Feb. 21, 1956 J. M. HOFF 2,735,484

AUTOMATIC IGNITION AND CONTROL MECHANISM FOR GASEOUS FUEL BURNERS

Filed May 4, 1953 4 Sheets-Sheet 1

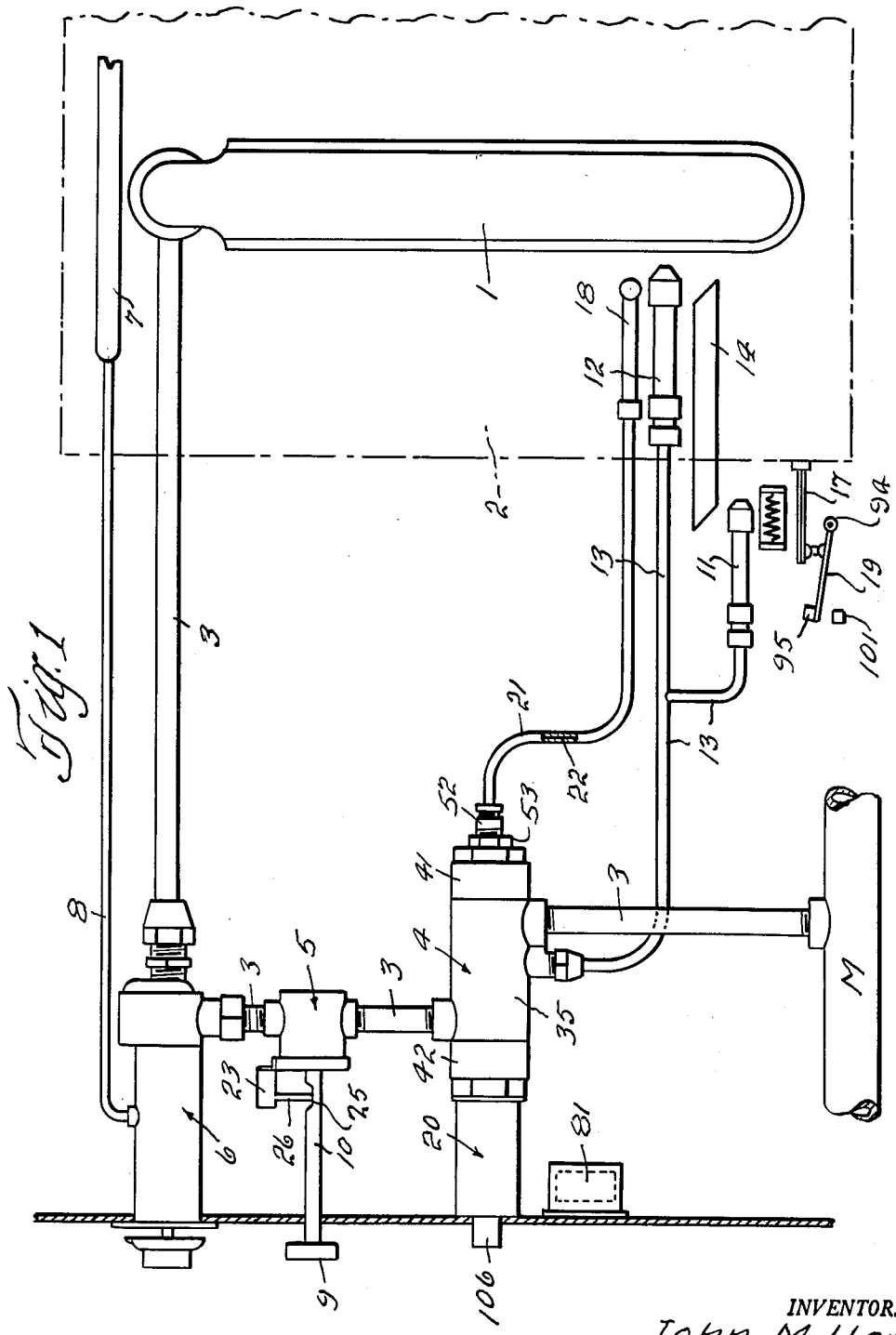


Fig. 1

INVENTOR.
John M. Hoff
BY
Chas. H. Trotter
Atty.

