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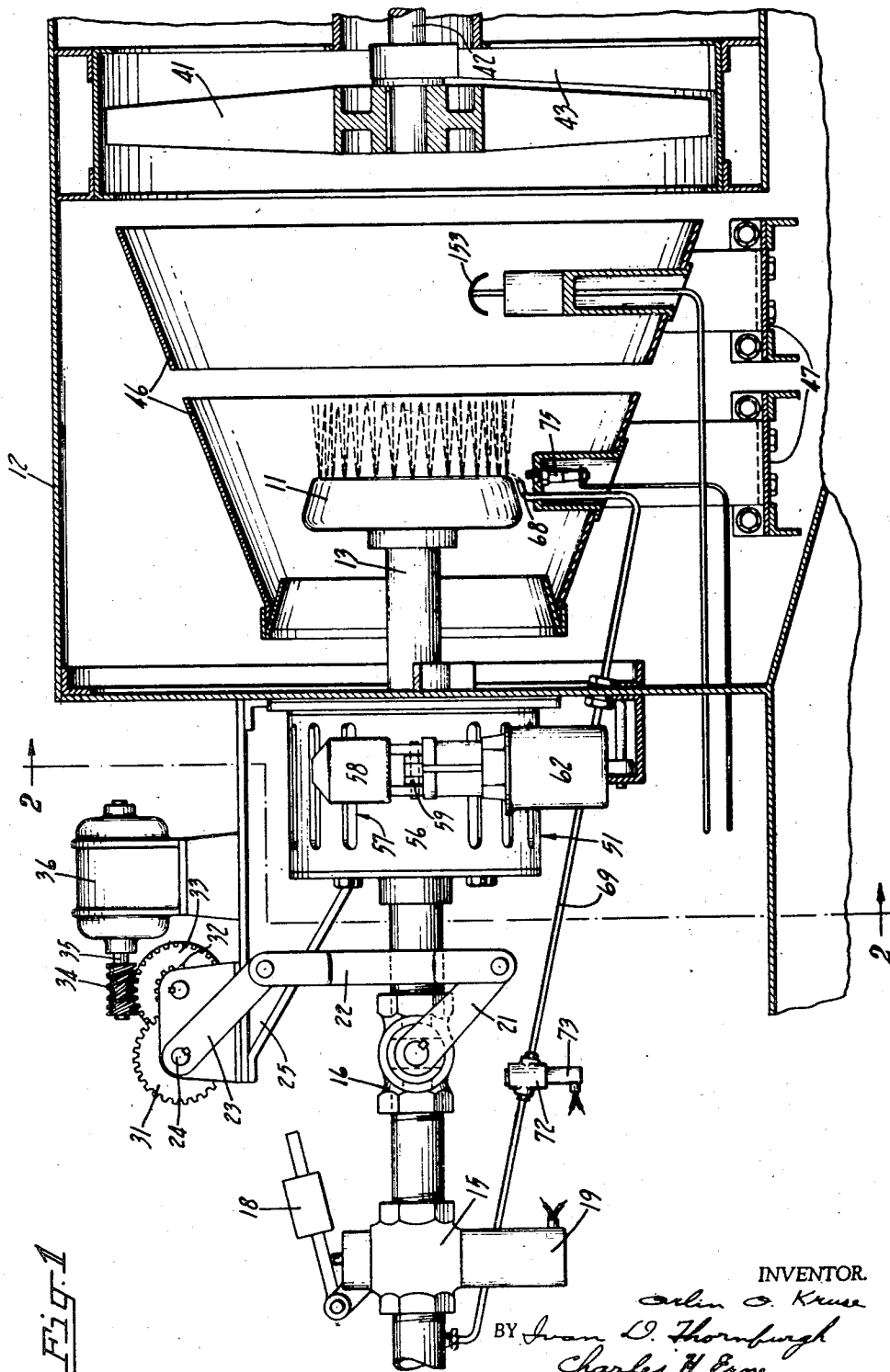
O. O. KRUSE

