

Aug. 11, 1953

L. J. SHOREK ET AL
WIRE ENAMELING OVEN

2,648,531

Filed Nov. 26, 1949

3 Sheets-Sheet 1

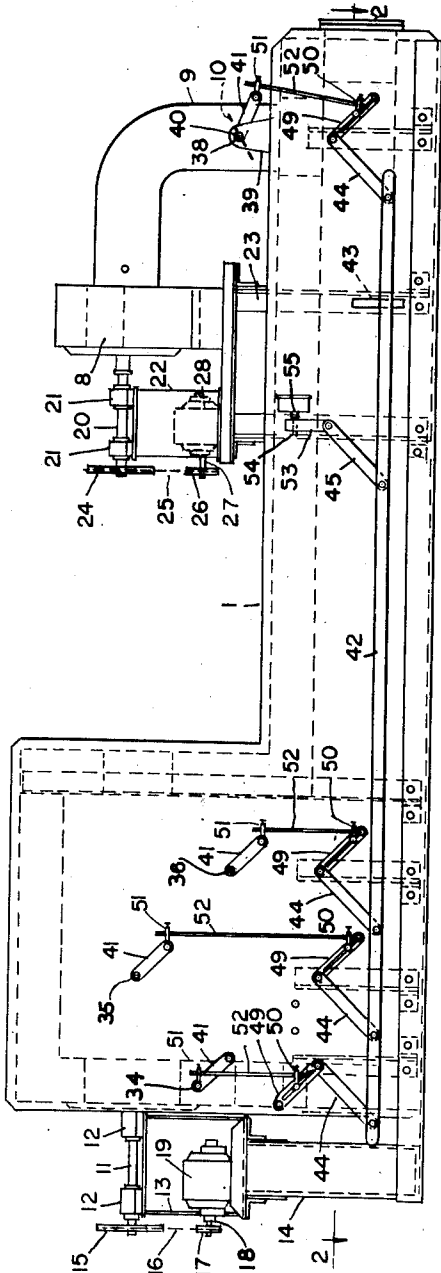


Fig. 1

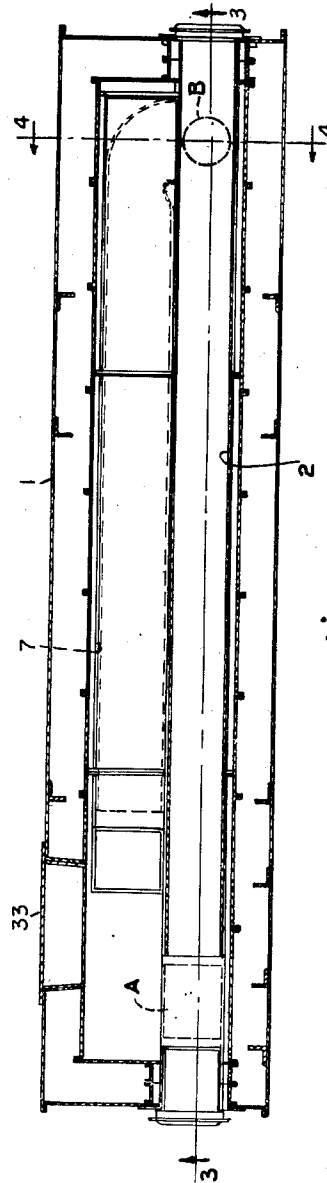


Fig. 2

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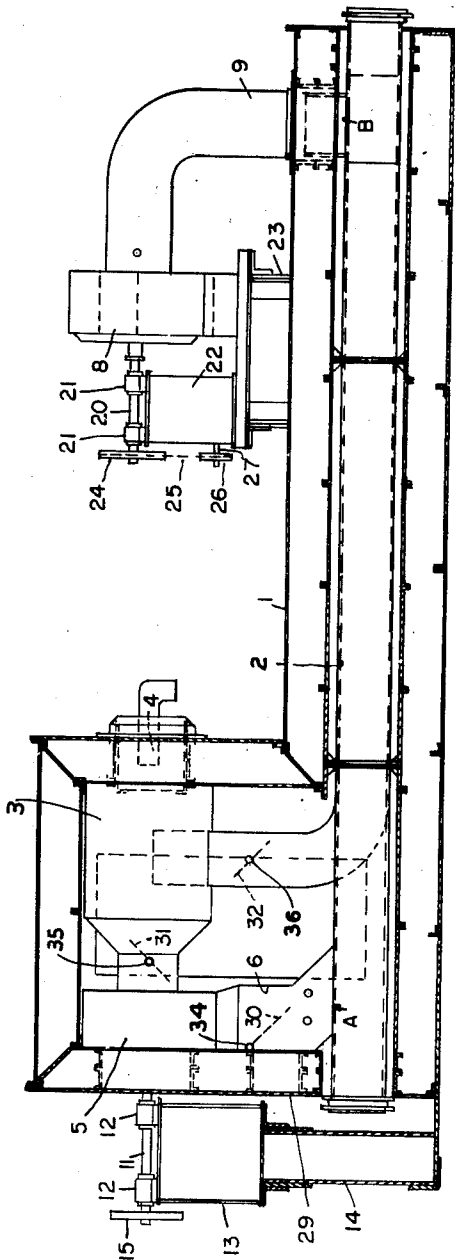