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Fig. 2

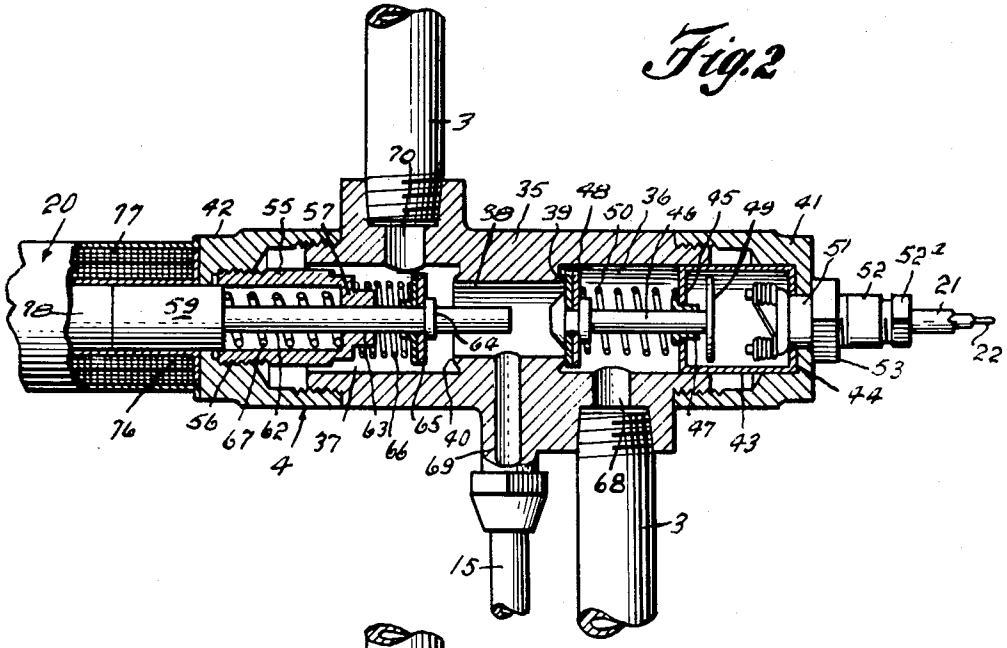


Fig. 3

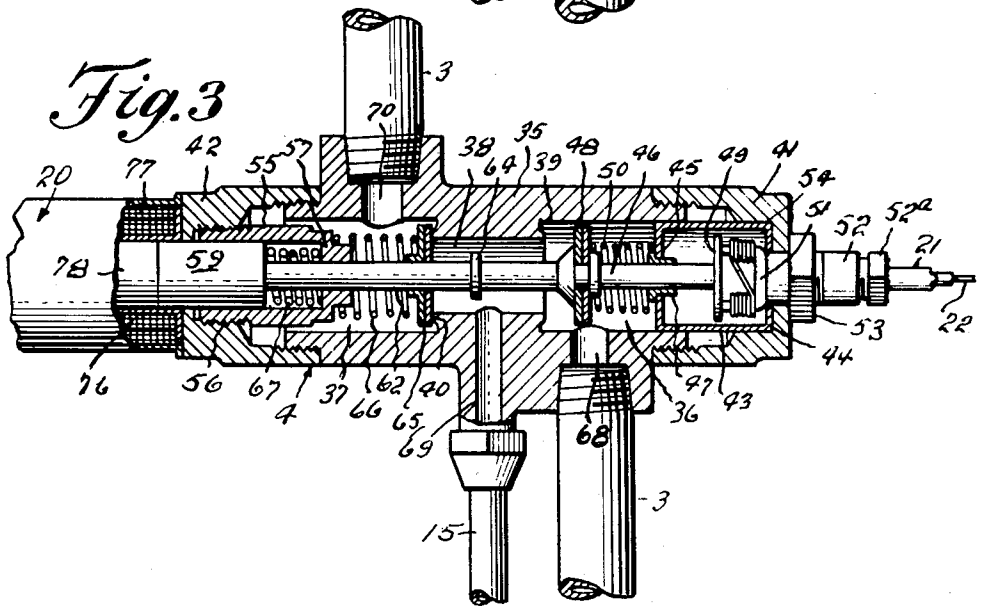
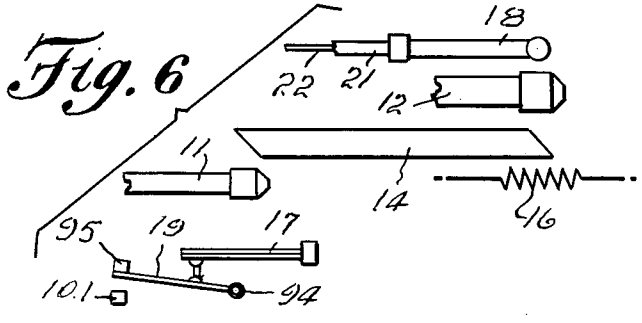


Fig. 6



INVENTOR.
John M. Hoff
BY Chas. H. Trotter
ATTORNEY

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AUTOMATIC IGNITION AND CONTROL MECHANISM FOR GASEOUS FUEL BURNERS

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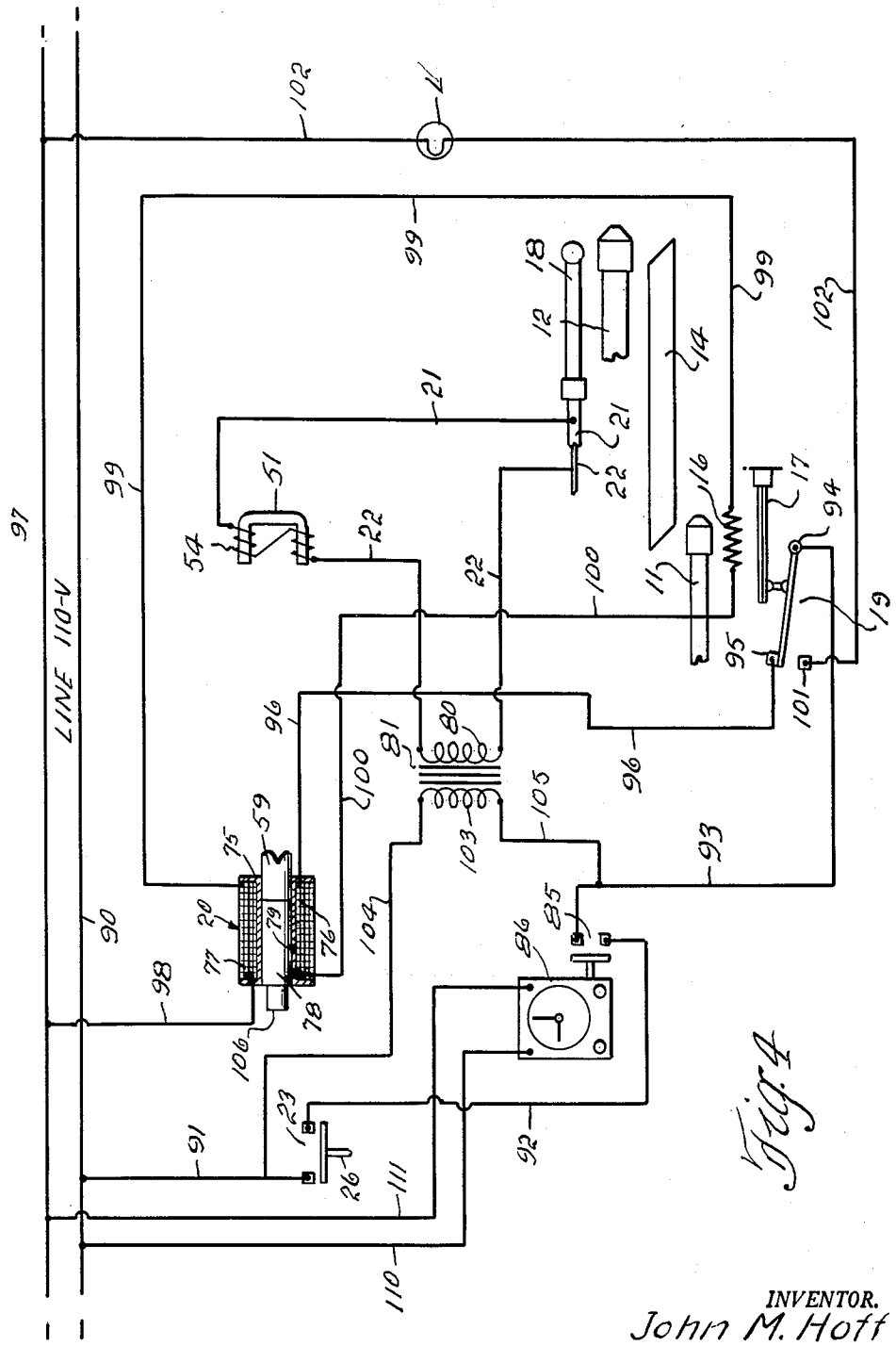


Fig. 4

INVENTOR.
John M. Hoff
BY Chas. H. Trotter
Atty.

