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SAFETY CONTROL FOR PORTABLE HEATERS AND LIKE EQUIPMENT

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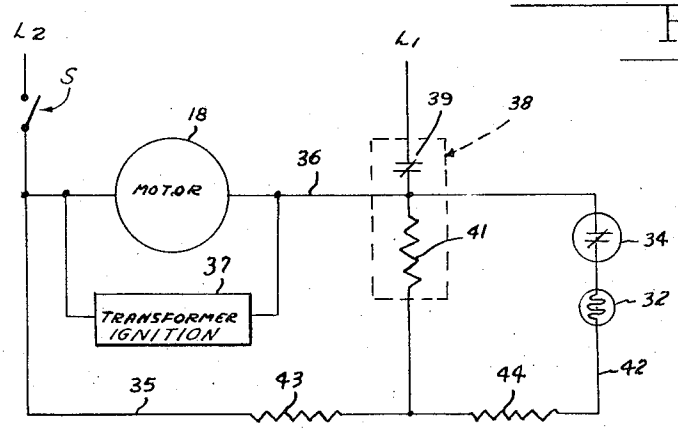
Fig-1



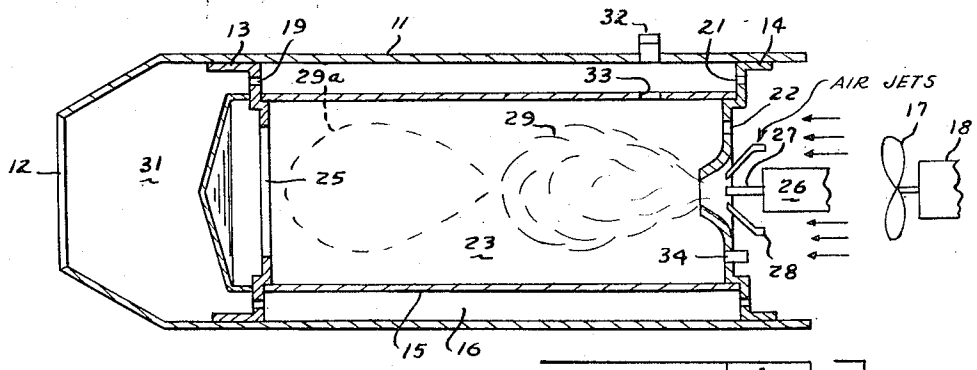


Fig-2

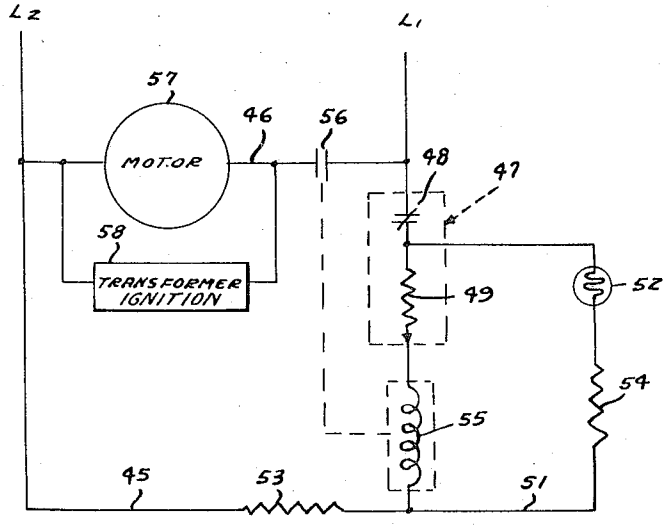


Fig-3

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SAFETY CONTROL FOR PORTABLE HEATERS AND LIKE EQUIPMENT

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This invention relates to safety controls in fuel burning apparatus, having particular although not limited reference to portable space heaters.

A primary object of the invention is to provide a safety control for space heaters and like equipment which is economical to fabricate, most efficient and satisfactory in use, adaptable to a wide variety of applications and unlikely to malfunction.

An additional object of the invention is to provide improved means to shut down a heater automatically in the event of faulty ignition, loss of flame, or improper burning as from insufficient air.

Another object of the invention is to provide safety control means for a heater as described functioning through a continuous monitoring of the combustion chamber for the presence or absence of a proper flame, it being an attendant object in this connection to use light sensitive means stable in operation, quick in response and having general utility in fuel burning apparatus.

