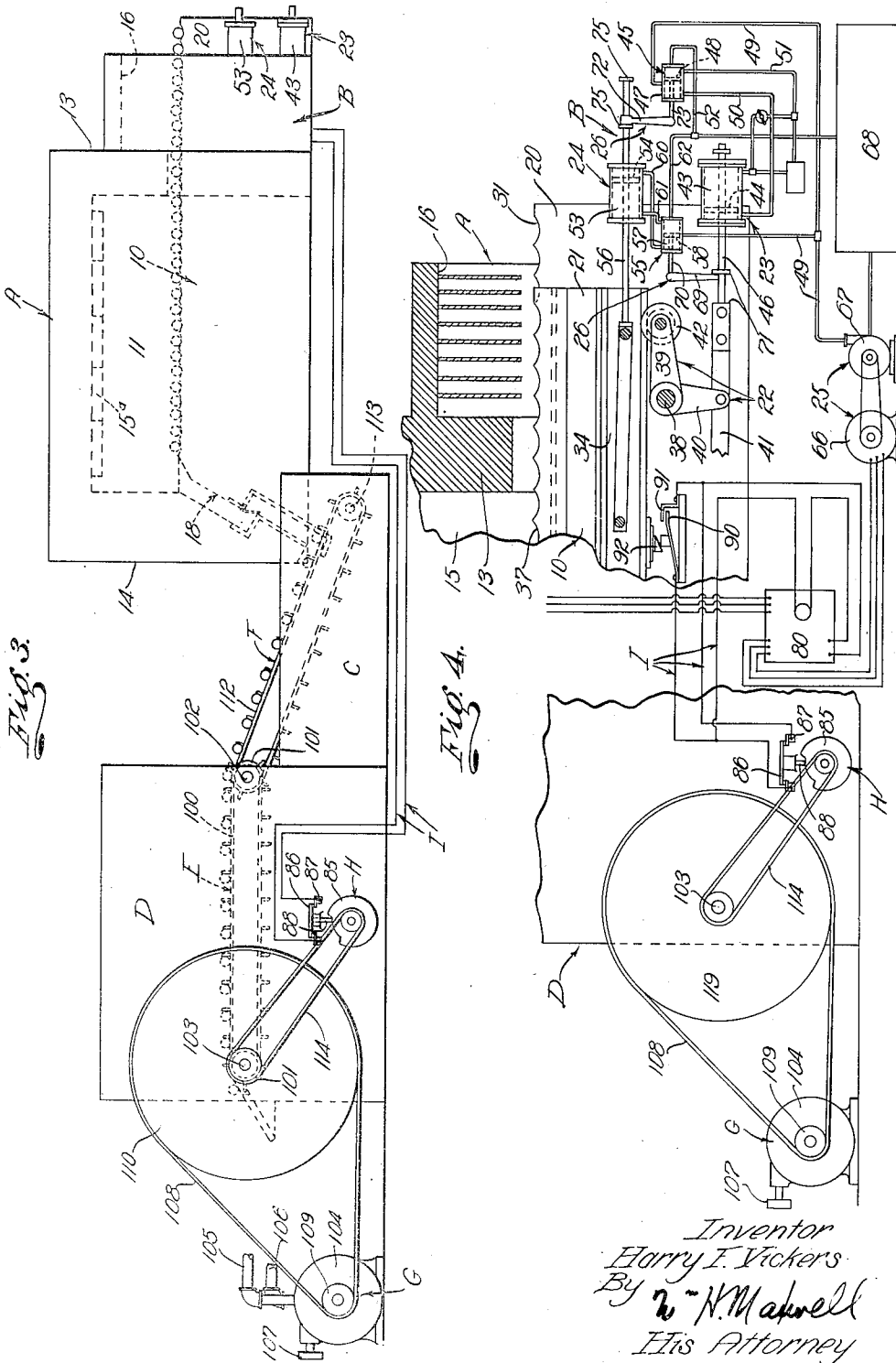
H. F. VICKERS

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CONTROL FOR HEAT TREATING APPARATUS

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CONTROL FOR HEAT-TREATING
APPARATUS

Harry F. Vickers, Detroit, Mich.