Feb. 21, 1956 J. M. HOFF 2,735,484

AUTOMATIC IGNITION AND CONTROL MECHANISM FOR GASEOUS FUEL BURNERS

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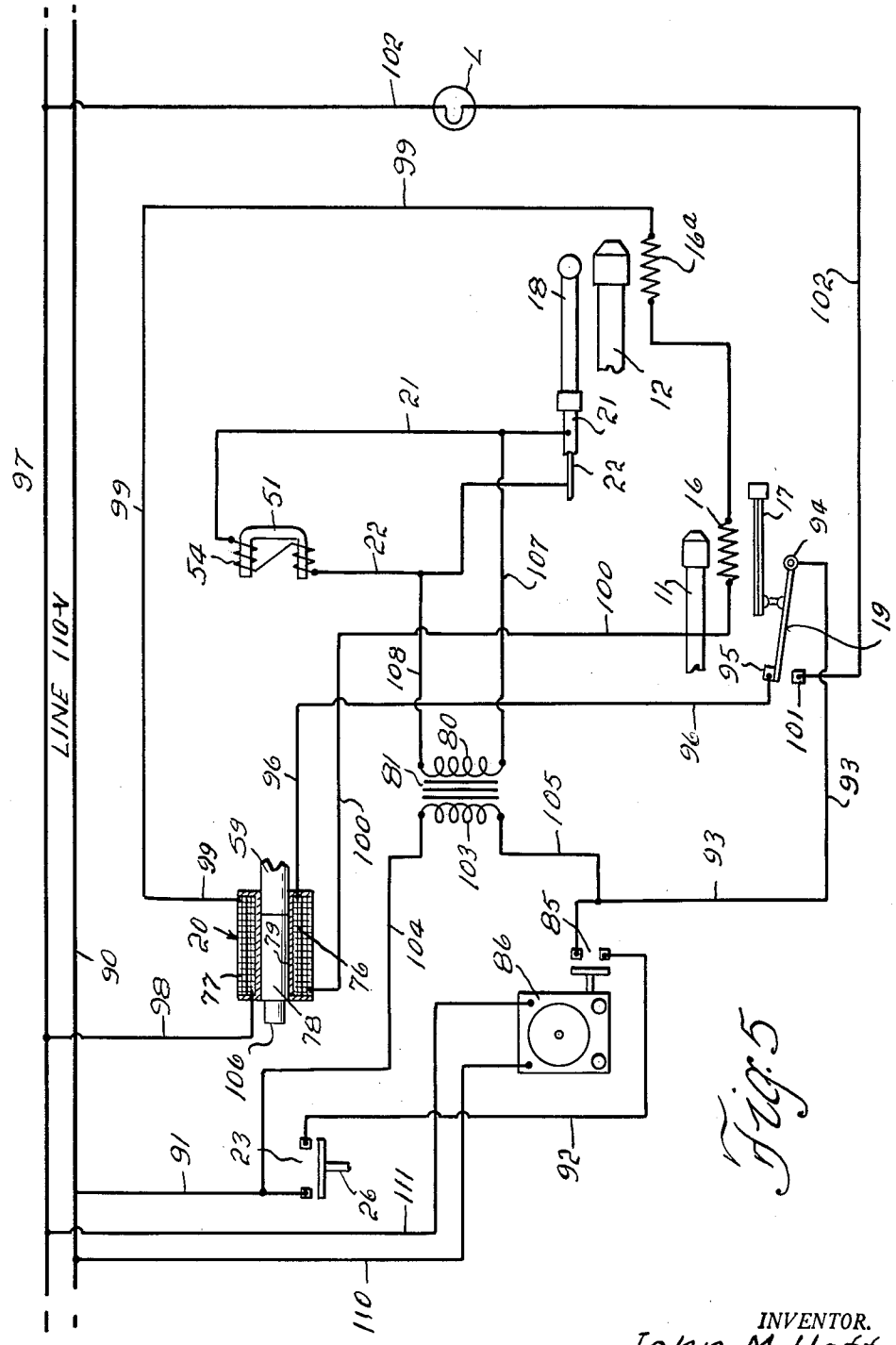


Fig. 5

INVENTOR.
John M. Hoff
BY Chas. H. Trotter
Atty.

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2,735,484

AUTOMATIC IGNITION AND CONTROL MECHANISM FOR GASEOUS FUEL BURNERS

John M. Hoff, Mansfield, Ohio, assignor to The Tappan Stove Company, Mansfield, Ohio, a corporation of Ohio

Application May 4, 1953, Serial No. 352,635

13 Claims. (Cl. 161—9)

This invention relates to an automatic electric ignition and control mechanism for cooking range burners using gaseous fuel and is a modification of the control mechanisms shown in the patent to Charles M. Mayer and John M. Hoff No. 2,577,787 issued December 11, 1951, the patent to Charles M. Mayer No. 2,578,718 issued December 18, 1951, the co-pending application of Richard L. Perl and John M. Hoff filed December 10, 1951, Serial No. 260,906, now Patent No. 2,637,390, in the co-pending application of Charles M. Mayer Serial No. 286,194, filed May 5, 1952, now Patent No. 2,637,392, and in the co-pending application of Charles M. Mayer et al. Serial No. 293,282, filed June 13, 1952, now Patent No. 2,637,393. It is especially designed and adapted for automatically igniting and controlling the operation of oven burners in cooking ranges, and may be used in conjunction with a time control mechanism or independently thereof as desired.

The mechanism is designed for use with a main gaseous fuel burner which is adapted to be ignited by a gaseous fuel pilot burner. As long as the pilot burner is ignited it is immaterial whether or not the main burner burns constantly. It may be extinguished for some reason, but it will be promptly re-ignited by the pilot burner if fuel is supplied thereto. But if the pilot burner is extinguished for any reason while the main control valve is still open to supply gas to the main burner a very dangerous situation sometimes arises. Let us assume that both the pilot burner and the main burner are extinguished during operation for some reason. Gas can then flow to the main burner but since the pilot burner is extinguished the main burner will not be ignited and unburned gas will accumulate in the oven which may violently explode when an attempt is made to ignite either the main or pilot burner. It has been found by experience that both the pilot burner and the main burner are frequently extinguished during operation. This is sometimes due to a momentary failure of the gas supply or the slamming of the oven door or to various other reasons.

In order to prevent any accumulation of unburned gas and thus eliminate danger of an explosion therefrom in the event the pilot burner is extinguished for any reason during operation, a safety control unit by which the supply of gas to both the main burner and the pilot burner is completely cut off, in the event the pilot burner is extinguished for any reason during operation, is provided.

