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TIME CONTROL MEANS FOR PERIODIC OPERATING APPARATUS

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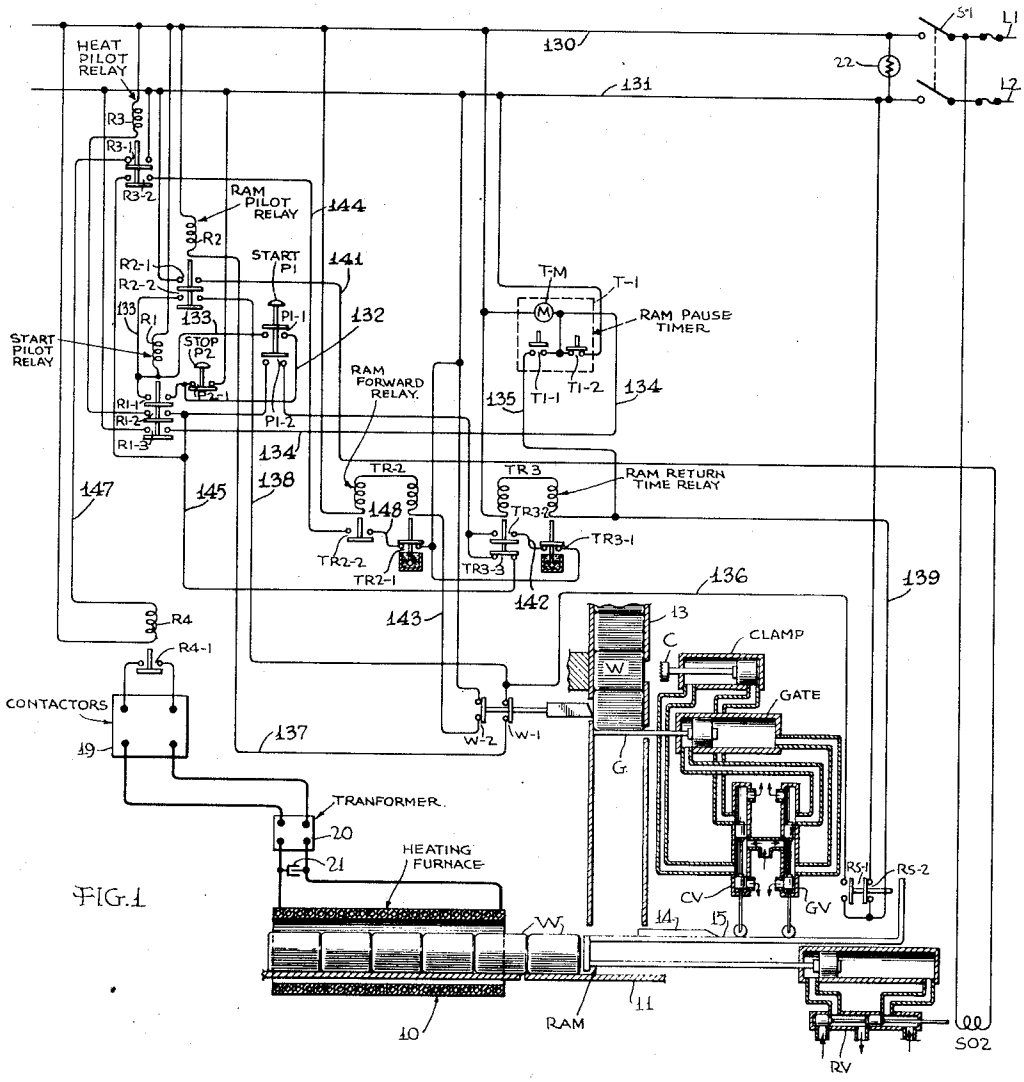