Fig. 3

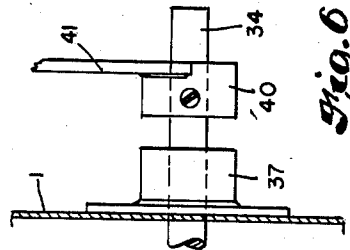


Fig. 6

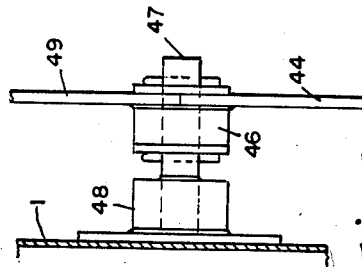


Fig. 5

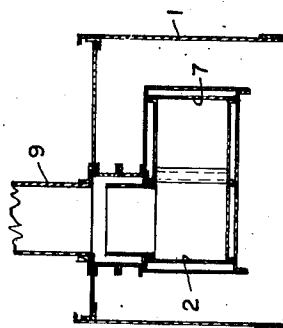


Fig. 4

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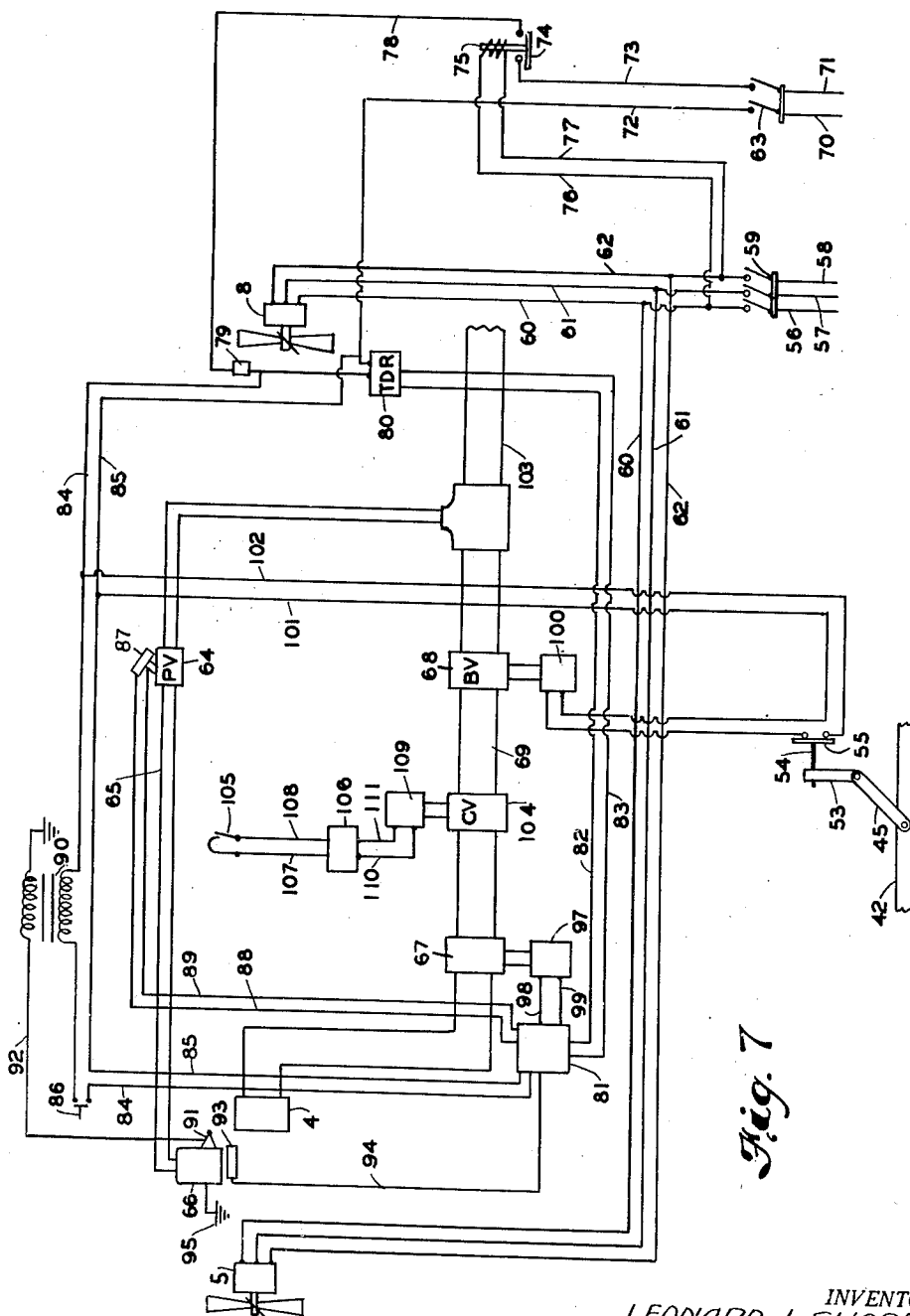


Fig. 7

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WIRE ENAMELING OVEN

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1 Claim. (Cl. 263—3)

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This invention relates to ovens, and more particularly to ovens adapted for processing enameled wire and the like.

In one method of insulating wire, and especially very heavy wire, a continuously traveling wire is wrapped with thread or other stranded material and then coated with enamel, which enamel is then baked on by conducting the wire continuously through the baking chamber of an oven. Such enamel acts as a bonding agent, and, being itself a dielectric, provides additional insulation. A relatively high operating temperature is employed in order to complete the baking operation in the very short time a given length of wire is within the oven.

The wire itself is not particularly subject to breakage, being often $\frac{1}{2}$ " or more in diameter, but breaks in the thread frequently occur. In such event, the wire must be halted, and the baking chamber of the oven must be immediately cooled since the high temperature therein will spoil the enamel if a given length of wire is permitted to remain within the baking chamber for too long a time.

In the past it has been the custom to admit unheated air into the entire oven when the wire is stopped. This has proved generally quite satisfactory in practice, in that the oven temperature is quickly brought down to a point where it will not damage the enamel, but has the serious disadvantage of making necessary the complete reheating of the oven when operation is resumed. Not only is heat wasted by this method, but such prolonged interruptions result in reducing the operating efficiency of the apparatus.

The primary object of this invention, therefore, is to provide means for rapidly cooling the work space of an oven of the type described, without affecting the temperature of the rest of the oven.

A further object is to provide means whereby the heating element of the oven may be shut off simultaneously with the cooling of the work space.