As shown herein the apparatus includes a main gaseous fuel burner by which the oven in a cooking range is heated. The main burner is adapted to be ignited by a gaseous fuel main pilot burner which is adapted to be ignited by a control burner and which burn only during the time the oven is in operation. At other times the supply of gas to the main burner, the pilot burner and the control burner is cut off by the safety control unit which is interposed in a main conduit between the gas supply manifold and the main burner. During operation gas flows from the manifold into the safety control unit. From the safety control unit gas flows through a small branch conduit

directly to the pilot and control burners; and through the main conduit, a manually operable normally closed main control valve, and a standard thermostatically operated oven temperature control valve to the main burner. A normally open master control switch which is associated with the main control valve is provided to initiate operation of the pilot and control burners and the main burner. The master control switch is arranged to be closed by the opening of the main control valve and to be opened by the closing of the main control valve. The closing of the master control switch energizes, through a normally closed thermostatically opened switch, a solenoid transformer which is operatively connected to the safety control unit, and the solenoid transformer when energized energizes an electric resistance ignition element. The energization of the solenoid transformer also causes it to set the safety control unit to permit the flow of gas from the safety control unit to the pilot and control burners while cutting off the supply of gas from the safety control unit to the main burner. The control burner is ignited by the electric ignition element and the pilot burner is ignited by the control burner through a flash tube which extends between the pilot and control burners. The control burner projects a flame against a thermostatic element which is operatively connected to a normally closed switch means, and the pilot burner projects a flame against a thermocouple which is operatively connected to an electromagnet in the safety control unit. After the thermostatic element becomes heated it opens the normally closed switch which de-energizes the solenoid transformer and the electric ignition element. As soon as the solenoid transformer is de-energized the safety control unit is automatically operated by spring means to maintain the supply of gas to the pilot and control burners through the branch conduit and to also supply gas to the main burner through the main control valve and the oven temperature control valve. The main burner is then ignited by the pilot burner. The thermocouple, as long as it is heated by the pilot burner, maintains the safety control unit, through the electromagnet in condition to supply gas to both the main burner and the pilot and control burners. The oven temperature control valve then regulates the supply of gas to the main burner so as to maintain the desired oven temperature. As long as the pilot and control burners are ignited the main burner will burn normally under the control of the oven temperature control valve. But if during operation the pilot burner is extinguished for any reason the thermocouple will immediately cool and allow the safety control unit to automatically cut off the supply of gas to the main burner and the pilot and control burners. As an example of the manner of operation of the apparatus, let us assume that during operation the pilot burner is suddenly extinguished, for instance, by a momentary failure of the gas supply from the manifold to the burners. The thermocouple immediately cools, allowing the safety control unit to cut off communication between the manifold and the main burner and the pilot and control burners. Then after the thermostatic element has cooled, closing the normally closed switch, which is maintained open by the thermostatic element during normal operation of the oven, the solenoid transformer and the electric ignition element are again energized, since the master control switch is still closed. The energization of the solenoid transformer will cause it to operate the safety control unit to re-establish communication between the manifold and the pilot and control burners only. Then when gas is again available the pilot and control burners will be re-ignited and re-establish normal operation of the oven as previously described.

To adapt the apparatus for use in conjunction with a standard time control mechanism, I provide a normally closed supplemental control switch which is disposed

in series with the master control switch. The supplemental control switch is adapted to be opened and closed at predetermined set times by the time control mechanism. When the time control mechanism is used the normally closed supplemental control switch is opened and the time control mechanism is set to initiate operation of the oven burner at a predetermined time by closing the supplemental control switch, and to terminate operation thereof at a predetermined set later time by opening the closed supplemental control switch. The main control valve is then manually opened and the master control switch is simultaneously closed. At the set time the control mechanism will close the supplemental control switch which will effect the energization of the solenoid transformer and the electric ignition element. The apparatus will then operate as previously described in connection with manual control until the time control mechanism opens the supplemental control switch at the set later time to terminate operation. The opening of the supplemental control switch will cause the safety control unit to cut off the supply of gas to both the main burner and the pilot burner, thus terminating operation.

Prolonged power failures of many hours and sometimes of even several days duration frequently occur in various parts of the country. In order to eliminate the necessity of either keeping the main burner burning constantly during a prolonged power failure or manually actuating the safety control unit, as is normally done by the solenoid transformer, and then lighting the pilot burner with a match each time the oven is used, the mechanism is so constituted and arranged that the pilot and control burners can burn constantly during a power failure instead of being extinguished each time the supply of gas to the main burner is cut off. The operation of the main burner is then controlled by the opening and closing of the main control valve.

The principal object of the invention is to provide an improved electrical ignition and automatic control system for cooking range oven burners using gaseous fuel.

Another object of the invention is to provide in an electrical ignition and control system of the character described means for completely shutting off the supply of gas to the main burner and the pilot and control burners in the event the pilot burner becomes extinguished for any reason during operation.

Another object of the invention is to provide in an automatic ignition and control system for oven burners means by which the system may be easily converted from a fully automatic system to a constantly burning pilot burner system during power failures.

Still another object of the invention is to provide an improved electrical ignition and control system of the character described which may be used in conjunction with a time control mechanism or independently thereof as desired.

Another object of the invention is to provide an automatic ignition or control mechanism of the character described in which the safety control unit and the thermocouple circuit are utilized to initiate and terminate operation of the main burner by the time control mechanism.

Other and more limited objects of the invention will be apparent from the following specification and the accompanying drawings forming a part thereof, wherein:

Fig. 1 is a diagrammatic layout showing my improved electrical ignition and safety control mechanism applied to a cooking range oven burner using gaseous fuel;

Fig. 2 is an enlarged central vertical section through the safety control unit showing the various parts in position to cut off the supply of fuel to both the pilot burner and the main burner;

Fig. 3 is a view similar to Fig. 2 showing the various parts in the position they are automatically moved to when the master control switch is closed to initiate the operation of the main oven burner;

Fig. 4 is a wiring diagram of the apparatus;

Fig. 5 is a view similar to Fig. 4 showing a slightly modified arrangement; and

Fig. 6 is a fragmentary detail view showing another slightly modified arrangement.