A further object of the invention is to provide a fail-safe electrical control circuit for fuel burning apparatus featuring use of a resistance heater with a thermally sensitive circuit breaker and a light sensitive cadmium sulfide cell, the latter serving to shift a major part of current flow in the bypassing relation to the heater in the presence of combustion flame light while maintaining minor current flow continuously through the heater, thereby conditioning the heater for quick response in the event of flame loss.

Still another object of the invention is to incorporate other controls in an electrical circuit as described, such as means opening a main motor circuit in the event of failure of the main circuit, which means is unaffected by the cadmium cell bypass described.

A still further object of the invention is to provide a control circuit obviating the need for use in space heaters of plural fail-safe relay opening devices.

A further object of the invention is to provide safety control means as described utilizing a simple circuit and relatively few parts as compared to similarly applicable systems of the prior art.

A further object of the invention is to provide a safety control system for heaters possessing the advantageous structural features, the inherent meritorious characteristics and the mode of operation herein mentioned.

With the above and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

Referring to the accompanying drawing wherein is shown one but obviously not necessarily the only form of embodiment of the invention,

FIG. 1 is a diagram illustrating, in circuit form, a first illustrated embodiment of the invention;

FIG. 2 is a diagrammatic view, in longitudinal section, of the fuel burning portion of a portable space heater, showing elements of the invention as installed therein; and

FIG. 3 is a view similar to FIG. 1, showing a second illustrated form of the invention.

Like parts are indicated by similar characters of reference throughout the several views.

Although generally applicable, as noted, to fuel burning systems, the invention is illustratively disclosed in connection with a portable space heater, a device in common use as an article of contractors equipment for temporary heating and drying purposes.

Viewing FIG. 2 of the drawings, the combustion section of such a heater may comprise an outer cylindrical housing **11**, the left hand end of which is slightly tapered and formed with a central axial discharge opening **12**. Fixed within the housing **11**, at longitudinally spaced apart locations, are end plates **13** and **14** mounting an inner tubular housing **15** which defines a combustion chamber **23**. The latter is in concentric spaced relation to the outer housing **11** and defines therewith an annular chamber **16**.

The right hand or opposite end of the outer cylindrical housing **11** is open and receives, in the operation of the apparatus, a draft of forced air, as from a fan **17** driven by a motor **18**. The air flows longitudinally through the annular chamber **16**, by virtue of openings **19** and **21** in the respective end plates **13** and **14**. The end plate **14** also affords a circumferential series of openings **22** by which air may enter the interior of the housing **15** and the combustion chamber **23**. Still further, end plate **14** has an outstruck portion **24** defining a central through opening therein while end plate **13** has a central through opening **25**. Fuel is brought to the combustion chamber **23** through a projecting nozzle **27** on a burner means **26**. The nozzle projects partly within the central opening through end plate **14**. Incorporated in the nozzle are educator means **28**, shown schematically in a flanking angular relation to the main flow passage defined by the nozzle **27**. The educator means discharge jets of air to draw, mix with and atomize fuel in delivery thereof through the central opening in the end plate **14**. The nozzle together with eductors **28** discharge a combustible fuel-air mixture into the chamber **23**, where, after initial ignition, continuous burning occurs, schematically represented in the drawings by a flame **29**.

In operation of the described heater convection heat current issue from the opening **12**. Other heat radiates from the surface of the housing **11**.

As long as secondary air is induced by fan **17** to flow through openings **22**, and such flow continues at the planned rate, the flame **29** will remain substantially in the position indicated in FIG. 2 of the drawings, full burning thus occurring at what may be considered the rear of the combustion chamber or that portion thereof near the end plate **14**. In the event of fan misoperation, however, or blocking of the openings **22**, the inflow of secondary air becomes inadequate to support flame at the rear of the combustion chamber and the flame moves forward, as to a position as indicated at **29***a*, seeking air in advance of end plate **13** from the chamber **31** adjacent the discharge opening **12**. Combustion becomes unsteady and inadequate for proper heating and it is desirable under these conditions to shut down the heater.

It similarly is desirable to shut down the heater in the event of fuel exhaustion or of blocking of the fuel nozzle **27**. In any event the invention is concerned with automatic controls for this purpose.