FIG.1

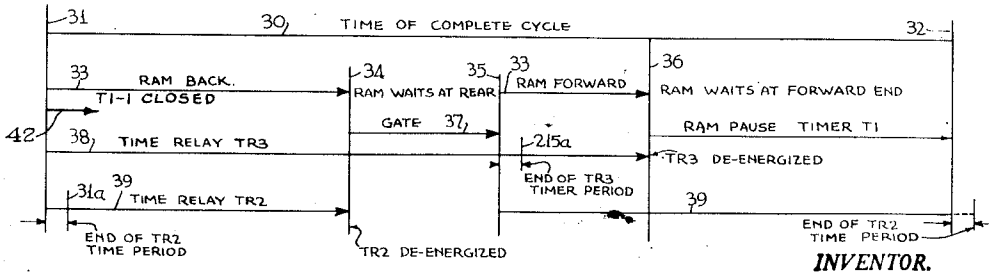


FIG.2

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TIME CONTROL MEANS FOR PERIODIC OPERATING APPARATUS

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This invention relates to induction-heating apparatus and, more particularly, to time control means for periodic operating mechanism of such apparatus and has for an object the provision of improvements in this art.

One of the particular objects of the invention is to provide time control means in induction-heating apparatus which causes a supervisory action when a matched means fails to perform a given action within a predetermined time.

Another object is to provide time control means in induction-heating apparatus which causes a supervisory action when a matched consecutively acting means fails to perform a given action within a predetermined time.

Another object is to provide time control means which causes a supervisory action when a similar means fails to begin each of a plurality of different actions within predetermined times.

Another object is to provide time control means which causes a first means to perform a given action different from its normal action when a second and related means fails to perform its normal action within its normal time.

The invention will be described in connection with a reciprocatory pusher and escapement which feed a line of workpieces through a heating furnace and in which the heating means for the furnace is cut off in case the pusher fails to begin a succeeding stroke within a predetermined time from the beginning of a preceding stroke.

The invention will be illustrated in the accompanying drawings, wherein:

Figure 1 is a schematic and wiring diagram of apparatus embodying the invention; and

Figure 2 is a timing chart.

In the drawings, an induction heating furnace coil 10 provides a through passage for a line of workpieces or billets W which are moved forward at intervals by a reciprocating pusher or ram and are fed down to the guide 11 in front of the pusher, while the pusher is in its rearward position, by escapement means from an inclined supply chute 13. The escapement means comprises a clamp C and a gate G, controlled respectively by a clamp valve CV and a gate valve GV, which valves are actuated in timed relationship with the pusher by a cam 14 carried by a cam bar 15 operated by the pusher.

Switches W—1, W—2 are opened when a billet is fed down from the last position in the chute and are closed when another billet drops down into the last position. At the forward end of its stroke, the ram closes a switch RS—1 and opens a switch RS—2, which switches reverse as the ram starts back. A solenoid SO2, when energized, operates the ram valve RV and causes the ram to move back and when deenergized allows the ram to move forward.

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The control means comprises an electrical system which includes a "start" push button P1 having normally open switches P1—1, P1—2, a "stop" push button P2 having a normally closed switch P2—1, a start pilot relay R1 having three normally open switches R1—1, R1—2 and R1—3, a ram pilot relay R2 having two normally open switches R2—1 and R2—2, a heat pilot relay R3 having two normally open switches R3—1 and R3—2, a time-delay relay TR2 for forward ram movement, a time-delay relay TR3 for rearward ram movement, and a timer T1 for interposing a pause in the ram movements.

The time-delay relay TR2 includes a normally open instantaneous switch TR2—2 and a normally closed time-delay opening switch TR2—1. The time-delay relay TR3 includes a normally closed switch TR3—3 and a normally open switch TR3—2 and a normally closed time-delay opening switch TR3—1. The timer T1 has a synchronous motor T—M which operates continuously after the apparatus is started, being energized through switch R1—3 of relay R1 which is locked in through its switch R1—1 after once being energized.

The timer motor actuates a gear train which in turn sets up a "pulse" motion.

T1—1 and T1—2 are switch elements of a double pole double throw switch. T1—1 is only closed momentarily (approximately 2 seconds) out of the complete cycle time. When T1—1 closes, and if the ram is in the forward position, it will energize the ram pilot relay R2 which in turn will bring the ram back.

Switch T1—2 is placed in the circuit only to keep the timer motor energized after the start pilot relay switch R1—2 has been opened and only until the timer assumes starting position (that is when T1—1 is closed).

T1—2 opens when T1—1 closes, thus opening the L2 circuit to the timer motor.