2,412,990

DRYING OVEN CONTROL

Filed July 6, 1942

3 Sheets-Sheet 1



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Fig. 3

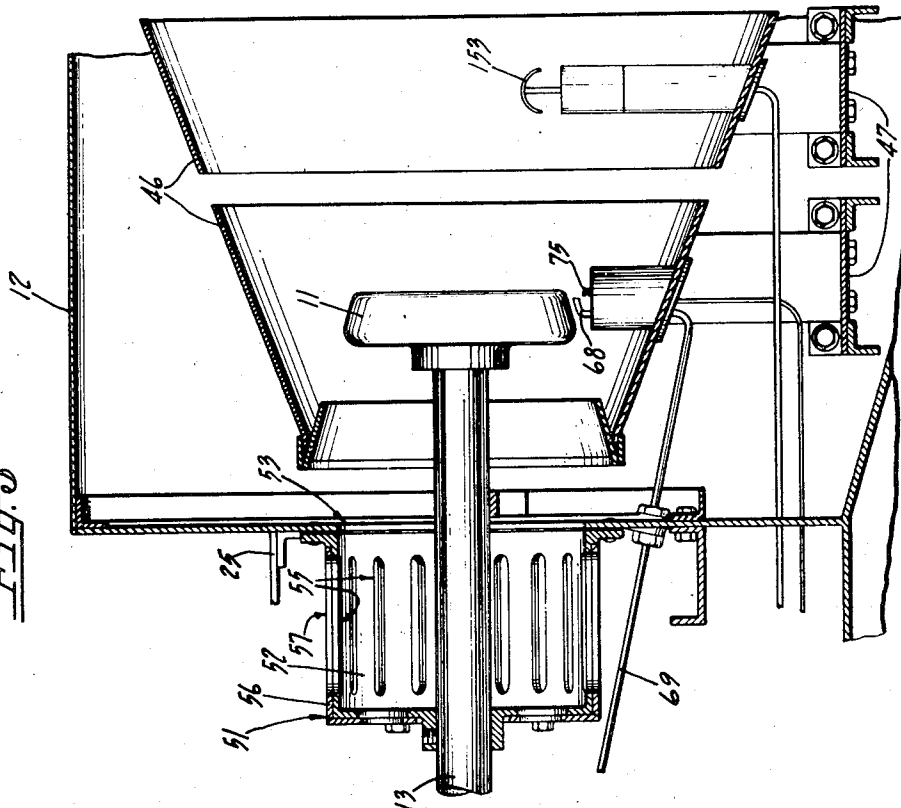
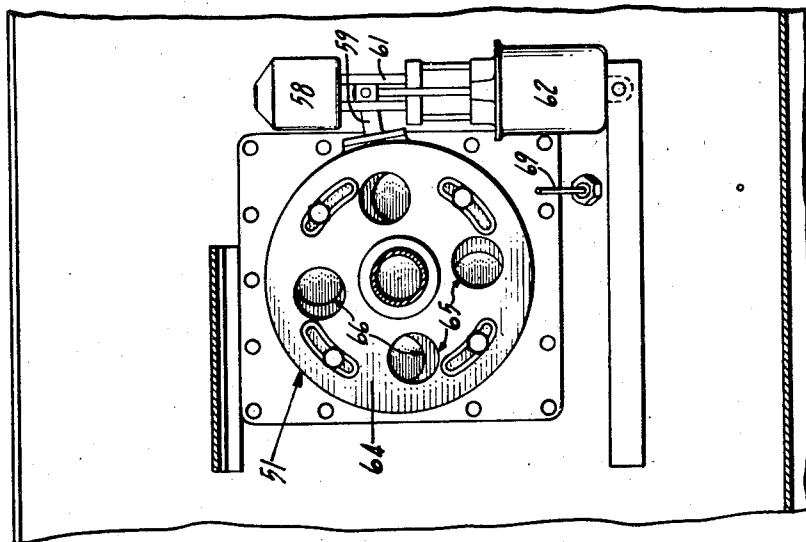