Other objects and advantages will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claim, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 is a side elevation of a wire enameling oven and its associated apparatus constructed in accordance with the principle of this invention;

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

Fig. 3 is a longitudinal vertical section of such wire enameling oven;

Fig. 4 is a sectional view taken along the line 4—4 on Fig. 2;

Figs. 5 and 6 are fragmentary details showing the linkage connections employed in conjunction with the control feature of the oven; and

Fig. 7 is a diagram of the electrical circuit and fuel supply system.

Referring now to the drawing and more especially to Figs. 1 and 3 thereof, the oven, generally indicated at 1, is L-shaped having an elongated portion wherein is contained a work tube 2. The work tube 2 of the oven is provided with inlet and outlet ends, shown in Figs. 1 and 3 as the right and left hand ends respectively, such ends having apertures of a size sufficient to permit the passage of a continuous length of wire through the oven. The wire may be drawn through the oven by a suitable source of power as, for example, a motor driven reel. A combustion chamber 3 is located in the upper portion of the oven at the outlet end thereof, having associated therewith a gas burner 4 blowing into the combustion chamber. Also associated with the combustion chamber 3 is a recirculating fan 5, which is adapted to blow the heated gases from the combustion chamber downwardly through duct 6 which is in communication with the work tube at A, adjacent the outlet end thereof. The heated gases then travel the length of the work tube 2 counter to the direction of travel of the wire, a major portion then being returned to the combustion chamber by means of return duct 7 for reheating and recirculating. The inlet and outlet apertures of the oven are relatively small (being only large enough to receive the traveling wire) so that loss of heated gases via such apertures is negligible. An exhaust fan 8 is provided to draw off a portion of the gases from the work tube (including volatiles given off in the baking process) through the exhaust duct 9, the latter being in communication with the work tube at B, adjacent the inlet end thereof. An exhaust damper 10, which is approximately one-half open in the normal operation of the oven, is provided to regulate the proportion of gases drawn from the work tube by the exhaust fan, in order to maintain the volatile content in the oven below the explosive concentration.

The recirculating fan 5 is driven by a shaft 11 mounted in pillow blocks 12 bolted to the support 13, which latter is bolted to the stand 14. Keyed to the shaft 11 is a pulley 15 driven by a belt 16 from pulley 17 keyed to the shaft 18 of an electric motor 19, the motor 19 being bolted to the stand 14. The exhaust fan 8 is driven

by shaft 20 mounted in pillow blocks 21 bolted to the support 22, the latter member being bolted to stand 23. Keyed to the shaft 20 is a pulley 24 driven by a belt 25 from the pulley 26 keyed to the shaft 27 of an electric motor 28, the motor 28 being bolted to the stand 23.

A fresh-air inlet 29 is in communication with the work tube at the outlet end thereof, having a tight-fitting damper 30 which is normally closed during the operation of the oven. In the event of interruption in the passage of the wire through the oven, as when the driving means is stopped because of a thread breakage at the winding machine, for example, the damper 30 will be opened and the exhaust fan damper 10 will be opened to its full extent so that the exhaust fan 8 may draw a maximum amount of unheated air through the work tube 2 and thereby rapidly cool the same, in order to avoid damage to the work by local overheating which would otherwise occur. Dampers 31 and 32 which are positioned in the duct 6 and the return duct 7 respectively, are normally open during operation of the oven, but are closed whenever unheated air is drawn into the work tube, thus sealing off the combustion chamber 3 so that a high temperature may be maintained therein.

A door 33 is provided in a wall of the oven so that ready access may be had to the internal parts of the same.

The dampers 30, 31 and 32 are provided respectively with damper rods 34, 35 and 36, each of which projects through a separate aperture in the wall of the oven and through a boss 37 welded thereto. The damper 10 is provided with a damper rod 38 which projects through an aperture in the exhaust duct 9 and likewise through an opening in the support 39. A collar 40 is secured to the end of each damper rod, as by means of a set screw, and welded to each such collar is a damper rod arm 41.