When the ram pilot relay or the ram solenoid valves are deenergized, the ram assumes the forward position (normal), this in turn closes switch RS—1, the timer also assumes its starting position closing switch T1—1. With this condition, it allows the ram to be called back immediately after the start button is pushed and the heater will go into production without any delay.

When the switch R3—1 of heat pilot relay R3 is closed, it causes the induction heating coil

10 to be energized. This may be done in a number of ways and for illustration, a relay R4 is shown, having a normally open switch R4—1 which, when closed, causes an appropriate circuit and contactors represented by 19 to operate to apply heating current in the coil 10. A transformer 20 and capacitor 21 are shown in the high frequency heating circuit.

The main lines L1, L2 are provided with a switch S—1 and a pilot lamp 22.

To prepare for the start of operations, the main line switch S—1 of L1, L2 is closed to energize power buses 30, 31 respectively. This lights pilot lamp 22 to show that the control system is energized.

For the purpose of describing the operation of the apparatus, it will be assumed that workpieces W are in the chute 13 preparatory to being dropped into position for pushing into the heating coil. Thus, with a workpiece W in position, the normally open switches W—1, W—2 are closed. Closure of the switch W—2 completes a circuit from the power line bus 131 to the now closed switches W—2, the wire 143, the energization coil of the ram forward relay TR—2 to the power bus 139. This closes switch TR2—2 and starts delayed opening switch TR2—1 to open. It will be assumed that the time period has expired and this switch is now open. It will also be assumed that the ram is in the forward or left position, thus closing RS—1 and opening RS—2.

To start operations, the "start" push button P1 is pressed to momentarily close normally open switches P1—1 and P1—2.

Closure of switch P1—1 completes a circuit from the bus 131 through the normally closed switch P2—1, wire 132, the now closed normally open switch P1—1, wire 133 through the energization coil of the start pilot relay R1 to the bus 130, thus energizing R1. Energization of relay R1 closes its normally open switches R1—1, R1—2 and R1—3. Closure of switch R1—1 completes a holding circuit for relay R1 from the wire 132 to the wire 133. Relay R1 remains energized as long as current is on unless the "stop" push button P2 is pressed. The "start" push button may be released. The closure of P1—2 has no effect at this stage of operations.

Energization of relay R1 also closes R1—2 in the circuit of heat pilot relay R3 but this has no effect as yet because the circuit is open elsewhere. It also closes R1—3 energizing the ram pause timer T1 to L2, the circuit being from the wire 131, the normally open now closed switch R1—3, wire 134, and the motor M to the wire 130. Energization of the motor M immediately opens normally closed switch T1—2 and closes normally open switch T1—1. T1—1 remains closed long enough to initiate the following steps and then reopens.

Closure of T1—1 completes a circuit from wire 134, the energization of which was previously traced, through the now closed switch T1—1, wire 135, the now closed switch RS—1, the wire 136, the now closed switch W—1, the wire 137 and through the energization coil of the ram pilot relay R2 to the bus 130.

Energization of the ram pilot relay R2 closes it normally open switches R2—1 and R2—2. Closure of switch R2—2 completes a circuit from the wire 133, the energization of which was previously traced through the now closed switch R2—2, the wire 138 and through the now closed switch W—1 to the wire 137 to complete a holding circuit for the ram pilot relay R2, which circuit will not be broken unless the switch W—1 opens as a result of a billet being dropped to the ram level. Closure of switch R2—1 completes the circuit from the bus 131 to the wire 141 through the energization coil of the solenoid SO2 to the wire L—1. Energization of ram valve solenoid SO2 operates valve RV and supplies fluid to the rod end of the ram cylinder and the ram returns, that is, its piston moves rearwardly or to the left to the head end of the cylinder.

Energization of the wire 135 by closure of switch T1—1 of the pause timer also serves to energize time delay relay TR3 thus preparing the normally-closed, delayed-opening switch TR3—1 to start at the same time that the ram starts back so that, in effect, the timer TR3 "races" the ram on its return and up to a time when it is supposed to complete some action, for example, to start forward again after a billet has been fed down. At this stage, energization of TR3 has no effect.

When the ram starts to return, it opens RS—1 and closes RS—2. Closure of RS—2 serves to bypass the timer switch T1—1, holding TR3 energized and tending to open the time delay switch TR3—1, which remains closed, however, unless the ram fails to function and return forward in a predetermined time.