Application October 5, 1931. Serial No. 566,976

11 Claims. (Cl. 263—6)

This invention has to do with a control for heat-treating apparatus, or the like, and it is a general object of the invention to provide a mechanism operable to effectively and efficiently relate the operations of a multiplicity of units or elements of equipment, such as two furnaces, or the like, so that material is handled in a predetermined manner and at a definite rate. The present invention may be used to advantage in connection with various devices or units of equipment, it being particularly useful and practical in connection with furnaces, such, for instance, as a heat-treating furnace and an annealing furnace. For the purpose of facilitating an understanding of the present invention, I will describe it as applied to a furnace installation in which there is an automatic main or heat-treating furnace discharging into a quenching tank, a drawing furnace, and a conveyor receiving material from the quenching tank and passing it through the drawing furnace. In this particular case, articles to be treated are advanced through the main furnace by the mechanism thereof and are discharged into the quenching tank from which they are carried by the conveyor and passed through the drawing furnace.

It is an object of the present invention to provide a control or interconnection for the operating parts of units of the type mentioned whereby the articles being treated are handled at the desired rate in order to obtain the desired treatment or results.

A further object of this invention is to provide apparatus of the character mentioned in which the control or timing of the entire assembly or the several units of apparatus is effected through a single adjustable element. By the present invention, the variation or adjustment of one element changes the timing or operation of the entire assembly.

It is another object of this invention to provide apparatus of the character mentioned in which the operation of one unit, say, for instance, of one furnace, is controlled by the operation of another unit, say for instance, the other furnace, through a simple, practical, and dependable electric control connection, leaving the prime movers or power means of the two units or furnaces independent or distinct one from the other. By the present invention, the two furnaces may have totally and distinctly different operating mechanisms, for instance, one may be actuated by fluid pressure and may have an intermittent action, while the other may be actuated by any suitable prime mover and may have a continuous action.

A further object of the present invention is to provide, in combination, two units of apparatus, say, for instance, two furnaces, or the like, one of which has an intermittent action, and the other a continuous action, the start of each cycle of the intermittent action being controlled by the continuous action, and the completion of each cycle of the intermittent action being entirely independent of the continuous action.

The various objects and features of my invention will be best and more fully understood from the following detailed description of a typical form and application of the invention, throughout which description reference will be had to the accompanying drawings, in which:

Fig. 1 is a longitudinal detailed sectional view of a main or heat-treating furnace that may be employed in carrying out the present invention, being a section showing, generally, the mechanism of the furnace provided for advancing articles to be heat treated through the furnace. Fig. 2 is a detailed transverse sectional view of the furnace taken as indicated by line 2—2 on Fig. 1. Fig. 3 is a side elevation of a complete mechanism or apparatus embodying the present invention, being a view showing the main or heat-treating furnace, the quenching tank into which the main furnace discharges, a drawing furnace, a conveyor for carrying articles from the quenching tank to the drawing furnace, and various related parts, and Fig. 4 is a diagrammatic view illustrating the invention.

The apparatus of the present invention, as illustrated throughout the drawings, includes, generally, a main or heat-treating furnace A including an operating mechanism B which acts to advance articles to be heat-treated through the furnace, a quenching tank C arranged to receive articles from the furnace A, a second or drawing furnace D, a material conveyor E in the drawing furnace D for carrying articles through the furnace, a conveyor F receiving articles in the quenching tank C and delivering them to the conveyor E, a variable drive means G for the mechanism of conveyor E of the drawing furnace D, a timer H operatively connected with the mechanism of the drawing furnace D, and a control connection I operatively connecting the timer H and the mechanism B so that the operation of the furnace A is related or timed to that of the furnace D.