Fig. 2



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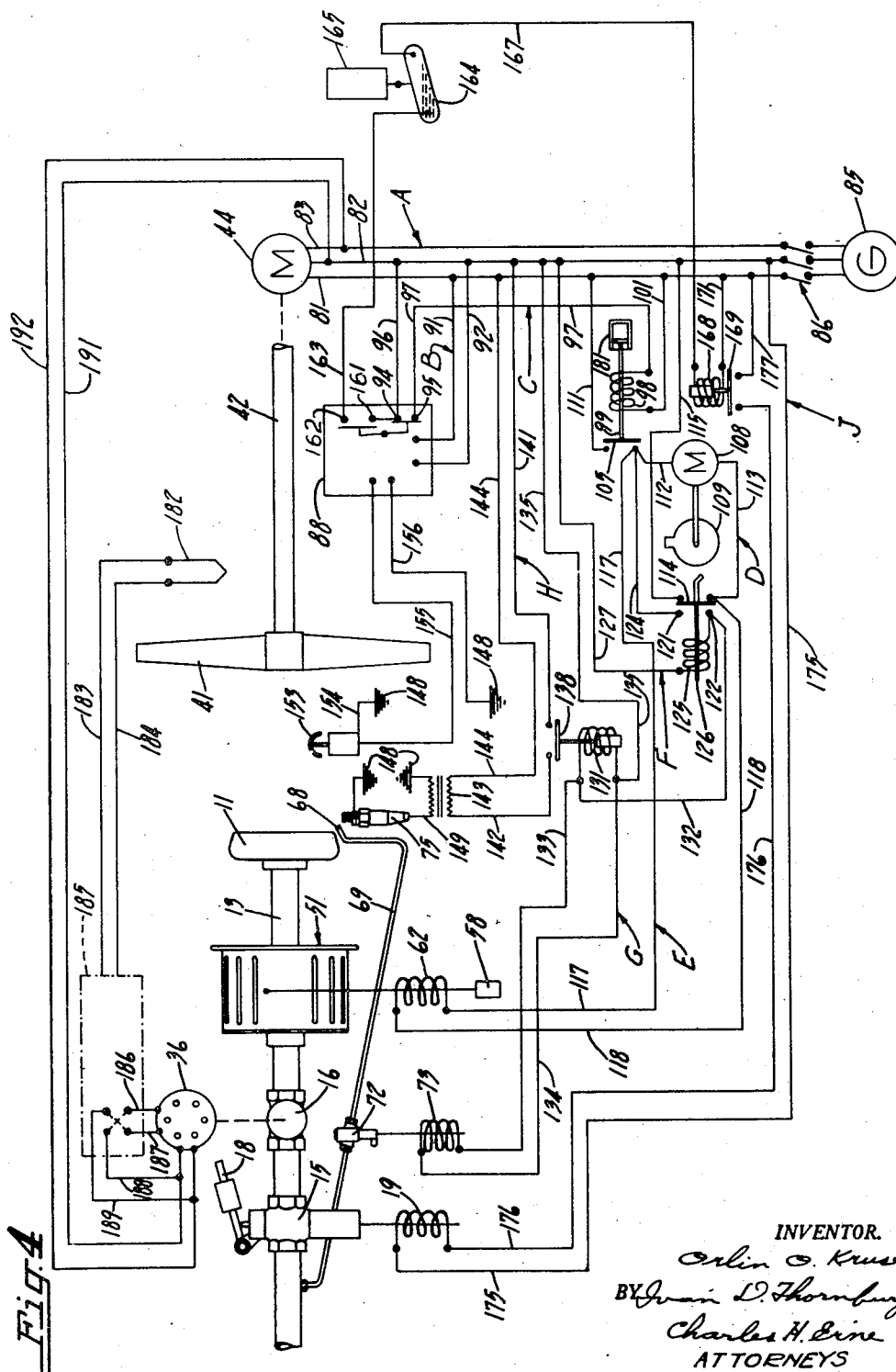
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UNITED STATES PATENT OFFICE

2,412,990

DRYING OVEN CONTROL

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Application July 6, 1942, Serial No. 449,939

5 Claims. (Cl. 158—28)

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The present invention relates to drying ovens and the like which are heated by gas burners and has particular reference to devices for controlling the lighting of the burners and for purging the oven of unburned gases and other vapors prior to lighting the burners to safeguard the oven against explosions.

In drying ovens used for baking coated and lithographed metal sheets, such as tin plate and the like from which container or can parts are produced, the drying of the sheets usually is effected by circulating heated air through the ovens. The air is heated by way of gas burners. In starting up such an oven and when re-lighting a burner, which for some reason has gone out, unburned gas sometimes collects in the oven and results in a terrific explosion if proper precautions are not taken.