As the ram approaches the rear end of its stroke, its cam 14 causes clamp valve CV to be actuated to clamp a billet in the next to last position in the chute. At the rear end of its stroke, it opens the gate to feed down a billet upon the guide support 12.

When a billet drops out of last position upon the guide, it opens switches W—1 and W—2. Opening of W—1 deenergizes R2, opening switches R2—1 and R2—2. Opening of switch R2—1 deenergizes the ram valve solenoid SO2 to allow the valve RV to operate and cause the ram to move forward.

It should here be noted that when the control system is energized by closing S1, and assuming that a billet is in the last or feed-down position to keep W—2 closed, the time-delay relay TR2 will at once be energized and will be kept energized as long as W—2 is kept closed, the circuit being from the wire 131 through the now closed switch W—2, the wire 143, the energization coil of the relay TR2 to the wire 130. Opening of W—2 deenergizes TR2 and causes it to open its switch TR2—2 and to close TR2—1, both without delay.

As the ram moves forward, its cam first causes the gate to close the bottom end of the chute and later causes the clamp to release its billet and allow that and the whole stack of billets to descend. The lowermost billet in descending again closes switches W—1 and W—2. Closure of W—1 has no immediate effect but closure of W—2 energizes TR2 again.

Energization of TR2 closes its switch TR2—2 at once and begins a new timing period for time delay opening switch TR2—1 to open. It is here set to open after the ram has moved forward and paused at the end of the forward stroke for its preset waiting period.

At the end of its forward stroke, the ram closes RS—1 and opens RS—2. Opening of RS—2 deenergizees wire 135 and TR3 and this closes TR3—1 and TR3—3 and opens TR3—2, all without delay.

Closure of TR3—3 (TR2—2 and TR2—1 being closed) energizes the heat pilot relay R3, the

circuit being traced from the wire 131, normally closed switch TR2—1, the wire 148, now closed switch TR2—2, the wire 144, now closed switch TR3—3, the wire 145, closed normally open switch R1—2, the wire 146, the energization coil of R3 to the bus 130 to close its switches R3—1 and R3—2. Closure of R3—2 locks R3 in past TR3—3 and through TR2—2 and TR2—1. Closure of R3—1 energizes the contactor relay R4 to close R4—1 and through contactors 19 and the related high frequency current system to supply heating current to the heating coil 10.

At the end of the waiting period, the timer T1 energizes ram pilot relay R2 to cause the ram to return, as before, the circuit being traced from the bus 131, the normally open now closed switch R1—3, the wire 134, the now closed switch T1—1, the wire 135, the now closed switch RS1—1, the wire 136, the now closed switch W—1, the wire 137, the energization coil of the relay R2 to the bus 130. It also energizes TR3; as before.

It may also be here noted that in order for the heat pilot relay R3 to be energized, it is necessary that either one of the normally closed time delay opening switches TR2—1 or TR3—1 must be closed even though the particular relay coil is energized. Energization of TR3 closes TR3—2 and leaves TR3—1 closed (until later opened) so heat pilot relay R3 is held in when TR2—1 shortly opens. This circuit may be traced from the wire 131, the closed switch TR3—1, the wire 142, the now closed switch TR3—2, the wire 144, the now closed switches TR3—3, the wire 145, the closed normally open switch R1—2 and through the energization coil R3 to the wire 130. If TR2—1 opens first, R3 will be deenergized to open R3—1 so that the later closure of TR3—2 will be ineffective to keep the heat on. However, closure of push button switch P1—2 would restore the heating current.

Similarly, if TR3—1 opens (as it should shortly after the gate closes) before TR2—3 closes when the gate closes, R3 will be deenergized and closure of TR2—2 (TR3 still being energized and TR3—3 open) will not energize R3. Again, closure of P1—2 would apply heat. This permits the operator to put billets in the chute and start the machine again without waiting.