The furnace A illustrated in the drawings is a typical heat-treating furnace including, generally, a body or base 10, sides 11, a top 12, a front end 13, and a rear end 14. The various parts just mentioned form a horizontal chamber 15 pro-

vided with heating elements 15^a. The front end 13 is provided with a shielded opening 16 through which material or articles to be heat-treated are introduced into the chamber 15, while the end 14 is provided with a discharge chute 18 through which material or articles, after being heated in the furnace, are discharged therefrom into the quenching tank C. The particular discharge chute 18 illustrated in the drawings is designed to handle elongated bodies of material or articles in a manner to deliver them into the quenching tank C in a horizontal position so that they are effectively and uniformly quenched. This particular chute is more fully set forth and is claimed in my co-pending application entitled Apparatus for handling material, filed October 5, 1931, Serial Number 566,975.

The mechanism B of the furnace A, which operates to advance articles through the furnace A, operates intermittently and has a definite cycle of operation through which it acts several times in advancing an article through the furnace. The particular mechanism B illustrated throughout the drawings includes, generally, a stationary rack 20 for supporting the articles when they are not in motion, a movable rack 21 for advancing or moving the articles, means 22 supporting the movable rack means 23 for operating the removable rack vertically through the means 22, means 24 for operating the movable rack 21 horizontally, means 25 for supplying actuating fluid to the means 23 and 24, and means 26 interconnecting the means 23 and 24 so that their operations are synchronized. The stationary rack 20 extends longitudinally through the furnace and projects from the front of the furnace through the opening 16 to present a portion onto which objects can be arranged conveniently. The stationary rack preferably includes a plurality of spaced longitudinal rails 28 mounted on the furnace floor 29 to project upwardly a suitable distance therefrom. The floor 29 is shown mounted on beams 30 extending longitudinally of the furnace. The particular structure illustrated is designed to handle bars, or the like, and, therefore, the upper edges or faces of the rails are provided with suitably rounded notches 31. The several rails of the rack 20 are parallel and are spaced so that the objects are supported at suitable intervals. The notches 31 in the rails 28 are uniform in size and shape, and the notches of the several rails are in line transverse of the furnace.

The movable rack 21 co-operates with the stationary rack to advance objects along the stationary rack. The movable rack 21 comprises one or more rails 32 similar to the rails 28 but adapted to be moved vertically to lift the objects from the stationary rails and lower them onto the stationary rails and to move horizontally to shift the positions of the objects longitudinally of the stationary rails. The number and arrangement of rails 32 may correspond to that of the stationary rails 28, so that there is a movable rail adjacent each stationary rail. The rails 32 are shown mounted on movable beams 34 through movable floor sections 35 operable in longitudinal openings 36 in the floor of the furnace 29. The upper edges or faces of the rails 32 have notches 37 similar in shape and arrangement to the notches 31 in the rails 28. The parts are set or related so that the movable rails lift the objects from the stationary rails, advance or carry them longitudinally of the stationary rails, and then return them to the stationary

rails, during the course of which operation the notches in the rails co-operate to cause the objects to be turned or rotated.

The means 22 supporting the movable rack 21 is adapted to be operated to move the rack vertically. In the preferred construction, the means 22 includes a plurality of shafts 38 mounted transversely below the beams 34 at points spaced longitudinally of the furnace, arms 39 projecting from the shafts 38 to engage under the beams 34, arms 40 projecting downwardly from the shafts, and a connecting rod 41 operatively connecting the arms 40 of the several shafts. The arms 39 and 40 are keyed or otherwise fixed on the shafts 38 so that movement of the arms 40, as by operation of the connecting rod 41, causes turning of the shafts and consequent swinging of the arms 39 so that the beams 34, resting on the arms 39, move vertically. In the preferred construction, rollers 42 are provided on the outer ends of the arms 39 to reduce friction between the engagement of the arms and the beams 34.