The instant invention contemplates the prevention of such explosions by the provision of control devices which insure purging of the oven prior to the lighting of the burners.

An object therefore of the invention is the provision in a drying oven which is heated by gas burners, of control devices which operate to purge the oven of unburned gases prior to the lighting of the burners so that an explosion resulting from ignition of such gases will be prevented.

Another object is the provision of such oven control devices wherein the heating burners are held inoperative, i. e., ignition is delayed, for a predetermined time cycle after the beginning of the purging operation so that the burners are not lighted until the oven is cleared of explosive gases.

Another object is the provision of control devices of this character wherein electric instrumentalities and suitable electric circuits are interconnected in such manner as to interlock the control devices so that they are dependent for operation upon the flow of air through the oven with the result that the latter will be purged fully of unburned gases before the burner is made ready for lighting.

Numerous other objects and advantages of the invention will be apparent as it is better understood from the following description, which, taken in connection with the accompanying drawings, discloses a preferred embodiment thereof.

Referring to the drawings:

Figure 1 is a sectional view taken through the burner and air circulating portion of a drying oven embodying the instant invention, with parts broken away;

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Fig. 2 is a transverse sectional view taken substantially along the broken line 2—2 in Fig. 1;

Fig. 3 is a view similar to Fig. 1 with parts omitted and with other parts shown in section; and

Fig. 4 is a wiring diagram of the electric apparatus used with the devices.

As a preferred embodiment of the invention the drawings illustrate a portion of a sheet drying oven of the general character disclosed in United States Patent 1,691,683, issued July 6, 1926, to C. G. Preis. In such an oven freshly coated or lithographed sheets of tin plate or the like material are conveyed through a drying chamber in an upright or "on-edge" position while heated air is circulated through the chamber to dry the coating on the sheets.

In the instant oven the air to be circulated through the chamber is heated to a predetermined temperature by a ring shaped main gas burner 11 (Fig. 1) which is located in a sheet metal duct 12 formed on top of the oven. The duct communicates, by way of suitable entrance and return openings, with the drying chamber in the oven. The burner is supplied with gas by a pipe 13 which leads from any suitable supply of gas outside the oven.

The flow of gas to the burner 11 is controlled by a main cut-off or service valve 15 and a regulator valve 16 which are connected into the supply pipe 13. The cut-off valve 15 is of the normally closed type and is formed with a manually operable opening lever 18. The valve is provided with a locking electric solenoid 19 which when energized permits of opening the valve by manipulation of the lever 18 and holds it open regardless of any further manipulation of the lever. Closing of the valve is effected by the solenoid.

The regulator valve 16 is partially opened or closed, as the case may require, to control the heat output of the burner and to maintain the air circulated through the oven at a predetermined constant temperature. Actuation of the valve is effected preferably by a valve arm 21 which is connected by a link 22 to an actuating arm 23 mounted on a gear shaft 24 carried in suitable bearings formed in a bracket assembly 25 bolted or otherwise secured to the burner end of the duct 12.

The gear shaft 24 is part of a speed reduction transmission which includes a pair of meshing gears 31, 32 and a worm wheel 33. The worm wheel is rotatable in either direction by a worm 34 which is mounted on a rotor shaft 35 of a reversible electric motor 36 bolted to the bracket

assembly 25. The motor is operated by suitable circuits which will be explained hereinafter in connection with the wiring diagram in Fig. 4.

Air heated by the burner 11 is circulated through the drying chamber of the oven by a rapidly rotating fan 41 which is located within the duct 12 and which is disposed in axial alignment with the burner. The fan is mounted on a horizontal shaft 42 journaled in bearing brackets 43 secured in place within the duct 12. The fan shaft is rotated in any suitable manner by an electric motor 44, which is indicated in the wiring diagram in Fig. 4. A pair of spaced and aligned sheet metal frusto-conical deflector elements 46 located around and adjacent the burner 11, direct the heated air toward the circulating fan 41. These deflector elements are secured to transverse support beams 47 secured in place within the duct 12.

Provision is made to safeguard the oven against explosion when first lighting the burner 11 or when relighting the burner if for any reason it goes out during operation of the oven. This is brought about by purging the duct 12 and the drying chamber for a predetermined time cycle of any unburned gases, fumes, or vapors which may have collected in the oven and around the burner. It has been found that a time cycle of approximately three minutes is sufficient to clear the average oven of unburned gases.

