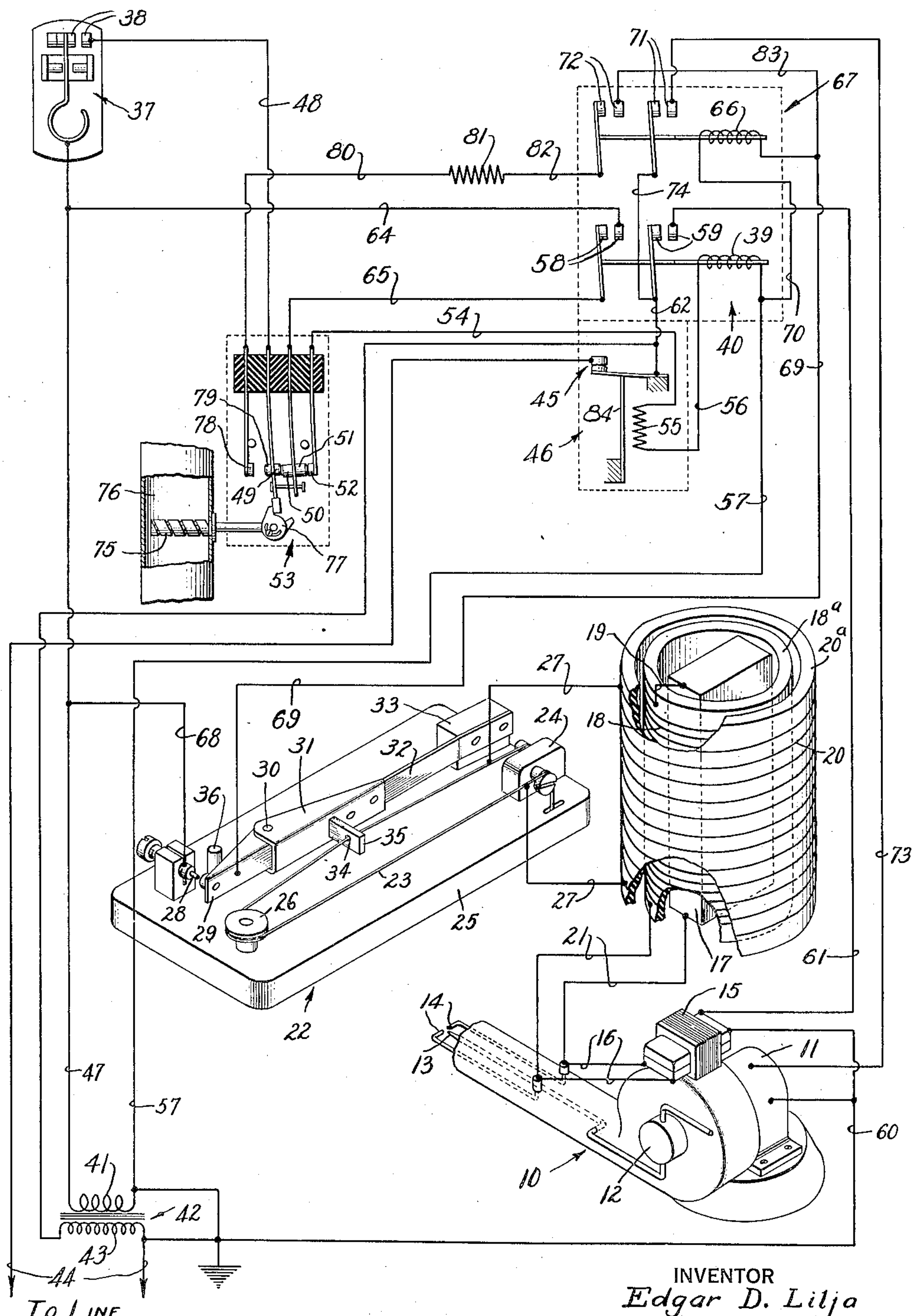
Aug. 9, 1938. E. D. LILJA 2,126,199

FUEL BURNER CONTROL SYSTEM

Original Filed May 11, 1936



INVENTOR
Edgar D. Lilja
BY
Parker, Carlson, Pitzner & Hubbard
ATTORNEYS

Patented Aug. 9, 1938

2,126,199

UNITED STATES PATENT OFFICE

2,126,199

FUEL BURNER CONTROL SYSTEM

Edgar D. Lilja, Rockford, Ill., assignor to Howard D. Colman, Rockford, Ill.