The means 23 provided for operating the movable rack 21 through the supporting means 22 is a fluid pressure actuated means including, generally, a cylinder 43, a piston 44 operable in the cylinder, and a control valve 45 for the cylinder and piston mechanism. The cylinder 43 is mounted at a suitable point, preferably at the forward end of the furnace, and a rod 46 carrying the piston 44 is suitably connected or linked to the connecting rod 41 so that movement of the piston in the cylinder causes longitudinal movement of the rod 41. The valve 45 includes, generally, a cylindrical body 47, and a piston valve 48 operable in the body 47. A fluid supply conduit 49 connects with the middle portion of the cylinder 47, while conduits 50 and 51 connect the end portions of the cylinder 47 with the ends of the cylinder 43, as will be apparent from the diagram Fig. 7. An exhaust or discharge line 52 is suitably connected with the cylinder so that, when the supply line 49 is put in communication with either end of the cylinder 47, the other end of the cylinder is in communication with the exhaust line 52.

The means 24 provided for operating or moving the movable rack 21 horizontally includes, generally, a cylinder 53, a piston 54 operable in the cylinder, and a control valve 55. The cylinder 53 is preferably mounted at the forward end of the furnace, and the rod 56 carrying the piston 54 is suitably connected or linked directly to the movable rack 21, say, for instance, to the beams of the rack. With this arrangement, movement of the piston 54 in the cylinder 53 causes corresponding movement of the movable rack 21, the rack 21 being free to move horizontally due to its being supported on rollers, as hereinabove described.

The valve 55 includes a cylindrical body 57 carrying a piston valve 58. The fluid supply line 49 connects with the middle portion of the cylinder 57, while lines 60 and 61 connect the ends of the cylinder 57 with the ends of the cylinder 53. An exhaust or return line 62 connects with the cylinder 57 in the same manner that the exhaust line 52 connects with the cylinder 45.

The means 25 for supplying actuating fluid to the means 23 and 24 is preferably a motor pump unit including, generally, an electric motor 66 and a suitable fluid-handling pump 67. This unit may be such as to deliver fluid at a certain volume and pressure when in operation. In the arrangement illustrated, the pump is adapted to

draw fluid from a reservoir 68 and deliver it to the fluid supply line 49. The exhaust lines 52 and 62 connect with the reservoir 68 so that the fluid, after circulating through the system, is returned to the reservoir.

The means 26 interconnecting the means 23 and 24 connects the means 23 and 24 so that their actions or operations are synchronized, giving them a definite cycle of operation. In accordance with the invention, the connecting means 26 is such that, upon operation of the means 25, the means 23 first operates to move the movable rack 21 up vertically so that objects are lifted from the stationary rack 20, whereupon the means 24 operates to advance the objects through the furnace, whereupon the means 23 functions to allow the movable rack to lower and move down vertically returning the objects to the stationary rack in the advanced position, whereupon the means 24 operates to return or retract the movable rack to the original or starting position ready for another operation.

In the form of the invention shown, the means 26 includes, generally, an arm 69 having one end connected to the stem 70 of the valve 58 and the other end related to spaced stops 71 on the rod 46 carrying the piston 44, and an arm 72 connected to the stem 73 of the valve 48 and related to stops 75 on the piston rod 56 carrying the piston 54. When the operation of the apparatus starts, the valve 48 is in position so that fluid is admitted from the supply line 49 to the cylinder 43 to move the piston in a direction to cause the movable rack 21 to lift or move vertically. As this operation is completed, one of the stops 71 on the piston rod 46 operates the arm 69 so that the valve 58 is moved in the cylinder 57 so that fluid is admitted from the supply line 49 to the cylinder 53 to cause the piston 54 to move so that the movable rack advances in the furnace. As this operation is completed, the arm 72 is operated by a stop 75 on the rod 56 so that the valve 48 is operated to allow fluid from the supply line 49 to enter the cylinder 43 so that the piston 44 is moved to lower the rack. At the completion of this operation, one of the stops 71 operates the arm 69 so that the valve 58 admits fluid from the fluid supply line 49 to the cylinder 53, causing the piston 54 to be operated to return the rack to the normal or original position, at the close of which operation the valve 48 is operated through the arm 72 to leave the mechanism set so that it is ready for another cycle of operation.