When the burner 11 goes out, the main gas service valve 15 closes and cuts off the supply of gas to the burner. Before the burner can be again ignited the circulating fan 41 must be in operation or must be set in operation. The setting of the fan in operation at the starting of the purging time cycle is accompanied by the opening of a rotary damper 51 (Figs. 1, 2 and 3) which admits large quantities of fresh air into the duct. This unheated air is circulated through the drying chamber and is discharged by way of a vent pipe.

The rotary damper 51 includes a stationary hollow cylinder 52 which surrounds the burner supply pipe 13 and which is or may be bolted to the burner end of the duct 12. The inner end of the cylinder is open and communicates with the interior of the duct by way of an opening 53 formed in the end wall of the duct. The cylindrical wall of the cylinder is formed with a plurality of elongated peripherally spaced slots 55.

The stationary cylinder 52 carries a surrounding sleeve 56 which is formed with a plurality of elongated slots 57. Normally these slots are held out of register with the slots 55 in the cylinder so that no air passes through them. The sleeve is held in this position by a weight 58 which is connected to the sleeve by an arm 59. The weight is fixed to a plurality of vertical rods 61 which are connected to a vertically movable member of what may be termed an "oil gear thruster unit" which includes an electric solenoid 62. The "thruster unit" usually is actuated by a motor through a solenoid. In order to make the explanation brief it is sufficient at this time to show in the wiring diagram the solenoid directly connected to the damper.

When the solenoid 62 is energized the weight 58 and its arm 59 are raised and this rotates the sleeve 56 on the cylinder and thus brings the slots 55, 57 into register so that fresh air will enter the duct 12. An adjustable end plate 64 having circumferentially spaced holes or apertures 65 is clamped on the rotary damper and is provided to permit air to enter the duct for combustion pur-

poses. The holes communicate with cooperating circumferentially spaced holes or apertures 66 in the outer end of the cylinder for this purpose.

At the end of the purging cycle, the rotary damper 51 is closed and a pilot 68 located adjacent the burner 11, is lighted. The pilot is formed on the inner end of a gas supply tube 69 connected into the main gas pipe 13 adjacent the inlet side of the service valve 15. A normally closed valve 72 connected into the pilot supply tube is opened at the end of the purging cycle by a connecting solenoid 73. This permits gas to flow to the pilot.

Lighting of the pilot 68 is effected by a spark from a spark plug 75 which is located adjacent the pilot. The operation of this spark plug and the solenoid 73 of the pilot valve 72 will be more fully explained hereinafter in connection with the wiring diagram.

After lighting the pilot 68, the burner 11 is ignited therefrom by the opening of the main service valve 15. This is brought about by energizing the valve solenoid 19 by suitable circuits hereinafter to be explained. These circuits are established by ionized gas given off by the lighted pilot 68.

Reference should now be had to the wiring diagram shown in Fig. 4. In this diagram the circulating fan motor 44 is directly connected by three main lead lines 81, 82, 83, to a suitable source of power such as an electric generator 85. This constitutes a fan or main circuit A. A service switch 86 is interposed in the line to start and stop the fan motor. Closing of this switch sets the fan in motion and starts the oven purging cycle through a control circuit B and a time delay circuit C which will now be explained.

The control circuit B includes a conventional flame operated protecting relay unit 88 of the character disclosed in United States Reissue Patent 20,210, issued December 22, 1936, to Dewey D. Knowles, on Safety system. Such a unit picks up low voltage current set in motion by ionized gas from the burner 11 and from the pilot 68 and this current is amplified to operate certain switches in the unit. This unit is supplied with electric energy from the generator 85 by way of a pair of wires 91, 92 which connect with the main lead wires 81, 82.

Hence when the main line service switch 86 is closed the unit 88 is immediately actuated and sets a normally closed switch having contacts 94, 95 which are included in the time delay circuit C. Contact 94 is connected by a wire 96 to the main lead wire 82. Contact 95 is connected by a wire 97 to one side of a solenoid relay 98 having a movable core 99. The other side of the solenoid coil is connected by a wire 101 to the main lead wire 81. Electric energy passing along this circuit energizes the solenoid relay 98 and closes a switch 105 which is actuated by the core 99 of the solenoid.