Referring now to the drawings by reference characters, the numeral **1** indicates a gaseous fuel main burner which is mounted in or in heating relation to a cooking range oven **2**. Gaseous fuel is supplied to the burner **1** from a manifold M through a conduit **3**. Interposed in the conduit **3** are a safety control valve mechanism generally indicated by the numeral **4**, a manually operable main control valve **5**, and an oven temperature control valve **6**. During operation gas flows from the manifold M through the conduit **3** to the safety control unit **4**, to be described in detail hereinafter. From the safety control unit **4** the gas flows through the conduit **3**, the main control valve **5**, and the oven temperature control valve **6** to the burner **1**. The oven temperature control valve **6** is operative to regulate the amount of gas flowing to the burner **1** during operation in order to maintain the oven **2** at any desired set temperature. The valve **6** is set to any desired temperature by a suitable handle having a pointer which cooperates with a graduated dial carried by the valve **6**. The valve **6** is controlled according to the temperature setting by a thermostatic element **7** which is mounted in the oven **2** and is connected to the valve **6** as shown at **8**. The main control valve **5** is a standard shut off valve which is manually opened and closed by a handle **9** and a valve stem **10**. The oven temperature control valve **6** is of standard well known construction. Consequently it is not shown in detail herein. There are many different constructions available any one of which will work equally well herein. If desired the shut off valve **5** and the oven temperature control valve **6** may be combined as a single unit and both actuated by the same handle and stem. Many such combined valves are available. Gas is also supplied to control burner **11** and a pilot burner **12** through a branch conduit **13** which extends between the safety control unit **4** and the control and pilot burners **11** and **12**. The pilot burner **12** is disposed within the oven **2** adjacent the main burner **1** in position to ignite the main burner **1** when gas is supplied thereto, and the control burner **11** is disposed in spaced relation to the pilot burner **12**, exteriorly of the oven **2**. A flash tube **14** extends between the control and pilot burners **11** and **12** and is operative to ignite either one of the burners **11** and **12** from the other burner. An electrical ignition element **16** is operatively associated with the control burner **11** in position to ignite the control burner **11** when gas is supplied thereto. The control burner **11** then ignites the pilot burner **12** through the flash tube **14**. A thermostatic element **17** is mounted in position to be heated by a flame from the control burner **11**, and a thermocouple **18** is mounted in position to be heated by a flame from the pilot burner **12**. The thermostatic element **17** is operative to actuate a double throw switch **19** which controls the energization of the electrical ignition element **16** and a solenoid transformer **20** which when energized operates the safety control unit to supply gas to the control and pilot burners **11** and **12** only, as will be described in connection with the description of the safety control unit and the operation of the whole apparatus. The switch **19** also controls the energization of a signal light bulb L which when energized indicates that the apparatus is functioning properly. The thermocouple **18**, when heated, is operative to hold the safety control unit in condition to maintain the supply of gas to the control and pilot burners **11** and **12** and to the main burner **1**, as will also be described in connection with the description of the safety control valve mecha-

nism and the operation of the apparatus. An electric circuit between the thermocouple 18 and the safety control unit 4 is established by a copper tube 21 and an insulated wire 22 within the tube 21. The control burner 11, the thermostatic element 17 and switch 19 are all disposed exteriorly of the oven 2 where they will not be exposed to the high ambient temperature in the oven during use.

A master control switch 23 is provided to control the operation of the apparatus. The master control switch 23 is associated with the main control valve 5 and is adapted to be opened and closed by a cam 25, carried by the valve stem 10, through a link 26. The arrangement is such that the switch 23 is simultaneously closed with the opening of the main control valve 5, and is simultaneously opened with the closing of the valve 5.

The construction of the safety control unit 4 and its connection to the solenoid transformer 20 will now be described, reference being had to Figs. 2 and 3, of the drawings. This unit comprises a casing 35 having a chamber 36 in one end thereof and a chamber 37 in the other end thereof. The chambers 36 and 37 are connected by a bore 38 of reduced diameter. A valve seat 39 is located at one end of the bore 38 and a similar valve seat 40 is located at the other end of the bore 38. The chamber 36 is closed by a removable cap 41 and the chamber 37 is closed by a removable cap 42. A sleeve 43, having end walls 44 and 45, is carried by the cap 41 and extends into the chamber 36. A valve stem 46 which is slidably mounted in a bushing 47 carried by the end wall 45 of the sleeve 43, extends from the chamber 36 into the sleeve 43. A control valve 48 of suitable material is secured to one end of the valve stem 46 within the chamber 36, and an armature 49 in the form of a thin light metal disc is secured to the other end of the stem 46 within the sleeve 43. A very light relatively weak coiled compression spring 50 disposed about the valve stem 46 between the control valve 48 and the end wall 45 of the sleeve 43 normally holds the control valve 48 against the valve seat 39. An electromagnet 51 is secured to one end of a hollow exteriorly threaded stud 52 which extends out through aligned apertures in the end wall 44, of the sleeve 43, and in the end of the cap 41. A nut 53 screwed onto the outer portion of the stud 52 securely holds the magnet 51 and the sleeve 43 in place. The legs of the magnet 51 have a winding 54 thereon, one end of which is connected to the tube 21 and the other end of which is connected to the wire 22 in the tube 21. The tube 21 is inserted in the hollow stud 52 and is held in place by a screw fitting 52*a*. A sleeve 55 is screwed into a threaded recess in the end of the cap 42, as indicated at 56, and extends into the chamber 37 a slight distance. One end of the sleeve 55 is closed by an end wall 57, and the other end, which is open, registers with a circular aperture 58 in the end wall of the cap 42. A plunger 59 is slidably mounted in the sleeve 55 and extends out through the aperture 58 in the cap 42. A stem 62, which is secured to the inner end of the plunger 59, extends out through an aperture 63 in the end wall 57 of the sleeve 55, and through the chamber 37 and into the bore 38. The stem 62 has a collar 64 rigidly secured thereon between the end wall 57 and the outer end of the stem. An interrupter valve 65 of suitable material is slidably mounted upon the stem 62 between the end wall 57 of the sleeve 55 and the collar 64. The interrupter valve 65 is adapted to engage the valve seat 40 to cut off the flow of gas into the chamber 37 during the initiation of operation as will be hereinafter described. A compression spring 67 which is stronger than the spring 66 is disposed about the stem 62 within the sleeve 55 between the inner face of the end wall 57 and the inner end of the plunger 59. The spring 67 is operative to return the plunger 59, stem 62 and valve 65 from the position shown in Fig. 3 back to their normal position as shown in Fig. 2, against the resistance of the spring 66. A port 68 in the casing 35 provides communication between the chamber 36 and the conduit 3 to allow gas to flow from the manifold M through the conduit 3 into the chamber 36. During normal operation of the main burner 1 gas flows from the chamber 36 through the reduced intermediate bore 38 and into the chamber 37. A port 69 which establishes communication between the branch conduit 15 and the bore 38 is provided to supply gas to the pilot burner 12; and a port 70 establishes communication between the chamber 37 and the conduit 3 to permit the flow of gas from the chamber 37 to the main burner 1 through the main control valve 5 and the oven temperature control valve 6.

The solenoid transformer 20 comprises a spool 75 on which are wound the primary winding 76 and the secondary winding 77. An armature 78 is slidably mounted in the bore 79 of the spool 75. The solenoid transformer 20 may be operatively associated with the safety control unit 4 in any suitable manner. As shown herein it is secured to the cap 42 of the safety control unit 4, with the armature 78 thereof in axial alignment with the plunger 59 of the safety control unit 4.

In order to accommodate the apparatus for automatic control whereby operation of the main oven burner 1 may be automatically initiated at a predetermined set time and automatically terminated at a predetermined set later time, we provide a normally closed supplemental master switch 85 which is adapted to be opened and closed by a standard time control mechanism 86, and interpose the secondary winding 80 of a transformer 81 in the thermocouple circuit 21—22 in series with the winding 54 of the electromagnet 51. The winding 80 is heavy wire having substantially no resistance.