The mechanism B of the furnace A, as above described, is more fully set forth and is claimed in my co-pending application entitled Material-handling apparatus, Serial Number 454,316, filed May 21, 1930.

The present invention provides an automatic control for the mechanism above described from the conveyor E of the drawing furnace D so that the mechanism B of the furnace A operates in synchronism with the conveyor E of the furnace D.

In the drawings I have illustrated a simple, typical belt or chain-type conveyor E operating in the furnace D to carry articles continuously through the furnace. The conveyor, as illustrated, includes, generally, a flexible element that may be formed of a plurality of spaced chains 100 operating over pulleys or sprockets 101 carried on shafts 102 and 103. The shafts 102 and 103 are spaced apart so that the chains 100 extending between them operate through the furnace D to

carry articles through the desired portion of the furnace.

In accordance with the present invention, the conveyor E is provided with variable operating means G. I have illustrated a variable fluid-pressure-actuated motor 104 for operating the conveyor E. The motor 104 is suitably connected with supply and discharge lines 105 and 106, respectively, and is provided with a control or adjusting means 107 whereby its speed of operation may be varied. The present invention is not specifically concerned with the details of the motor 104 or the means G in that any suitable variable speed power means may be employed in carrying out the invention.

The motor 104 is operatively connected with the conveyor E to operate the conveyor in the desired manner. In the drawings I have shown a chain 108 operatively connecting the motor 104 and shaft 103 of the conveyor. The chain operates over a drive sprocket 109 on the motor shaft and a sprocket 110 on the shaft 103 of the conveyor E. In practice, it has been found desirable to relate the sprockets 109 and 110 so that a substantial speed reduction is effected between the motor shaft and the conveyor shaft.

The conveyor F is in substance a continuation or extension of the conveyor E. In the construction illustrated, the conveyor F is a chain type conveyor including a plurality of chains 112 operating over sprockets carried on the shaft 102 and a shaft 113 located in the quenching tank C so that the chains 112 are in position to receive articles discharged into the quenching tank by the furnace A and convey them to the conveyor E which operates them through the drawing furnace D.

The control connection I operatively connecting the timer H and the mechanism B of the furnace A includes, generally, a magnetic starting switch 80 controlling the motor 66 of the means 65 and a disconnect switch connected in parallel with the timer H in the actuating circuit of the switch 80. The magnetic starting switch 80 may be any suitable type of switch operable to close the motor circuit upon the switch circuit being closed and to leave the motor circuit closed until such time as the switch circuit is open. The timer H and the disconnect switch are connected in parallel in the switch control circuit to control the action of the switch 80.

The timer illustrated in the drawings is operatively connected with the mechanism of the furnace D, for instance, it may be driven from one of the parts operated by the motor 104. In the drawings I have illustrated the timer operated by means of a chain drive 114 from the shaft 103 of the conveyor E. The timer includes, generally, a cam 85 to be operated by or in synchronism with the mechanism of the furnace D, a movable contact 86, a stationary contact 87, and a follower 88 on the movable contact co-operating with the cam. The profile of the cam is such that for each revolution of the cam there is a period during which the contact 86 is in engagement with the contact 87, thus closing the circuit through the timer, and there is a period during which the contact 86 is spaced from the contact 87 so that the circuit is open.

The disconnect switch is connected in the control circuit of the switch 80 in parallel with the timer and includes, generally, a movable contact 90, a stationary contact 91, and an operating member 92. The contacts 90 and 91 are normally together to close the circuit through the

disconnect switch. The actuating member 92 is carried by a movable part of the mechanism B, for instance, by one of the beams 34 of the movable rack 21, and is related to the movable contact 90 so that the movable contact is moved away from the contact 91 as the movable rack is returned to or reaches its original or starting position.