Closing of the switch 105 establishes a motor circuit D and a damper circuit E. The motor circuit D is part of the time delay circuit C and includes a motor 108 and a timing cam 109 that is rotated by the motor in any suitable manner. Electric energy for the motor flows from the main lead wire 81 along a connecting wire 111, through the closed switch 105, a wire 112, motor 108, a wire 113, a normally closed cam actuated switch 114, and a connecting wire 115 back to the main lead wire 82.

Electric energy passing along this motor circuit drives the motor 108 which rotates the cam

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109 through one revolution. It is this cam that holds the three minute purging cycle hereinbefore mentioned. At the completion of said revolution of the cam, the cam switch 114 is opened and this breaks the circuit D. The cam switch motor thereupon ceases operation.

The damper circuit E includes the solenoid 62 that opens the rotary damper 51. This solenoid is connected by a wire 117 to one side of the switch 105 and by a wire 118 to one side of the switch 114, as shown in the wiring diagram. Thus when the switch 105 closes, electric energy passes from the lead wire 81, along wire 111, closed switch 105, wire 117, solenoid 62, wire 118, closed switch 114, and wire 115 back to the lead wire 82. This flow of energy energizes the solenoid 62 and thus opens the damper.

The damper 51 remains open for the duration of the purging cycle. At the completion of this cycle, at which time the switch 114 opens to break the motor circuit D, the damper circuit E is broken also and thus the solenoid becomes de-energized. This closes the damper and it remains closed until a subsequent purging cycle is initiated.

Opening of the cam switch 114 by the cam 109 brings the movable element of the switch into closing engagement with two normally open contacts 121, 122 of a holding circuit F which cuts out the cam motor 108. Contact 121 is connected by a wire 124 to the switch 105 of the motor circuit D. Contact 122 is connected to one side of a solenoid relay 125 which surrounds a movable core 126 connecting with the switch element 114. The other side of the solenoid is connected by a wire 127 to the main lead wire 82. Electric energy passing along this holding circuit energizes the solenoid 125 and thus holds the switch element 114 closed against the contacts 121, 122. This maintains the motor circuit D and the damper circuit E in open condition.

Connecting the two contacts 121, 122 by the switch element 114 also establishes a pilot circuit G which includes the pilot gas valve solenoid 73 and an auxiliary solenoid relay 131. Contact 122 is connected by a wire 132 to one side of the auxiliary solenoid relay 131 and to a wire 133 which connects with one side of the pilot valve solenoid 73. The opposite sides of these solenoids are connected by a wire 134 and this wire is connected by a wire 135 to the main lead wire 82.

Hence when the switch element 114 connects the contacts 121, 122 electric energy from the wire 111 passes along the holding circuit F and the pilot circuit G and thus energizes the two solenoids 73, 131. Energizing of the pilot gas valve solenoid 73 opens the pilot gas valve 72 and permits gas to flow to the pilot 68. Energizing of the auxiliary solenoid relay 131 establishes a spark circuit H which is associated with the spark plug 75.

The spark circuit H includes a normally open switch 138 which constitutes a part of the solenoid relay 131. One side of the switch is connected by a wire 141 to the lead wire 82. The opposite side of the switch is connected by a wire 142 to the primary side of a step-up transformer 143. The primary side of the transformer also connects by a wire 144 to the main lead wire 81. The secondary side of the transformer is connected to a ground 148 (which may be the oven frame) and to one wire 149 of the spark plug 75. The other wire of the plug is connected to the ground 148.

Hence closing of the relay switch 138 completes

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the spark circuit H and electric energy passes through the transformer 143 and is induced into the spark plug 75 to create a spark adjacent the pilot 68. It is this spark that ignites the pilot.

When the pilot 68 is lighted, ionized gas from the pilot impinges against a detector element or electrode 153 which is located adjacent thereto. This electrode is connected by a wire 154 to the ground 148 and by a wire 155 to the flame operated relay unit 88 hereinbefore mentioned. This unit is also connected by a wire 156 to the ground.