The operation of the apparatus will now be described, particular reference being had to Fig. 4 of the drawings. During manual control the supplemental control switch 85 is maintained closed. To initiate operation under manual control it is only necessary to manually open the main control valve 5 and close the master switch 23, and then manually close the main control valve 5 and open the master switch 23 to terminate operation. When the switch 23 is closed current will flow from one side 90 of the line through the lead 91, switch 23, lead 92, switch 85 and lead 93 to the terminal 94 of the double throw switch 19. The current then flows through the switch 19 to the terminal 95 thereof and then through the lead 96 to the primary winding 76 of the solenoid transformer 20 and from there back to the other side 97 of the line through the lead 98. The solenoid transformer 20 and the electric ignition element 16 which is connected to the secondary winding 77 of the solenoid transformer 20 by the leads 99 and 100 are now energized. The solenoid transformer 20 being energized shifts the various parts of the safety control unit 4 from the position shown in Fig. 2 to the position shown in Fig. 3, opening the control valve 48 and closing the interrupter valve 65. Gas can now flow to the control and pilot burners 11 and 12 which are ignited by the ignition element 16 and flash tube 14, but gas cannot yet flow to the main burner 1 since the interrupter valve mechanism in the chamber 37 of the safety control unit is maintaining the entrance thereto closed. The pilot and control burners being ignited heat the thermocouple 18 and the thermal element 17. The thermocouple being heated generates a minute current of the order of .015 volt which flows from the thermocouple through the tube 21 to the winding 54 of the electromagnet 51 and from there through the wire 22 and secondary winding 80 of the transformer 81 back to the thermocouple 18. The thermocouple current energizes the electromagnet 51 sufficiently for it to hold the control valve mechanism in the chamber 36 in the position shown in Fig. 3 against the slight resistance of the spring 50 after it has

been moved to this position by the solenoid transformer **20**, but not enough for the electromagnet to attract the mechanism from the position shown in Fig. 2 to the position shown in Fig. 3. The heating of the thermal element **17** by the control burner **11** causes it to actuate the switch **19** to break the circuit to and deenergizes the solenoid transformer **20** and consequently the electric ignition element **16**, and to make the circuit to the signal light bulb L through the terminal **101** and lead **102**. As soon as the solenoid transformer **20** is deenergized the spring **67** returns the interrupter valve mechanism in the chamber **37** back from the position shown in Fig. 3 to the position shown in Fig. 2 while the electromagnet **51** holds the control valve mechanism in the chamber **36** in the position shown in Fig. 3. Gas can now flow through the main control valve **5** to the main burner **1** where it is ignited by the pilot burner **12**. Under normal conditions the burner **1** will now operate under control of the oven temperature control valve **6** until its operation is terminated by the opening of the switch **23** and the simultaneous closing of the valve **5**. The closing of the manually operable valve **5** cuts off the flow of gas from the control unit **4** to the main burner **1**, but it does not cut off the flow of gas to the control and pilot burners **11** and **12**. This is effected by the opening of the master control switch **23** which effects the energization of the primary winding **103** of the transformer **81**. When the switch **23** is opened to terminate operation current flows from the side **90** of the line through leads **91** and **104** to the primary winding **103** of the transformer **81**, and from the primary winding **103** through the leads **105** and **93** to the terminal **94** of the switch **19**. From the terminal **94** the current flows through the switch **19** to the terminal **101** and from there back to the other side **97** of the line through the lead **102** and signal light bulb L. The energizing of the primary winding **103** of the transformer **81** generates an alternating current of the order of .15 volt in the secondary winding **80** thereof which is superimposed upon the minute direct current generated by the thermocouple in the thermocouple circuit. The superimposing of the higher voltage alternating current upon the much lower direct current in the thermocouple circuit momentarily deenergizes the electromagnet **51** after which the spring **50** returns the control valve mechanism in the chamber **36** back from the position shown in Fig. 3 to the position shown in Fig. 2, thus cutting off the flow of gas from the safety control unit **4** to both the main burner and the pilot burners.

Both the direct current generated by the thermocouple **18** and the alternating current generated by the transformer **81** are of such minute amplitude that neither one can energize the electromagnet **51** sufficiently for it to attract the armature **49** to it after the armature has once been released by the electromagnet **51** and moved away therefrom by the spring **50**, no matter how minute the separation between the magnet and armature may be. The force exerted by the spring **50** tending to move the armature **49** away from the electromagnet **51** is so slight that it cannot overcome the holding force exerted upon the armature **49** by the electromagnet **51** when the armature is in contact therewith, but is sufficient to separate the armature **49** and electromagnet whenever the electromagnet is momentarily deenergized. When the electromagnet **51** is energized only by the direct current generated by the thermocouple the polarity of the electromagnet remains constant, but when the alternating current generated by the transformer is applied to the electromagnet the polarity thereof is constantly reversed. The superimposing of the higher voltage alternating current upon the lower voltage direct current momentarily renders the holding force of the electromagnet zero each time the polarity thereof reverses, which occurs when the negative value of the alternating current is equal to the positive value of the direct current. At this moment the holding force of the electromagnet is zero the spring **50** will separate the armature and magnet after which the electromagnet cannot attract the armature back to it.

As long as outside current is available the main control valve **5** performs no useful function in either initiating or terminating operation of the apparatus, as the flow of gas from the manifold M to the main burner **1** is cut on and off before it reaches to valve **5** by the safety control unit **4** which is interposed in the conduit **3** between the manifold M and the valve **5**. The master control switch **23** through the safety control unit **4** controls both the initiation and the termination of the operation of the main burner **1**. The closing of the normally open master control switch **23** effects the opening of the control valve **48** and the closing of the interrupter valve **65** in the control unit **4**. Gas then flows to the control and pilot burners **11** and **12**, but it is cut off from the burner **1** by the interrupter valve **65**. After the control burner has been ignited and heats the thermostatic element **17** the interrupter valve **65** is opened after which gas can flow from the safety control unit **4** through the open valve **5** to the main burner **1**. The valve **5** is provided only to control the operation of the main burner **1** during prolonged power failure after the apparatus has been converted from a fully automatic ignition and control system to a constantly burning pilot burner system.

If the pilot and control burners are extinguished for any reason during operation, then the thermocouple **18** and the thermal element **17** will cool. The electromagnet **51** will then be deenergized and release the control valve mechanism in the chamber **36** which will then be returned by the spring **50** to the position shown in Fig. 2 cutting off the supply of gas to the control and pilot burners **11** and **12** and the main burner **1**. When the thermal element **17** cools, which is after the thermocouple **18** has cooled, it will actuate the switch **19** to again make the circuit to the solenoid transformer **20** and break the circuit to the signal light bulb L. The apparatus will then re-cycle as described as soon as gas is available.