From the foregoing description it is believed that the operation of the apparatus will be fully understood, it being apparent that the speed of operation of the entire apparatus is dependent upon the setting or operation of the motor 104. The means of the present invention interconnects the mechanism of the two furnaces so that they remain in proper timed relation or synchronism, the speed of operation of the furnace A speeding up or slowing down according to whether or not the action of the furnace D is speeded up or slowed down. Under normal operating conditions, the motor 104 is set or adjusted to drive the conveyor E and, therefore, the conveyor F at the desired speed. The timer H, being operatively connected with the shaft 103 of the conveyor E through the chain drive 115, is operated with the conveyor E, the speed of operation of the timer H being directly related to that of the conveyor E. Assuming the mechanism B of the furnace A to be in its normal position ready for operation, the disconnect switch is open, the contact 90 being held away from the contact 91 by the actuating member 92. The valve 48 is positioned in the cylinder 45 so that fluid is admitted to the cylinder 43 to cause lifting of the movable rack 21 as soon as circulation of fluid is started in the system. The parts of the mechanism B will all remain at rest until the timer cam 85 operates to a position allowing the contact 86 to engage the contact 87, at which time the control circuit for the switch is closed, causing actuation of the switch 80 so that the motor 66 is put in operation. As soon as the motor 66 starts operation, the pump 67 operates to circulate fluid through the system of the mechanism B, causing the parts to go through the cycle of operation hereinabove described until the movable rack is returned to its original position, at which time the actuating member 92 of the disconnect switch opens the circuit to the control switch 80 by moving the contact 90 away from the contact 91, the timer having, during operation of the apparatus, operated so that its circuit is open by the time the movable rack reaches the end of its cycle. It will thus be apparent that the timer switch operates as a starting switch for closing the circuit to the switch 80 in order to start the cycle of operation of the mechanism B of the furnace A, while the disconnect switch operates to open the control circuit at the completion of the cycle of operation of the mechanism B. The outstanding feature of this system or arrangement is that the operation of the mechanism B is started at a definite time with reference to operation of the conveyor E of the furnace B, whereas the operation of the mechanism B is stopped only upon full completion of its cycle of operation. It is to be understood that the parts are related and proportioned so that the mechanism B of the furnace A completes its cycle of operation and is ready to start another cycle of operation by the time the cam of the timer operates to a position to close the circuit to the switch 80 for starting a cycle of operation of the mechanism B.

Having described only a typical preferred form

of my invention, I do not wish to limit myself to the specific details set forth, but wish to reserve to myself any changes or variations that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. In combination, a furnace, an intermittent feed mechanism in the furnace, a second furnace, a feed mechanism in the second furnace, the intermittent feed mechanism delivering material to the feed mechanism of the second furnace, a control for the feed mechanism of the first-mentioned furnace operated by the feed mechanism of the second furnace, the control including a control circuit governing actuation of the feed mechanism of the first mentioned furnace and a timer in the circuit operated by the mechanism of the second furnace, and means associated with the control whereby the feed mechanism of the first mentioned furnace is stopped at predetermined intervals.
2. In combination, a furnace, an intermittent feed mechanism in the furnace, a second furnace, a feed mechanism in the second furnace, the feed mechanisms being related so that one mechanism is operable to receive material from the other variable speed drive means for the mechanism of the second furnace, and a control for the feed mechanism of the first-mentioned furnace operated by the feed mechanism of the second furnace, and means associated with the control whereby the feed mechanism of the first mentioned furnace is stopped at predetermined intervals.
3. In combination, a furnace, an intermittent feed mechanism in the furnace, a second furnace, a feed mechanism in the second furnace, one feed mechanism being operable to receive material from the other feed mechanism, variable speed drive means for the mechanism of the second furnace, and a control for the feed mechanism of the first-mentioned furnace operated by the feed mechanism of the second furnace, the control including a control circuit governing the actuation of the feed mechanism of the first mentioned furnace, and a timer in the circuit operated by the mechanism of the second furnace.
4. In combination, a furnace, an intermittent feed mechanism in the furnace, power means for operating the mechanism of the furnace, means whereby the mechanism of the furnace is stopped at the completion of a predetermined cycle of operation including an electric circuit governing the actuation of the power means, and a contact device in the circuit operated by the feed mechanism, a second furnace, a feed mechanism in the second furnace receiving material from the mechanism of the first-mentioned furnace, and means controlled by the mechanism of the second furnace to start operation of the mechanism of the first furnace.
5. In combination, a furnace, an intermittent feed mechanism in the furnace, power means for operating the mechanism of the furnace, means whereby the mechanism of the furnace is stopped at the completion of a predetermined cycle of operation including an electric circuit governing the actuation of the power means, and a contact device in the circuit operated by the feed mechanism, a second furnace, a feed mechanism in the second furnace receiving material from the mechanism of the first-mentioned furnace, and means controlled by the mechanism of the second furnace to start operation of the