The flow of ionized gas between the electrode 153 and the ground 148 sets up a flow of low voltage electric energy in the flame operated relay unit 88 and this is amplified sufficiently to open the normally closed switch bridging the contacts 94, 95. It also closes a normally open switch including a pair of contacts 161, 162 located within the unit. Contact 161 is connected by a short jump wire to the contact 94. Contact 162 is connected by a wire 163 to a pivotally mounted normally open conventional mercury switch 164 which is rocked or its pivot into closed position by a vane 165 secured to the switch. Vane 165 is located adjacent the fan 41 and is disposed in the path of travel of the air set in motion thereby.

The mercury switch 165 is connected by a wire 167 to one side of a solenoid 168 of a relay switch 169 which forms a part of a burner circuit J. The opposite side of the solenoid coil is connected by a wire 171 to the main lead wire 81.

Hence with the circulating fan 41 in operation and the vane switch 164 closed, electric energy from the main lead wire 82 flows along the wire 96, contacts 94, 161, 162, wire 163, closed vane switch 164, wire 167, solenoid 168, and wire 171 back to the main lead wire 81. This electric energy energizes the solenoid 168 and thus closes the relay switch 169 for the burner circuit J.

The burner circuit J includes the main gas valve solenoid 19. One side of the solenoid coil is connected by a wire 175 to the main lead wire 82 while the opposite side is connected by a wire 176 to the relay switch 169. This switch is connected by a wire 177 to the main lead wire 81.

Hence closing of the relay switch 169 establishes the burner circuit J and permits electric energy to energize the main gas valve solenoid 19. As hereinbefore mentioned the energizing of this solenoid permits opening of the main gas valve 15 by way of the lever 18 and thus allows gas to flow into the burner 11. This gas is immediately ignited by the previously lighted pilot 68.

As mentioned above, the switch bridging the normally closed contacts 94, 95 opens simultaneously with the closing of the switch that bridges the normally open contacts 161, 162. Opening of the switch contacts 94, 95 breaks the time delay circuit C and thus deenergizes the solenoid 98 of this circuit. The de-energizing of solenoid 98 opens the switch 105 and thus breaks the motor circuit D, the holding circuit F, the pilot circuit G and the spark circuit H. This restores all of these circuits to original open condition in readiness for subsequent establishment by the same procedure as just explained, in case the burner 11 is extinguished for any reason after it is once lighted.

In order to permit of sufficient time for the lighting of the burner 11 after the burner circuit J is established, a time delay dash pot 181 may be secured to the movable core of the control circuit-solenoid 98. This dash pot prevents too rapid an opening of the switch 105 following the opening of the switch that bridges the flame op-

erated relay unit contacts 84 and 85. This allows sufficient time for the burner valve 15 to open and for the burner to be lighted, before the circuits controlling the pilot 68, act to extinguish the pilot.

If the fan 41 is not in operation when an attempt is made to light the burner or if for any reason the fan should stop operating, the gravity controlled vane switch 164 would be opened and the circuit leading to the solenoid 168 of the relay switch 169 would be broken. The solenoid 168 would be deenergized and thus the relay switch is open. The burner circuit J being broken under such circumstances, the valve solenoid 19 would be deenergized. A deenergizing of the solenoid 19 immediately closes the burner valve 15 and locks it against opening until the valve solenoid is again energized.

Opening of the main switch 86 as by manual actuation disconnects the generator 85 from all of the circuits. All solenoids are deenergized when their respective circuits are open and the entire apparatus remains inoperative since all motors are idle.

After the burner 11 is lighted its heat output is controlled by a thermo-couple 182 which is located within the duct 12 and which is disposed adjacent the circulating fan 41 on its discharge side. The thermo-couple is connected by wires 183, 184 to a conventional temperature control electric relay panel 185 which in turn is connected by wires 186, 187, 188, 189 to the reversible electric motor 36. This motor it will be recalled opens and closes the regulator valve 16 as it operates in forward or reverse. The motor is connected by wires 191, 192 to the main lead wires 82, 83.

Thus the thermo-couple 182 detects a temperature higher than a predetermined desired amount and then acts through the control panel, to set the motor 36 in operation in one direction to close the gas regulator valve 16 an amount in accordance with the actual temperature. This reduces the flow of gas and thus reduces the heat output of the burner.

When the temperature falls below the predetermined set value, the thermo-couple acts through the control panel to rotate the motor in the opposite direction to open the valve and thus increase the heat output of the burner as required. In this manner the thermo-couple maintains the temperature of the air heated by the burner at a constant predetermined value.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description, and it will be apparent that various changes may be made in the form, construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred embodiment thereof.