All of the dampers, and also a burner shut-off switch, hereinafter more fully described, are controlled by means of a manually operable control rod 42 extending the length of the oven and having a linkage stop 43 which is secured to the oven wall. The control rod 42 is movable to left or right, as viewed in Fig. 1, the linkage stop 43 providing a limit in both directions. Such control rod is pivotally connected to the lower ends of lever arms 44 and 45, the upper ends of arms 44 being pivotally mounted on the wall of the oven and operatively connected with the respective damper rod arms, thereby to effect control of each damper by movement of the control rod. The linkages connecting the lever arms 44 of the control rod with the several damper rod arms 41 are clearly shown in Figs. 1 and 5 include a collar 46 welded to the upper end of each of the arms 55; a pin 47 on which each such collar 46 is rotatably mounted; a boss 48, to which each such pin is welded, welded to the oven wall; a slotted arm 49 welded to each of the collars 46; a snap connector 50 pivotally mounted in the slotted portion of each such slotted arm; a snap connector 51 pivotally mounted on the end of each damper rod arm 41; and a connecting rod 52 secured to respective snap connectors of each corresponding slotted arm 49 and damper rod arm 41. The arm 45 is pivotally secured to the wall of the oven in a manner similar to that provided for the arms 44. Welded to the end of the arm 45 is an arm 53 carrying a spring pin 54 which is adapted to engage the burner switch 55 secured to the wall of the oven.

Before initiating operation of the oven, the control rod is moved by the operator to its extreme left position as viewed in Fig. 1 of the drawing, so that the fresh-air inlet damper is closed, the dampers 31 and 32 are open, and the damper 10 is partly open. Thus, in operation, heated gases are blown into the work tube at the left hand end thereof and returned to the combustion chamber by means of return duct 7, a portion of the gases from the burner (including volatiles given off in the baking process) being drawn off by the exhaust fan.

Fig. 7 shows diagrammatically the system whereby the fan motors are energized and the burner controlled. The electrical system consists of power lines 56, 57 and 58 having a single throw main switch 59. This controls the energization of the fan motor lines 60, 61 and 62. Thus, to initiate operation of the oven (the control rod being in its extreme left position, as viewed in Fig. 1, against the linkage stop), the switch 59 is closed, thereby energizing the fan motors by way of lines 60, 61 and 62 causing air to be forced through the oven to remove any combustibles which may have accumulated.

The operator will then close the manually operated switch 63 of the control circuit. The control circuit is operative to control the pilot valve 64 of the branch line 65 to the pilot burner 66, and the safety valve 67 and burner shut-off valve 68 of the branch line 69 to the main burner 4, respectively, and is energized by means of the current supply lines 70 and 71 which supply current to the lines 72 and 73 upon closing of the switch 63. The control circuit includes the contactor switch 74 having an operative coil 75 connected to the lines 60 and 62 by lines 76 and 77. The contactor switch 74 is normally open, and is closed by the energization of the coil 75 upon closing of the switch 59, which latter, upon being closed, also energizes the two fan motors.

Running from the current line 73 is a line 78 which is provided with a normally open air-responsive switch 79, which latter is associated with the fan 8 and is closed when such fan is operating by the blast of air therefrom, permitting current to be transmitted to the time-delay relay 80, the opposite pole of which is connected to the line 72. Thus, when the fan 8 is operating, the contactor switch 74 closes and the air-responsive switch 79 likewise closes permitting the energization of the time-delay relay 80. After the latter has run through its cycle it energizes the flame protective relay 81 by means of the lines 82 and 83, the flame protective relay 81 being operative to open the normally closed valves 64 and 67 in a manner hereinafter described. Thus, the time-delay relay 80 delays the opening of the valves 64 and 67 until the fans have been in operation a predetermined length of time in order to clear the oven of any combustibles before the main burner or pilot burner can be lighted.