Application May 11, 1936, Serial No. 78,975
Renewed December 30, 1937

2 Claims. (Cl. 158—28)

My invention relates to control systems for fuel burners and more particularly to such systems embodying electrical ignition means for igniting the fuel to initiate operation of the fuel burner.

Difficulty has heretofore been encountered in the operation of fuel burners provided with such control systems since dangerous explosions are likely to occur if the operation of the ignition means is inadvertently delayed until a substantial quantity of fuel has been delivered to the burner. That is, if a spark of the proper intensity is produced immediately when the burner motor is started or before any substantial quantity of fuel has been discharged into the fire box, satisfactory ignition will take place. If, on the other hand, a spark of proper intensity is produced only after a comparatively large quantity of fuel has been supplied to the burner, there is danger of an explosion.

The primary object of my invention is to provide a control system for fuel burners including an improved detector arrangement operable in response to an electrical discharge of sufficient intensity to ignite the fuel and adapted to control the burner fuel supply mechanism in a manner such as to avoid the possibility of an explosion in case the igniter does not function properly.

More specifically, it is an object of my invention to provide an ignition detector arrangement for use in the control system described for fuel burners in which an oscillatory current is set up by the electrical discharge in the ignition means and is utilized to condition the fuel supply of the burner for operation, the oscillatory current being of a relatively high frequency as compared to the frequency of the current supplied to the ignition means.

Further objects and advantages of my invention will become apparent as the following description proceeds and the features of novelty which characterize my invention are pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawing in which the single figure is a diagrammatic representation of a fuel burner control system embodying my invention and showing particularly the circuit connections therefor.

In the exemplary form shown in the drawing, my invention is embodied in a control circuit adapted to control the operation of a conventional liquid fuel burner 10 in accordance with the temperature requirements of a room or other compartment supplied with heat from the burner. The burner 10 includes an electric motor 11 which serves to drive a pump 12 that supplies liquid fuel to a burner nozzle 13.

It is desirable that some arrangement be provided for automatically igniting the fuel discharged from the nozzle 13 when operation of the burner is initiated. Accordingly, a pair of electrodes 14 are arranged in spaced relation adjacent the open end of the nozzle. An electrical discharge is produced between the electrodes by a suitable step-up ignition transformer 15 having inductively coupled primary and secondary windings. The electrodes 14 are connected across the secondary winding of the ignition transformer 15 by conductors 16. The primary winding of the transformer 15 is connected to a source of electrical energy through a control circuit hereinafter described, which is adapted to effect cyclic operation of the fuel burner.

In accordance with my invention, I have provided an arrangement for controlling the fuel supply means of the burner 10 which is responsive to the passage of a substantially continuous electric discharge between the electrodes 14 of sufficient intensity to ignite the fuel. This arrangement preferably includes an auxiliary circuit to which energy is transferred in response to changes in voltage or current at the electrodes 14, a capacitance and a coupling coil of low mutual inductance associated with the auxiliary circuit being utilized to render the auxiliary circuit resonant at a comparatively high frequency and thereby prevent the transfer of appreciable energy to the auxiliary circuit at the frequency of the power supply to the ignition transformer 15. By comparatively high frequency is meant a frequency high as compared to the frequency of the power supply for the transformer 15. Such a capacitance or inductance renders the detector arrangement insensitive to the open-circuit voltage and short-circuit current of the ignition gap while rendering it sensitive to impulses of energy transferred as a result of a discharge of predetermined intensity between the electrodes. Thus, a circuit including a capacitance and an inductance may be associated with the electrodes in such manner that an oscillatory current is set up therein upon the passage of an electrical discharge of predetermined intensity between the electrodes 14. This oscillatory current may then be utilized to control the operation of the motor 11 of the burner 10.