mechanism of the first furnace the last mentioned means including a timer in said circuit operated by the mechanism of the second furnace.

mechanism, the other including a feed mechanism and a variable speed operating means for the feed mechanism, one feed mechanism being operable to receive material from the other feed mechanism means whereby the operating means for the feed mechanism of the first-mentioned unit is stopped upon the mechanism completing a predetermined cycle, and means controlled by the mechanism of the said other unit for starting operation of the operating means of the feed mechanism of the first-mentioned unit at predetermined intervals, the last mentioned means including an electrically controlled element for governing the said operating means, a control circuit for the element, and a timer in said circuit operated by the mechanism of said other unit.

10. In combination, two units, one including a feed mechanism and operating means for the feed mechanism, the other including a feed mechanism and operating means for the feed mechanism, one feed mechanism being operable to deliver material to the other feed mechanism means whereby the operating means for the feed mechanism of the first-mentioned unit is stopped upon the mechanism completing a predetermined cycle, and electric means controlled by the mechanism of the said other unit for starting operation of the operating means of the feed mechanism of the first-mentioned unit at predetermined intervals.

11. In combination, two units, one including a feed mechanism and an electric power means for operating the feed mechanism, the other including a feed mechanism and operating means for the feed mechanism, the feed mechanisms being related so that one mechanism is operable to feed objects to the other mechanism, means whereby the operating means for the feed mechanism of the first-mentioned unit is stopped upon the mechanism completing a predetermined cycle, and electric means controlled by the mechanism of the said other unit for starting operation of the operating means of the feed mechanism of the first-mentioned unit at predetermined intervals, said electric means including a switch in the energizing circuit of the said power means, a contact circuit governing the switch, and a timer in the contact circuit operated by the operating means of the feed mechanism of said other unit.

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5 6. In combination, a furnace, an intermittent feed mechanism in the furnace, power means for operating the mechanism, means whereby the mechanism of the furnace is stopped at the completion of a predetermined cycle of operation, a second furnace, a feed mechanism in the second furnace receiving material from the feed mechanism of the first mentioned furnace, and means controlled by the mechanism of the second furnace to start operation of the mechanism of the first furnace, the last-mentioned means including, means for putting said power means into operation, a control circuit for the last mentioned means, and a timer in the circuit operated by the mechanism of the second furnace.

20 7. In combination, a furnace, an intermittent feed mechanism in the furnace, means whereby the mechanism of the furnace is stopped at the completion of a predetermined cycle of operation including an electric circuit governing the operation of the feed mechanism, and a contact device in the circuit operated by the feed mechanism, a second furnace, a feed mechanism in the second furnace for receiving material from the feed mechanism of the first mentioned furnace, variable speed drive means for the mechanism of the second furnace, and means controlled by the mechanism of the second furnace to start operation of the mechanism of the first furnace.

35 8. In combination, a furnace, an intermittent feed mechanism in the furnace, electric power means for operating the feed mechanism, means whereby the mechanism of the furnace is stopped at the completion of a predetermined cycle of operation, a second furnace, a feed mechanism in the second furnace receiving material from the first-mentioned feed means, variable speed drive means for the mechanism of the second furnace, and means controlled by the mechanism of the second furnace to start operation of the mechanism of the first furnace, the last-mentioned means including a control circuit for the said electric power means, and a timer in the circuit operated by the mechanism of the second furnace.

50 9. In combination, two units, one including a feed mechanism and operating means for the feed

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