Lines 84 and 85, connected across lines 78 and 72 of the control circuit, respectively, lead to the flame protective relay 81 and are controlled by a manually operated push button 86. Thus, after closing of the switches 59 and 63 as above described, the operator presses the button 86 closing the circuit comprising the lines 84 and 85 to the flame protective relay which is effective to close the circuit from the now energized flame protective relay to the solenoid 87 through lines 88 and 89, thus energizing such solenoid and opening the pilot valve 64. A spark plug trans-

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former 90, in the line 84, is likewise energized by closing of the push button 86, and is effective to energize a spark plug 91 through line 92 causing the latter to spark and thereby ignite fuel admitted to the pilot burner 66 by way of the now open pilot valve 64 and the branch line 65. The flame from the pilot burner is directed against a flame rod 93. The ionized atmosphere present in the flame area provides an electrical bridge between the pilot burner and flame rod, thus permitting current to flow from the energized flame protective relay through the line 94 to the pilot burner. It will be noted that the pilot burner is grounded at 95. The circuit thus closed by the pilot burner flame acts as a holding circuit, effective to hold closed the circuit from the flame protective relay to the pilot valve solenoid 87 permitting the operator to release the push button 86, and is further effective to close the circuit from the flame protective relay to the safety valve solenoid 97 by way of lines 98 and 99, thereby energizing such solenoid and opening the safety valve 67. Thus, it is seen that although the operator releases the push button 86, the circuits to the pilot valve solenoid and safety valve solenoid remain closed as long as the pilot burner remains lighted.

Of course, with the switch 63 and the air-responsive switch 79 closed, the normally closed burner shut-off valve 68 is lifted by means of the solenoid 100, the operative coil of which is connected across lines 84 and 85 by lines 101 and 102 (assuming, of course, that the control rod is in its extreme left position, as viewed in Fig. 1, so that the spring pin 54 bears against the burner switch 55 to complete the circuit to the solenoid 100).

Thus, a mixture of fuel, such as natural gas and air, is permitted to pass through the fuel supply line 103, the branch line 69, the burner shut-off valve 68, the normally open control valve 104 and the safety valve 67, to the burner, where it is ignited by the pilot burner flame. The control valve 104 in the branch line 69 to the main burner, is regulated by a thermocouple or gas filled control bulb 105 in the work tube through a temperature control switch 106. The normally open control valve 104 will thus remain open until the desired operating temperature is reached in the work tube at which point the current generated in the thermocouple 105 is transmitted to the temperature control switch 106 by means of lines 107 and 108, and is sufficient to close the same, energizing the solenoid 109 by way of lines 110 and 111, closing the control valve 104 and thus shutting off the fuel supply to the burner. It will be noted that neither the pilot burner nor the fans are affected when the burner is thus shut off.

When the temperature in the work tube reaches the desired working temperature, the operator causes the wire to be conducted through the oven, as by a motor driven reel, the wire having been wrapped with thread and a coating of enamel applied immediately prior to its entrance into the oven.

If, for any reason, it becomes necessary or desirable temporarily to stop the travel of the wire, as, for example, in the event of a thread breakage, the work tube of the oven must be immediately cooled in order that the enamel upon the length of wire within the work tube be not spoiled by the high temperature therein. Thus, when the wire is brought to a halt, the operator need merely grip the control rod at any point

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along its length and move it to its extreme right position against its linkage stop 43, as shown in Fig. 1 of the drawing, thereby opening the fresh-air inlet damper 30, and opening wide the exhaust fan damper 10 to permit a maximum amount of unheated air to be drawn into the work tube of the oven. The dampers 31 and 32 are closed upon actuation of the control rod, thereby sealing off the combustion chamber in order to maintain the same at its previous high temperature. Actuation of the control rod likewise causes the spring pin 54 to disengage the burner switch 55, thereby opening the circuit to the solenoid 100 and deenergizing the same, causing the burner shut-off valve to close, shutting off the supply of fuel to the burner. Thus, by a single simple operation, i. e., moving the control rod from left to right as viewed in Fig. 1 of the drawing, the work tube is quickly cooled, preserving the enamel from the damaging effect of the operating temperature employed, the combustion chamber is sealed off so that the high temperature therein may be retained, and the burner is shut off.