I claim:

1. In an oven for drying coated metallic sheets and the like, the combination of a main gas burner for heating the oven, a valve for controlling the admission of gas to said burner, electric devices including a pilot burner for lighting said gas burner, a fan for circulating air heated by said burner through said oven, a damper opening into said oven, damper actuating instrumentalities, time delay means operatively connected to said damper actuating instrumentalities and also operatively connected with said burner lighting devices for first opening said damper for a pre-

determined period of time to admit fresh air into the oven for purging it of unburned gases prior to the lighting of the burner to safeguard the oven against explosion, said time delay means after a predetermined period being operative to close said damper and light said pilot burner to ignite said main gas burner, and means energized by a flow of ionized gas issuing from the lighted pilot burner for controlling the actuation of said burner control valve.

2. In an oven for drying coated metallic sheets and the like, the combination of a gas burner designed for issuing ionized gas for heating the oven, a normally closed and locked shut-off burner valve controlling the flow of gas to said burner, a gas pilot for lighting said burner, a normally closed pilot valve controlling the flow of gas to said pilot, electric means for lighting said pilot, a fan for circulating air heated by said burner through said oven, time delay means connecting with said pilot valve and with said electric means for delaying the opening of said pilot valve for a predetermined interval of time to insure purging of the oven of unburned gases by said fan before the lighting of said pilot, said time delay means being further operative to commence and to terminate the purging operation for said predetermined time interval, and electric instrumentalities disposed adjacent said pilot and connecting with said burner valve and operable by ionized gas issuing from the lighted pilot for unlocking said burner valve to permit the burner valve to be opened to light said burner by said pilot after the purging of the oven, thereby safeguarding the oven against explosion.

3. In an oven for drying coated metallic sheets and the like, the combination of a gas burner designed for issuing ionized gas for heating the oven, a normally closed and locked shut-off burner valve controlling the flow of gas to said burner, a gas pilot for lighting said burner, a normally closed pilot valve controlling the flow of gas to said pilot, electric means for lighting said pilot, a fan for circulating air heated by said burner through said oven, time delay means connecting with said pilot valve and with said electric means for delaying the opening of said pilot valve for a predetermined interval of time to insure purging of the oven of unburned gases by said fan before the lighting of said pilot, said time delay means being further operative to commence and to terminate the purging operation for said predetermined time interval, electric instrumentalities disposed adjacent said pilot and connecting with said burner valve and operable by ionized gas issuing from the lighted pilot for unlocking said burner valve to permit the burner valve to be opened to light said burner by said pilot after the purging of the oven, whereby to safeguard the oven against explosion, and means operable by air circulated by said fan for closing said burner valve when the air fan stops operating, thereby extinguishing said burner.

4. In an oven for drying coated metallic sheets and the like, the combination of a gas burner for heating the oven, a valve for controlling the admission of gas to said burner, means for lighting said burner, purging means for exhausting unburned gases from the oven, time delay means interconnected with said burner lighting means and with said purging means for delaying the lighting of the burner for a predetermined time interval after the beginning of the oven purging operation to safeguard the oven against ex-

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plosion, said time delay means being further operative to commence and to terminate the purging operation for said predetermined time interval, a regulator valve disposed between said burner and said burner control valve for regulating the flow of gas to said burner, and means for actuating said valve in accordance with the heat output of said burner, thereby maintaining said oven at a predetermined constant temperature.

5. In an oven for drying coated metallic sheets and the like, the combination of a gas burner for heating the oven, a valve for controlling the admission of gas to said burner, means for lighting said burner, purging means for exhausting unburned gases from the oven, time delay means interconnected with said burner lighting means

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and with said purging means for delaying the lighting of the burner for a predetermined time interval after the beginning of the oven purging operation to safeguard the oven against explosion, said time delay means being further operative to commence and to terminate the purging operation for said predetermined time interval, a regulator valve disposed between said burner and said burner control valve for regulating the flow of gas to said burner, a reversible electric motor for actuating said valve, and means disposed in said oven for controlling the operation of said motor in accordance with the heat output of said burner, thereby maintaining said oven at a predetermined constant temperature.

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