Safety control apparatus in accordance with the instant invention includes a cadmium sulfide cell **32** installed in the outer housing **11** to sight into the combustion chamber **23** through an opening **33** in the wall of inner housing **15**. Cell **32** and aligned opening **33** are located toward the rear of combustion chamber **23** so that the cell is in an optimal position to sense the presence or absence of a flame **29**. Should the flame **29** be extinguished, or should the rear of combustion chamber **23** be otherwise darkened, as by the flame moving outward to the position **29***a*, the

absence of light is recognized by the cell 32 with results hereinafter to be described.

The described safety control apparatus is incorporated in a control circuit which may further include a thermally sensitive switch device 34 suitably installed in the burner apparatus, as in the end plate 14, to sense the temperature in the combustion chamber or of the parts defining such chamber. As will hereinafter more clearly appear, the function of part 34 is to shut down the fuel burning apparatus in the event of achieving of an undesirably high temperature value in the area of the combustion chamber.

Referring now to FIG. 1, safety control mechanism in accordance with the invention is incorporated in an electrical circuit including lines L1 and L2 leading from a source of electrical power. Lines L1 and L2 are connected by a conductor 35 and bridged by a conductor 36. Conductor 36 incorporates a motor 18 and, across the motor, an ignition transformer 37, the latter comprising, with the motor, the electrical power means of the fuel burning apparatus. Lines L1 and L2 and their bridging circuits including conductors 35 and 36 are selectively energized, as through conventional thermostatic or manual on-off switches. When so energized, a circuit is closed through motor 18 and transformer 37 and the fuel burning apparatus begins to operate, air being forced through the outer housing 11 and a spark being supplied for ignition of the combustible mixture discharging through the central opening in end plate 14. The motor 18 may also be considered as supplying air pressure for the eductors 28, and may provide a motive power for pumping fuel to the burner means 26 when the heater is of a class to supply fuel in this manner.

Line L1 of the described circuit includes or has installed therein a circuit breaking assembly 38 comprising a circuit breaker switch 39 and a resistance heater coil 41. Switch 39 is a conventional thermally sensitive circuit breaker which, however, instead of being made sensitive to motor temperature or to some other variable, is made responsive to a selected high thermal output of the resistance coil 41. According to the operation of the circuit breaker assembly 38, therefore, the energizing of lines L1 and L2 has the effect not only of closing a circuit across motor-transformer circuit 36 but also of heating coil 41. In the absence of some overriding control, the temperature of coil 41 quickly rises to a value to open circuit breaker 39 whereupon the circuit through L1 is open and the electrical power means represented by motor 18 and transformer 37 is shut down.

The overriding control circuit includes the previously mentioned cadmium sulfide cell 32 and is represented by a bypassing branch circuit 42 which is joined to line L1 on opposite sides of the heater coil 41. The cadmium cell 32 is disposed in the branch circuit 42, as is the aforementioned thermally sensitive switch 34. The devices 32 and 34 are in a series relation, the latter being an optional control useful in installations subject to overheating as described. The cadmium cell 32 incorporates, as will be understood, electrical resistance means affected by light in a manner to have a high resistance in the dark and to have a lowered resistance in the presence of light.

The cell 32 and the heater coil 41 are in a parallel relation to one another the cell being shunted across this heating element of the breaker. Upon initial energizing of lines L1 and L2, the interior of combustion chamber 23 is dark so that the resistance of cell 32 is high. Current flow accordingly takes place through the coil 41 in bypassing relation to cell 32 and motor 18 and transformer 37 are thus energized. Ignition will normally occur before coil 41 reaches a temperature value sufficient to open circuit breaker switch 39. Flame in the chamber 23 then creates light which is sighted by the cell 32 through opening 33 whereupon the electrical resistance imposed by the cell drops substantially. Current flow in the system is accordingly, to a major extent, immediately shunted or bypassed through the branch circuit 42 and around heater coil 41 which thus is not permitted to reach the temperature value required to open the circuit breaker. According to a feature of the invention, the resistance imposed by cell 32 is of a degree that a minor part of the total current will continue to flow through the coil 41. The coil accordingly is kept warm or partly heated so that if the major current flow shifts again back to the main circuit through the heater coil the response in opening circuit breaker 39 will be prompt. The circuit provides that only a relatively small change in current through the coil 41 will cause tripping of the breaker 39.