It will be noted, however, that although the main burner is shut off, the rest of the control circuit is not affected, i. e., the circuit to the time-delay relay 80 remains closed, thereby maintaining the flame protective relay 81 energized and thus holding open the pilot valve 64 and safety valve 67 of the branch lines 65 and 69, respectively. Thus, fuel continues to be supplied to the pilot burner, the latter remains lighted, and the heating system is maintained in stand-by condition ready to supply heat the moment the control rod 42 is shifted to the left, as viewed in Fig. 1, to close the circuit to the solenoid 100 and thus open the burner shut-off valve 68.

Of course, the control valve is open since its controlling thermocouple will be "calling for" heat because of the sudden drop in temperature in the work tube. When operation is to be resumed, the operator will move the control rod to its extreme left position against the linkage stop 43, as viewed in Fig. 1 of the drawing, causing the fresh-air inlet damper 30 to close, the exhaust fan damper 10 to return to its partly open operating position, and the dampers 31 and 32 to open. The burner switch 55 is simultaneously closed by action of the spring pin 54, closing the circuit to the solenoid 100 and energizing the same, thereby causing the burner shut-off valve 68 to open, permitting fuel to be supplied to the burner, where it is ignited by the pilot. The operator will then cause the wire again to be conducted through the oven. Thus, the baking operation may be immediately resumed since the combustion chamber was never subjected to the influx of unheated air, it having been sealed off by the dampers 31 and 32 so that a high temperature was maintained therein.

It is understood, of course, that if the pilot flame fails, the holding circuit comprising the flame rod 93, line 94 and the flame protective relay will be opened, thus opening the circuits from the latter to the pilot valve solenoid 87 and safety valve solenoid 97, whereupon the normally closed valves 64 and 67 will close. In such event, the operator must again press the push button 86 to re-light the pilot burner 66 and open the valves 64 and 67 before operation can be resumed.

Although the control rod has been indicated as being manually operable, it is obvious that

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suitable automatic means may be provided to actuate the same in response to a wire stoppage or thread breakage. Such means as may be employed, however, form no part of the present invention. However, whether manually or automatically actuated, the control rod serves the function of quickly cooling the work tube of the oven while sealing off the combustion chamber so that the latter may be maintained at a high temperature, thereby permitting immediate resumption of the baking process without the necessity of completely reheating the oven. The control rod serves the additional function of shutting off the burner simultaneously with the admission of cool air into the work tube. It will also be noted that the shutting down of the burner in no way affects the rest of the control circuit, in that the pilot remains lighted and stands ready to ignite the burner whenever fuel is supplied to the latter.

While the control feature of our invention has been indicated as being suitable for ovens processing enameled wire, it is clear that such control feature has a wider field of use and is suitable for ovens processing any material continuously travelling therethrough where interruptions in the travel of such material result in overheating of the portion of material within the oven. Means may also be provided for simultaneously actuating the control rod and starting or stopping the travel of the wire. For example, actuation of the control rod could be adapted to open or close the circuit to an electric motor-driven reel provided to conduct the wire through the oven.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in the following claim, or the equivalent of such, be employed.

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We therefore particularly point out and distinctly claim as our invention:

In an oven having a work tube through which a wire or the like is adapted to be conducted, a combustion chamber in communication with such work tube, a pilot burner and a main burner located in such combustion chamber, and a fresh air inlet likewise in communication with such work tube; a damper located intermediate such fresh air inlet and such work tube, a second damper located intermediate such combustion chamber and such work tube, and manual control means adapted selectively, in order to condition such oven for normal operation, simultaneously to render operative such main burner, close said first damper, and open said second damper, and also, in order to admit unheated air into such work tube while isolating such combustion chamber from the influence of such air, simultaneously to render inoperative such main burner without affecting such pilot burner, open said first damper, and close said second damper.

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