In the construction illustrated, a condenser

17 is disposed within an air core inductance coil 18 and is connected in series relation therewith by conductor 19. The coil 18 is wound on a cylindrical insulating core 18a. A second air core inductance coil 20 is arranged concentrically about the inductance coil 18 and is inductively coupled therewith. The coil 20 is wound on a cylindrical insulating core 20a. The windings 18 and 20, and condenser 17 thus form a compact unitary structure. The series connected winding 18 and condenser 17 are connected in shunt relation with the electrodes 14 by conductors 21. Consequently, upon the occurrence of a spark at the electrodes 14, a damped oscillatory current flows in the circuit including the condenser 17 and inductance coil 18. This current flowing through the inductance coil 18 induces a high frequency voltage in the secondary winding 20 which is utilized to control the operation of the fuel burner 10 as is described below.

It is desirable that fuel should be supplied to the burner 10 only in case a sustained electrical discharge of predetermined intensity is produced across the electrodes 14 as contrasted with a single unrepeated discharge or weak continuous discharge which would not insure proper ignition of the fuel subsequently supplied to the nozzle 13. Consequently, I prefer to utilize the voltage induced in the secondary winding 20 to operate what may conveniently be termed an integrating circuit control device; that is, a circuit control device which is responsive to the integrated rather than the instantaneous value of an electrical characteristic such as voltage or current.

In the control circuit illustrated, an electrothermal relay 22 serves as the integrating circuit control device. The relay 22 includes a U-shaped conductor or wire 23 having its ends secured to the opposite sides of an insulating projection 24 on the base 25 and passing over a peripherally grooved insulating disk 26 also mounted on the base 25. The conductor 23 has a comparatively high resistance as well as a high coefficient of thermal expansion. The terminals of the secondary winding 20 are connected to the ends of the conductor 23 by conductors 27. Consequently, the voltage induced in the secondary winding 20 will cause a current to flow through the conductor 23 and heat the same. When a sustained electrical discharge of predetermined intensity sufficient to ignite the fuel passes between the electrodes 14, the integrated heating effect of the current flowing through the conductor 23 will result in a sufficient expansion of the conductor 23 to cause it to operate a circuit controlling device. The electro-thermal relay is preferably so proportioned as to effect fairly rapid actuation thereof when a discharge of the required intensity or ignition value is produced.

The circuit controlling elements of the electrothermal relay 22 include a pair of normally open contacts 28. One of these contacts is mounted on the base 25 and the other is secured to a movable supporting arm including a channel-shaped outer link 29, which is pivotally connected by a pin 30 to a second channel-shaped link 31. The link 31 is in turn rigidly secured to the outer end of a flexible spring arm 32 fixed at its other end to a projection 33 on the base 25. The conductor 23 passes through an aperture 34 formed in a projection 35, which extends laterally from link 29 through the side of link 31.

The parts of the relay are so arranged that the resilient arm 32 normally tends to swing the links 31 and 29 in a direction to close the contacts 28. The conductor 23 passing through the aperture 34 in the projection 35 is made short enough, however, so that the contacts 28 are normally maintained open, the arm 32 being flexed toward the conductor 23. It will thus be seen that when the conductor 23 is heated by the passage of a sustained current therethrough, its consequent elongation will permit the contacts 28 to be closed by the resilient arm 32.

Since accidental breakage of the conductor 23 would result in the same motion of the arm 32 as is caused by heating of the conductor, an arrangement has been provided to prevent sustained closure of the contacts 28 in case of such breakage. This arrangement includes a pin 36 rigidly secured to the base 25 and spaced a sufficient lateral distance from the link 29 that it does not engage the same during the normal operation of the relay. Upon breakage of the conductor 23, however, the arm 32 and its attached links 31 and 29 swing in a clockwise direction farther than during their normal movement and, consequently, the link 29 is brought into contact with the pin 36. As a result, the link 29 is swung about its pivot 30, upon being pressed against the pin 36, so that the contacts 28 are maintained in open position.

Contacts 28 are closed momentarily during the abnormal motion of link 29, but not long enough to initiate operation of the burner.

I have shown, for purposes of illustration, a specific preferred form of burner control in connection with the improved ignition detecting arrangement described, but it should be understood that any desired main control may be used. In the specific arrangement illustrated, the control circuit is conditioned for operation by a main switch exemplified as a bimetallic thermostatic switch 37 which may be conveniently located within the chamber or room to be heated.

The exemplary control circuit is adapted to supply electrical energy to the ignition transformer 15 upon closure of contacts 38 of the thermostatic switch 37, when the temperature of the chamber in which the switch is located falls to a predetermined value. Thus, upon closure of the contacts 38, actuating winding 39 of an ignition control relay 40 is energized by current supplied thereto from secondary winding 41 of a transformer 42.