The timing of operations will be clearer from consideration of Fig. 2, showing the cycle diagram. The duration of one complete cycle is represented by the top horizontal line 30 which extends between the vertical start line 31 and the finish line 32. The second horizontal line 33 represents the ram movements. It starts back at line 31 and completes its backstroke at a vertical line 34. It starts again at the vertical line 35 and completes its forward stroke at the vertical line 36. The ram waits at the forward end of its stroke, as represented by the distance between the lines 36 and 32. The third horizontal line 37 represents the gate operation, which opens approximately at the line 34 to feed down a billet, and closes approximately at the line 35.

The short horizontal line 42 represents the period of time in which the switch T1—1 is closed, closing of which switch initiates the beginning of a new complete cycle.

The horizontal line 38 represents the action of time-delay relay TR3. It is energized at ordinate 31 and deenergized at the line 36 but its time-delay switch TR3—1 is set for actuation at a point 215*a* which is a short time after the ram is supposed to start forward. Hence, if there is any jam in the ram return or the billet feed, the heating current will be cut off. If there is no billet in the feed-down position to close switches W—1, W—2, the ram also will stop when it reaches the front end of its stroke, assuming that the ram did not jam on its backstroke but merely failed to get back on time.

The line 39 represents the action of time-delay relay TR2. It is energized at the ordinate 35 where the ram starts forward and remains energized until the ram returns. Its switch TR2—1, however, is timed for actuation at the point 31*a* which is slightly after the ram is scheduled to start its return movement. Hence, if there is any jam in the forward movement of the ram or if the proper pause at the front end of the ram stroke has not been observed, the heating current is cut off.

To make the original setting of the time relays TR2 or TR3, it is only necessary to place the movable contact element of the relay at a point some distance beyond the point required by the operations to be matched and supervised and then gradually to move the contact back until only a slight margin of safety is left. In this way the supervisory response may be made as fine or coarse as may be desired.

It will thus be seen that the invention provides a very useful means for supervising the timed operations of parts having one or more periods of proper operation, and that the supervisory means will act to control when and only when the periodic operating means fails to function within a predetermined period.

While the invention is illustrated in connection with an exemplary embodiment, it is to be understood that the uses of the invention are very wide and are not to be limited except by the prior art and the scope of the subjoined claims.

What is claimed is:

1. Induction-heating apparatus comprising, in combination, an induction-heating coil having a heating chamber into which a plurality of metallic workpieces are adapted to be moved; a source of power for said coil; switch means for controlling the application of power to said coil; reciprocatory mechanism for moving workpieces into said coil, the cycle of movement of said mechanism being divisible into a reciprocatory-movement portion and delay portion intermediate the reciprocating movement portions and each portion having a determinable time period; timer means for initiating a complete cycle of reciprocation; a supervisory timer means associated with at least one portion of each cycle, said supervisory timer means having a preset time period in excess of said last mentioned portion acting to actuate said switches and deenergize said coil if the said portion of said cycle exceeds said preset time period on said supervisory timer.

2. Induction-heating apparatus comprising an induction-heating coil having a heating chamber into which a plurality of metallic workpieces are adapted to be moved; a source of power for said coil, switch means for controlling the application of power to said coil; reciprocatory mechanism for moving workpieces into said coil, the cycle of movement of said mechanism being divisible into a reciprocatory-movement portion and delay portion intermediate the reciprocating movement portions and each portion having a determinable time period; timer means for controlling the time period of the complete cycle of reciprocation and a supervisory timer associated

with at least one of said portions having a preset time period greater than the normal time period of that portion, said supervisory timer being operatively associated with said switch means controlling the application of power to said coil for cutting off the source of power in the event the time of said portion equals or exceeds the preset time period.

3. Induction-heating apparatus comprising, in combination, an induction-heating coil having a heating chamber into which a plurality of metallic workpieces are adapted to be moved; a source of power for said coil; switch means for controlling the application of power to said coil; reciprocatory mechanism for moving workpieces into said coil, the cycle of movement of said mechanism being divisible into a reciprocatory-movement portion and delay portion intermediate the reciprocating movement portions and each portion having a determinable time period; timer means for controlling the length of a complete cycle of reciprocation; a pair of supervisory

timers each associated with different of said portions and having a preset time period in excess of the determined time of said portion, said timer being operatively associated with said mechanism and said switch to deenergize said coil in the event the time period for one of said portions is greater than the preset supervisory timer period.

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