A definite timed relation between the heating of the thermocouple **18** by the pilot burner **12** and the heating of the thermostatic element **17** by the control burner **11** must be maintained for the proper operation of the mechanism. By locating the thermostatic element **17** and the normally closed switch **19** outside of the oven **2**, where they will not be subjected to the heat of the oven, this timed relationship can always be uniformly maintained regardless of the temperature setting of the oven. The control burner **11** is provided only to heat the thermostatic element **17** during operation and thereby maintain the normally closed switch **19** open during operation. The control burner **11** is so adjusted that at the initiation of operation it will not heat the thermostatic element **17** sufficiently for it to open the normally closed switch **19** until after the pilot burner **12** has heated the thermocouple **18** sufficiently for it to generate enough current to energize the electromagnet **51**. The time required to open the normally closed switch **19** is therefore always the same, regardless of the oven temperature. The opening of the switch **19** breaks the circuit to and deenergizes the solenoid transformer **20**, and if the switch **19** is opened before the electromagnet **51** is energized the valve mechanism in the safety control **4** will resume the positions shown in Fig. 2 and thereby cut off the supply of fuel to all burners. Also the thermostatic element **17** is so constructed and arranged that in case the pilot and control burners are accidentally extinguished during operation the thermostatic element **17** will not close the switch **19** until after the thermocouple has cooled. When the thermostatic element **17** is mounted within the oven **2** in position to be heated by the pilot burner **12**, as was previously done, under certain conditions it will open the switch **19** too soon and under other conditions will not close the switch **19** soon enough.

In order to adapt the mechanism for automatic operation of the burner 1, I interpose the normally closed supplemental control switch 85 in series with the main control switch 23 and provide the standard electrically operated time control mechanism 86 which is operative to close and open the switch 85 at predetermined set times. Operating current is supplied to the time control mechanism through the leads 110 and 111. During manual control of the burner 1 the switch 85 is maintained closed. For automatic control the time control mechanism 87 is first set to initiate operation at a predetermined time and to terminate operation at a predetermined later time. The setting of the time control 87 automatically opens the switch 85. The valve 5 is then manually opened and the switch 23 closed. The opening of the valve 5 and the closing of the switch 23 will have no effect as long as the switch 85 is open since the safety control unit 4 is in the condition shown in Fig. 2 with the valve 48 in the chamber 36 cutting off the flow of gas from the safety control unit 4 to the main burner 1 and the control and pilot burners 11 and 12. At the set time the time control mechanism will close the switch 85 after which the mechanism will function exactly as described in connection with manual control until time to terminate operation. At the predetermined set time for terminating operation the time control mechanism 86 will open the switch 85 which will effect the energization of the primary winding 103 of the transformer 80 which in turn will effect the deenergization of the electromagnet 51, both exactly as described in connection with manual operation. The electromagnet will then release the control valve 48 in the safety control unit 4 and the spring 50 will then close the valve 48 and cut off the flow of gas to the main burner 1 and the control and pilot burners 11 and 12. At any time thereafter the apparatus may be reset for manual control by closing the valve 5 and switch 85 and opening the switch 23. If during automatic operation the pilot and control burners are extinguished for any reason the apparatus will function to cut off the supply of gas as described in conection with manual operation.

The signal light bulb L performs two separate and distinct functions. First, when energized it shows that the apparatus is functioning properly, and second it supplies the necessary impedance to prevent shorting across the line 90—97 when the switches 23, 85 and 94—101 are all closed. If desired a condenser or inductance or other resistance element can be substituted for the bulb L.

During periods of non-operation when either or both of the switches 23 and 85 are open current will flow from the side 90 of the line through the leads 91 and 104 to the primary winding 103 of the transformer 81, and from the primary winding 103 to the terminal 94 of the switch 19 through the leads 105 and 93. From the terminal 94 current flows through the switch 19 to the terminal 95 and from there back to the other side 97 of the line through the lead 96, primary winding 76 of the solenoid 20, and lead 98. A blanking out alternating current of higher voltage is thus always superimposed upon the direct much lower voltage current generated by the thermocouple in the thermocouple circuit whenever either of the switches 23 or 85 are open. From this it will be apparent that the electromagnet 51 can only be energized by the thermocouple current when both of the switches 23 and 85 are closed since current flowing from the side 90 of the line through the lead 91 will then follow the path of least resistance through the switches 23 and 85 instead of through the primary winding 103 of the transformer 81.

The oven may be repeatedly used during a prolonged power failure without the necessity of manually lighting the control and pilot burners 11 and 12 with a match each time it is used, as the construction and arrangement of the apparatus is such that it can be quickly and easily converted from a fully automatic electric ignition system to a constantly burning pilot burner system. In order to convert the apparatus to a constantly burning pilot burner system the safety control unit 4 is manually set and held in the condition shown in Fig. 3, by depressing the button 103 secured to the armature 78, in which condition gas can flow to the control and pilot burners 11 and 12 and be ignited by a match. The control unit 4 must be held as shown in Fig. 3 until the pilot burner 12 has heated the thermocouple 18 sufficiently for it to energize the electromagnet 51 after which the button 103 may be released. The electromagnet 51 will hold the control valve in the chamber 36 open as shown in Fig. 3 and the spring 67 will return the interrupter valve in the chamber 37 back to open position as shown in Fig. 2. Then the operation of the burner 1 is manually controlled by the opening and closing of the valve 5. Obviously the apparatus cannot be automatically controlled by the time control mechanism 86 during a power failure, nor can the electromagnet be deenergized by the transformer 81 during manual control.

In Fig. 5 I have shown a slightly modified form of the invention in which I place the secondary winding 80 of the transformer 81 in parallel with the electromagnet winding 54 instead of in series therewith. As shown one side of the winding 80 is connected to the tube 21 by the lead 107 and the other side of the winding 80 is connected to the wire 22 by the lead 108. Also I dispense with the flash tube 14 and provide a second electric ignition element 16a which is disposed in series with the electric ignition element 16 and is mounted in position to ignite the pilot burner 12. With this arrangement the control and pilot burners 11 and 12 are simultaneously ignited by the electric ignition elements 16 and 16a respectively. Otherwise the construction and operation of this form of the invention is the same as that shown in Figs. 1 and 4 and the same reference characters have been applied to similar parts.

If desired, the electric ignition element 16 may be mounted adjacent the main pilot burner 12 as shown in Fig. 6, instead of adjacent the control burner 11 as shown in Figs. 1 and 4. With this arrangement the ignition element 16 ignites the pilot burner 12, and the main pilot burner 12 ignites the control burner 11 through the flash tube 14.

From the foregoing it will be apparent to those skilled in this art that I have provided a very simple and efficient mechanism for accomplishing the objects of the invention.

It is to be understood that I am not limited to the specific constructions shown and described herein as various modifications may be made therein within the scope of the appended claims.

What is claimed is:

1. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a manually operable shut off valve interposed in said conduit between said safety control unit and said main burner, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condi-

tion to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, a normally closed supplemental master switch disposed in series with said master switch, said master switch and said supplemental master switch being operative when both are closed to effect the energization of said solenoid and said electric ignition means, a normally closed switch means disposed in series with said master switch which is operative when opened to effect deenergization of said solenoid and said electric ignition means, and a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and when cool to maintain said normally closed switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said master switch and said supplemental master switch each being operative when open to effect the energization of said transformer, and a time control mechanism operative to open and close said supplemental master switch at predetermined set times.

2. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a manually operable shut off valve interposed in said conduit between said safety control unit and said main burner, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burner while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, a normally closed supplemental master switch disposed in series with said master switch, said master switch and said supplemental master switch being operative when both are closed to effect the energization of said solenoid and said electric ignition element, a normally closed switch means disposed in series with said master switch, a normally open switch means, a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and said normally open switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, an impedance adapted to be connected in series with said master switches, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said normally closed switch means being operative when closed to connect said primary winding in series with said solenoid and when open to effect the deenergization of said solenoid and said electric ignition means, said normally open switch means being operative when closed to connect said impedance in series with said master switches, said master switch and said supplemental master switch each being operative when open to effect the energization of said transformer, and a time control mechanism operative to open and close said supplemental master switch at predetermined set times.

3. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, a normally closed supplemental master switch disposed in series with said master switch, said master switch and said supplemental master switch being operative when both are closed to effect the energization of said solenoid and said electric ignition means, a normally closed switch means disposed in series with said master switch which is operative when opened to effect deenergization of said solenoid and said electric ignition element, and a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and when cool to maintain said normally closed switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said master switch and said supplemental master switch each being operative when open to effect the energization of said transformer, and a time control mechanism operative to open and close said supplemental master switch at predetermined set times.

4. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner,

electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, a normally closed supplemental master switch disposed in series with said master switch, said master switch and said supplemental master switch being operative when both are closed to effect the energization of said solenoid and said electric ignition means, a normally closed switch means disposed in series with said master switch, a normally open switch means, a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and said normally open switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, an impedance adapted to be connected in series with said master switches, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said normally closed switch means being operative when closed to connect said primary winding in series with said solenoid and when open to effect the deenergization of said solenoid and said electric ignition element, said normally open switch means being operative when closed to connect said impedance in series with said master switches, said master switch and said supplemental master switch each being operative when open to effect the energization of said transformer, and a time control mechanism operative to open and close said supplemental master switch at predetermined set times.

5. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said main pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, said master switch being operative when closed to effect the energization of said solenoid and said electric ignition element, a normally closed switch means disposed in series with said master switch which is operative when opened to effect deenergization of said solenoid and said electric ignition element, and a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and when cool to maintain said normally closed switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said master switch being operative when open to effect the energization of said transformer.

6. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burner through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, said master switch being operative when closed to effect the energization of said solenoid and said electric ignition element, a normally closed switch means disposed in series with said master switch, a normally open switch means, a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and said normally open switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, an impedance adapted to be connected in series with said master switch, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, said normally closed switch means being operative when closed to connect said primary winding in series with said solenoid and when open to effect the deenergization of said solenoid and said electric ignition means, said normally open switch means being operative

when closed to connect said impedance in series with said master switch, and said master switch being operative when open to effect the energization of said transformer.

7. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, a normally closed supplemental master switch disposed in series with said master switch, said master switch and said supplemental master switch being operative when both are closed to effect the energization of said solenoid and said electric ignition means, a normally closed switch means disposed in series with said master switch, a normally open switch means, a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and said normally open switch means closed, a transformer having a primary winding and a secondary winding, said secondary winding being connected into said thermocouple circuit, said transformer being operative when energized to superimpose an alternating current upon the thermocouple current of sufficient voltage to blanket out the thermocouple current and thereby deenergize said electromagnet, a parallel circuit having two branches, said primary winding being interposed in one of said branches and said master switch and said supplemental master switch being interposed in series in the other of said branches, an impedance, said normally closed switch means being operative when closed to connect said primary winding in series with said solenoid and when open to effect the deenergization of said solenoid and said electric ignition element, said normally open switch means being operative when closed to connect said parallel circuit in series with said impedance, said master switch and said supplemental master switch each being operative when open to effect the energization of said transformer, and a time control mechanism operative to open and close said supplemental master switch at predetermined set times.

8. In an automatic ignition and control apparatus of the character described the combination of a main burner, a pilot burner operative to ignite said main burner, a control burner spaced from said pilot burner, electric ignition means operative when energized to ignite said pilot and control burners, a gaseous fuel supply manifold, a main conduit through which fuel is supplied to said main burner from said manifold, a safety control unit operative to cut off the supply of fuel to said main burner and said pilot and control burners interposed in said conduit between said main burner and said manifold, a branch conduit extending between said safety control unit and said pilot and control burners through which fuel is supplied to said pilot and control burners, a solenoid operatively associated with said safety control unit, said solenoid being operative upon energization to first set said safety control unit in condition to supply fuel to said pilot and control burners while cutting off the supply of fuel to said main burner and upon subsequent deenergization to set said safety control unit in condition to also supply fuel to said main burner, an electromagnet associated with said safety control unit and operative when energized to maintain said safety control unit in said last set condition, a thermocouple adapted to be heated by said pilot burner, an electric circuit between said thermocouple and said electromagnet through which said magnet is energized by said thermocouple when said thermocouple is heated, a manually operable normally open master switch, said master switch being operative when closed to effect the energization of said solenoid and said electric ignition element, a normally closed switch means disposed in series with said master switch which is operative when opened to effect deenergization of said solenoid and said electric ignition element, and a thermostatic element adapted to be heated by said control burner and operative when heated to maintain said normally closed switch means open and when cool to maintain said normally closed switch means closed.

9. An automatic ignition and control apparatus as defined in claim 8 in which said electric ignition means comprises an electric resistance ignition element mounted in position to ignite one of said pilot and control burners, and a flash tube extending between said pilot and control burners and operative to ignite the other of said pilot and control burners from the said one of said pilot and control burners.

10. An automatic ignition and control apparatus as defined in claim 8 in which said electric ignition means comprises an electric resistance ignition element mounted in position to ignite said control burner, and a flash tube operatively associated with said control burner and said pilot burner through which said pilot burner is ignited from said control burner.

11. An automatic ignition and control apparatus as defined in claim 8 in which said electric ignition means comprising an electric resistance ignition element mounted in position to ignite said pilot burner, and a flash tube operatively associated with said pilot burner and said control burner through which said control burner is ignited from said pilot burner.

12. An automatic ignition and control apparatus as defined in claim 8 in which said electric ignition means comprises two electric resistance ignition elements one of which is mounted in position to ignite said control burner and the other of which is mounted in position to ignite said pilot burner.

13. An automatic ignition and control apparatus as defined in claim 8 in which said electric ignition means comprises two electric resistance ignition elements disposed in an electric circuit in series with each other with one of said ignition elements mounted in position to ignite said control burner and the other of said ignition elements mounted in position to ignite said pilot burner.

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