Primary winding 43 of the transformer 42 is connected to a suitable source of alternating current 44, such as a household lighting system, through normally closed contacts 45 of a thermal safety switch 46. One terminal of the relay winding 39 is connected to the transformer 42 by a circuit including a conductor 47 extending from the transformer secondary winding 41 to the thermostatic switch 37, contacts 38, conductor 48, normally closed contacts 49—50 and 51—52 of a combustion responsive switch mechanism 53, conductor 54, heating coil 55 of the safety switch 46, and conductor 56. The other terminal of the relay winding 39 is connected to the second terminal of the power transformer secondary winding by a conductor 57. Consequently, upon closure of the contacts 38 of the thermostatic switch 37, the energizing circuit for the relay winding 39 is completed and contacts 58 and 59 of the ignition relay 40 are closed.

The closure of ignition relay contacts 59 completes an energizing circuit for the primary winding of the ignition transformer 15. Thus, one terminal of the primary winding of the ignition transformer is permanently connected to one side of the power supply line **44** by a conductor **60**. The other terminal of the transformer primary winding is connected to the other side of the supply line **44** through a conductor **61**, contacts **59**, conductor **62** and contacts **45** of safety switch **46**.

The contacts **58** of the ignition control relay **40** serve to shunt out the main thermostatic switch **37** from the control circuit of the ignition control relay. Thus, upon closure of the contacts **58**, the thermostatic switch is shunted out of the energizing circuit of the relay winding **39** by conductors **64** and **65**.

Upon energization of the ignition transformer **15** described, an electric discharge is produced between the electrodes **14** and a high frequency voltage is induced in the secondary winding **20** of the ignition detector. After the high frequency current has flowed through the conductor **23** of the electro-thermal relay **22** for a sufficient time, the conductor **23** is elongated due to thermal expansion so as to permit the closure of contacts **28**.

The contacts **28** are associated with the energizing circuit of the burner motor **11** in such manner that the burner motor is conditioned for operation upon the closure of these contacts. Thus, the energizing circuit of actuating winding **66** of a motor control relay **67** is completed upon closure of the contacts **28**. Current is supplied to the winding **66** from one terminal of the secondary winding **41** of the transformer **42** through conductor **47**, conductor **68**, contacts **28** and conductor **69**. The other terminal of the secondary winding **41** of the transformer **42** is permanently connected to the relay winding **66** through conductors **57** and **70**.

Energization of the winding **66** causes the closure of contacts **71** and **72** of the motor control relay **67**, which in turn results in the energization of burner motor **11**. Thus, one terminal of the motor **11** is permanently connected to one side of the supply line **44** through conductor **60**, while the other terminal of the motor **11** is connected to the other side of the supply line **44** through conductor **73**, contacts **71**, conductors **74** and **62** and contacts **45** of safety switch **46**. The motor **11** is thus set in operation and fuel is supplied under pressure to the nozzle **13** where it is ignited by the electrical discharge between the electrodes **14**.

It will be seen that if a sustained electrical discharge of predetermined strength is not had at the electrodes **14**, either because of short circuiting of the gap or failure of the gap voltage due to any other cause, the conductor **23** will not be heated sufficiently to permit closure of the contacts **28**. In such case, the motor control relay **67** will not be energized and no fuel will be supplied to the nozzle **13**. Hence, with the circuit arrangement described, the existence of a suitable ignition discharge at the electrodes **14** is a positive prerequisite to the operation of the burner fuel supply means.

If satisfactory operation of the ignition means is not had within a predetermined time, contacts **45** of the safety switch **46** are opened, disabling the entire control system as is hereinafter described. The safety switch **46** can only be reclosed by subsequent manual operation so that the attention of the operator is drawn to the failure of the ignition apparatus to operate properly.