Thus, a return shift of major current flow away from branch circuit 42 and back through heater coil 41 will occur upon a break in the circuit 42 or upon cell 32 sensing extinguishing of the flame 29 or a moving forward of the flame due to an insufficient secondary air supply as described. In the first event current flow through the branch circuit is cut off. In the latter two events the cell 32 senses an absence of light and its resistance consequently rises with a corresponding increase in current flow through the coil 41. The result in either case, whether the shift in current flow is due to a break in the line 42 or to an increase in resistance of cell 32, is to bring about an opening of circuit breaker 39 and a shutting down of the operating system. The directing of a major part of current flow either through the heater coil 41 or in a bypassing relation thereto accordingly is primarily a function of the resistance of cell 32 which in turn operates by sensing the presence or absence of flame light in the combustion chamber 23.

What may be considered the main or starting circuit of the system, including the heater coil 41, incorporates a resistor 43. It has a resistance of an ohm value selected to reduce the voltage both during starting and running to maintain the system at a fail-safe operating value through an operating range of selected voltage, as 98 to 135 volts. The running circuit further includes a resistor 44 which in further dropping the voltage applied across the cadmium sulfide cell 32 reduces the likelihood of damage thereto. It enables a safe operating range in the cell portion of the circuit, permitting use of an inexpensive cell device. In the preferred embodiment illustrated the load resistor 43 related to breaker 39 has an ohm value about twice that of control resistor 44 which is related to the cadmium cell.

The modification of FIG. 3 is similar to the circuit of FIG. 1 in that it provides a main circuit comprising lines L1 and L2, an interconnecting conductor 45, a motor-transformer bridging circuit 46 and a circuit breaker assembly 47 comprising a circuit breaker switch 48 and a resistance heater coil 49. Further, the system comprises a bypassing circuit 51 which includes a cadmium cell 52 and which may include a thermally sensitive switch corresponding to the switch 34 of FIG. 1. The main and bypassing circuits further include resistors 53 and 54 corresponding in position and function to the resistors 43 and 44 of FIG. 1.

The system of FIG. 3, however, further includes a relay switch comprising an electro magnetic coil 55 and a switch 56 operated thereby. The coil 55 is disposed in the main circuit in a series relationship to the heater coil 49 while switch 56 is in the motor-transformer circuit 46. The switch 56 is normally open and is closed by an energizing of coil 55. The latter is in turn energized by either minor or major current flows so that it is continuously powered both in the starting and running of the system to maintain the switch 56 in a closed condition. In the event of a break anywhere in the main circuit, coil 55 is de-energized and switch 56 opens to shut down motor 57 and transformer 58.

The relay has particular value in recognizing and responding to a break in the main circuit, as for example to a break between electro magnetic coil 55 and heater coil 49. In the absence of the instant arrangement, such

a break would disable the heater coil **49** but would allow continued running through the branch circuit **51**. This would be undesirable since the cadmium cell **52** could not then perform its function of signalling a loss of flame to the circuit breaker assembly **47**. The arrangement makes unnecessary the use of a second relay in the circuit **51**. In the event of a break in this circuit, major current flow is shifted back to the main circuit with coil **49** being thereby heated and opening circuit breaker **48**. The modification of FIG. 3 is like that of FIG. 1 in the maintaining of a minor current flow through the main circuit even in the presence of a lowered resistance in cell **52**. Thus when the cadmium cell recognizes and responds to the presence of flame light in the combustion chamber by dropping its resistance, major current flow shifts from the major circuit to the bypass circuit but minor current flow is continued through the main circuit. In both the instances of FIGS. 1 and 3 this minor flow in effect maintains the heater coil in a warmed or preheated condition. A relatively small change in resistance of the cadmium cell is thus necessary to trip the circuit breaker. In the instance of FIG. 3 the minor current flow is adequate, as described, to maintain relay coil **55** energized to keep the switch **56** closed.

Thus, the safety controls provided are of an exceedingly simple nature. Their cost is so minimal that they reduce by more than 50% the cost of conventional controls directed to the same purpose. It is noted that an inherent feature of the invention embodiments is that circuit components will always function in proper sequence. Moreover, the controls, in the event of need, will trip the breaker twice as fast as will conventionally designed controls. This is highly important as a safety factor.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise but one of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention I claim:

1. In a safety control circuit for a space heater or like equipment including a housing having means forming therein a combustion chamber having opposite ends, one end being open to atmosphere, syphon nozzle means at the opposite end, means for causing delivery of fuel through said nozzle activated by a power means, means for blowing secondary air through said housing from said opposite end toward and through said one end, a main circuit segment for delivery of power to said power means, said housing having a lateral opening near said opposite end, light sensitive means mounted to sight through said opening for the presence or absence of flame light in said combustion chamber, said light sensitive means providing increased electrical resistance in responsive either to extinguishing of the flame or to a projecting forward of the flame in the chamber due to insufficient secondary air, the flame being normally in the said opposite end of said chamber in line with said lateral opening and moving forwardly toward the said one end of said chamber attempting to draw air through the open end of said chamber to support combustion upon a lack of secondary air, said chamber having a length to enable said flame to move forwardly a distance placing it out of line with said lateral opening, and a branch electrical control circuit segment incorporating said light sensitive means, said main circuit segment including a thermally sensitive circuit breaker and a heater therefor, said light sensitive means being in the branch circuit in bypassing relation to said heater and functioning to induce said heater to open said thermally sensitive switch in absence of sensing flame light in said combustion chamber.

2. In a safety control circuit for a space heater or like equipment including an elongated housing open at its opposite ends, and inner housing received in and spaced from said outer housing and defining therebetween an elongated air chamber, the interior of said inner housing defining a combustion chamber, a plate received in one end of said outer housing in a closing relation to the corresponding one end of said inner housing, said plate having centrally thereof an opening to discharge therethrough into one end of said combustion chamber a combustible mixture of air and fuel, syphon nozzle means arranged to discharge air and fuel through said central opening of said plate as described, means for blowing secondary air into said outer housing through said one end thereof, the air flowing through said elongated air chamber toward the opposite end of said outer housing, the opposite end of said inner housing being foreshortened relatively to said outer housing whereby air from said air chamber has access to the outer end of said combustion chamber, said plate further having openings for admission of secondary air into said combustion chamber, said means for blowing said secondary air including an electrical motor, an electrical circuit segment for delivering power to said motor, said inner housing having a lateral opening therein near said one end thereof in adjacent relation to said plate, light sensitive means mounted in said outer housing to sight across said air chamber through said opening for the presence or absence of flame light in said combustion chamber, said light sensitive means providing increased electrical resistance in response either to extinguishing of the flame or to a projecting forward of the flame in the combustion chamber due to insufficient secondary air, the flame being normally in the inner end of said chamber in line with said lateral opening and moving forwardly toward the other end of said chamber upon a lack of secondary air, attempting to draw air through said other end of said combustion chamber from said air chamber and from the open opposite end of said outer housing, said combustion chamber having a length to enable said flame to move forwardly a distance placing it out of line with said lateral opening, and a branch electrical control circuit segment incorporating said light sensitive means, said motor circuit segment including a thermally sensitive circuit breaker and a heater therefor, said light sensitive means being in the branch circuit in bypassing relation to said heater and functioning to induce said heater to open said thermally sensitive switch in absence of sensing flame light in said combustion chamber.

3. In a space heater or like equipment including a housing having opposite ends one of which is open to the atmosphere, means forming therein a combustion chamber having correspondingly oriented opposite ends each of which includes an opening, syphon-type nozzle means arranged to discharge fuel into the one end of said chamber remote from said open end of said housing, means for causing delivery of fuel through said nozzle activated by a power means, means for igniting the fuel delivered from said nozzle to produce a flame in said chamber, means for blowing air through said housing to support the combustion initiated thereby, a main circuit segment for delivery of power to said power means, said housing having a lateral opening near its end opposite said one end thereof, light sensitive means mounted to sight through said lateral opening and into said one end of said combustion chamber for the presence or absence of flame light in said combustion chamber, said light sensitive means providing increased electrical re-

sistance in response either to extinguishing of the flame in the combustion chamber or to a projecting forward of the flame in the chamber due to insufficient combustion air, the flame being normally in the said one end of said chamber in sight of said lateral opening and moving forwardly toward the opposite end of the chamber attempting to draw air through the opening in the opposite end of said chamber to support combustion upon a lack of combustion air, said chamber having a length to enable said flame to move forwardly a distance placing it out of sight of the lateral opening and a branch electrical control circuit segment incorporating said light sensitive means, said main circuit segment including a thermally sensitive circuit breaker and a heater therefor, said light sensitive means being in the branch circuit in bypassing relation to said heater and functioning to induce said heater to open said thermally sensitive switch in absence of sensing flame light in said combustion chamber and thereby to immediately terminate the delivery of fuel from said nozzle means.

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