The combustion responsive switch **53** is adapted to remove the motor control relay **67** from the control of the ignition detecting device and place it under the control of the main thermostatic switch **37** as well as subsequently to deenergize the ignition transformer **15** in the event of successful ignition of the fuel. In order to effect this operation, the mechanism **53** is of the usual thermostatic type comprising a bimetallic thermostatic member **75** located within the furnace flue or stack **76**, which is heated by the products of combustion leaving the furnace. When the thermostatic element **75** becomes heated, it rotates an actuating member **77** in a counterclockwise direction, thus opening the contacts **49** and **50**. Upon further rotation of the actuating member **77**, contacts **78** and **79** are closed, thus completing an energizing circuit for the actuating winding **66** of the motor control relay **67** independent of the electro-thermal relay contacts **28**. This circuit extends from the secondary winding of the transformer **42** through conductor **47**, contacts **38** of the main switch **37**, conductor **48**, contacts **78—79**, conductor **80**, protective resistance **81**, conductor **82**, contacts **72** of the motor control relay **67**, and conductor **83** to one terminal of winding **66**. The other terminal of the relay winding **66** is, of course, permanently connected to the transformer **42** through conductors **57** and **70**.

Upon further rotation of the actuating member **77** of stack switch **53**, contacts **51—52** are opened, breaking the energizing circuit of the actuating winding **39** of the ignition control relay **40**. The winding **39** is thus deenergized permitting the contacts **58** and **59** to open, which in turn breaks the energizing circuit of the ignition transformer **15**. The electrical discharge between the electrodes **14** is thus terminated when the heating of the switch **53** indicates that satisfactory ignition of the fuel has been effected.

From the foregoing, it will be seen that the energizing circuit of the motor control relay **67** is in this part of the cycle, controlled by the contacts **38** of the main thermostatic switch **37**. After the fuel burner has been in operation for a sufficient length of time to raise the chamber temperature above the control point of the thermostatic switch **37**, the contacts **38** are again opened. The energizing circuit for actuating coil **66** of the motor control relay **67** is thus broken, thereby opening contacts **71** and **72** and in turn deenergizing the burner motor **11** to shut off the burner. The cycle described above is repeated at intervals in order to maintain the temperature of the chamber being heated within predetermined temperature limits.

It will be noted that the heating coil **55** of the safety switch **46** is energized immediately upon the initiation of the control cycle by the main control thermostatic switch **37**. This heating coil **55** is so positioned with respect to a bimetallic thermostatic latch **84** that the latter will be heated so as to permit the contacts **45** of the safety switch to open after a predetermined length of time. Thus, if satisfactory ignition is not had within a predetermined interval of time, the contacts **45** of the safety switch **46** will be opened, deenergizing the actuating winding **39** of the ignition control relay **40** and rendering the apparatus inoperative until the safety switch **46** is manually reset. If satisfactory ignition of the fuel is effected, however, the energizing circuit for the heating coil **55** of the safety switch is opened by contacts **51** and **52** of the combustion responsive switch **53**.

It will thus be seen that I have provided a compact and simple arrangement for positively controlling the fuel supply of a fuel burner in such manner that no fuel will be supplied to the burner until satisfactory operation of the ignition means thereof is had. Moreover, the circuit arrangement of the improved ignition detector means is such that normal cyclic operation of the burner under control of a main thermostatic switch is permitted.

Although I have shown a particular embodiment of my invention in connection with a liquid fuel type burner, I do not intend to limit the invention to the particular construction shown and described but aim to cover all modifications falling within the spirit and scope of the invention as expressed in the appended claims.

I claim as my invention:

1. A control system for a fuel burner comprising, in combination, electric motor driven means for supplying fuel to the burner, a supply circuit for said means, a spark igniter circuit including spark electrodes associated with said fuel supply means and a low frequency current supply for said electrodes, a high frequency circuit associated with said ignition circuit and energized to high frequency oscillations solely by normal spark at said electrodes, a thermally operated time delay switch having the heating element thereof energized solely by said high frequency circuit, said time delay switch having its contacts arranged to control said first-named circuit whereby to initiate fuel supply to the burner only after a sustained normal spark has occurred at said electrodes.

2. A control system for a fuel burner comprising, in combination, means for supplying fuel to the burner, a spark igniter circuit including spark electrodes associated with said fuel supply means and adapted to be connected to a low frequency current supply source, a high frequency circuit associated with said ignition circuit and energized by high frequency oscillations solely by normal sparking between said electrodes, and control means responsive only to a sustained energization of said high frequency circuit for a predetermined time interval for governing said fuel supply means whereby to initiate fuel supply to the burner only after a sustained normal spark has occurred at said electrodes.

EDGAR D. LILJA.