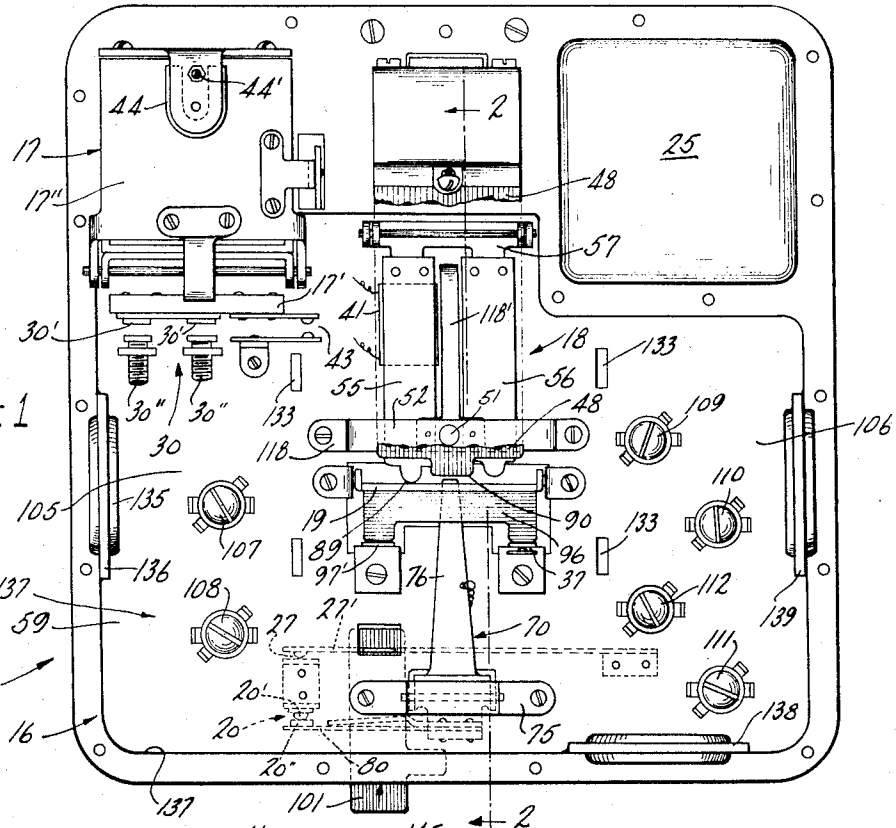
June 20, 1944. H. E. MALONE 2,351,622

FUEL BURNER SYSTEM

Filed June 22, 1940 3 Sheets-Sheet 1

Fig: 1



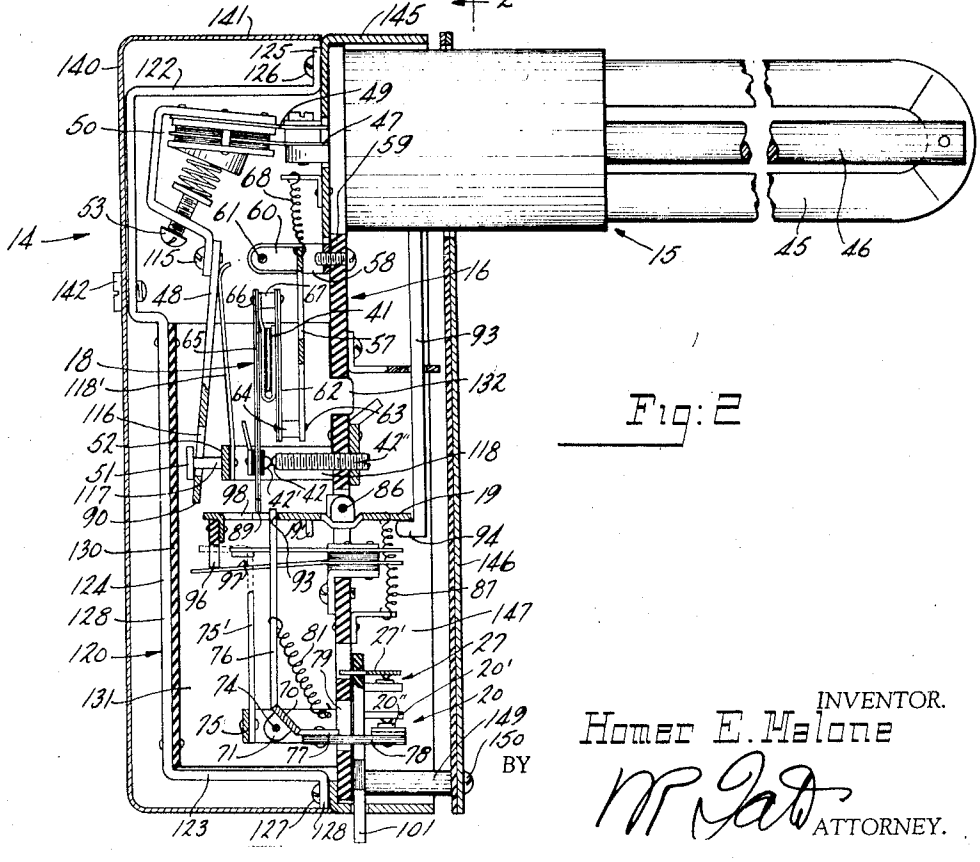


Fig: 2

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FUEL BURNER SYSTEM

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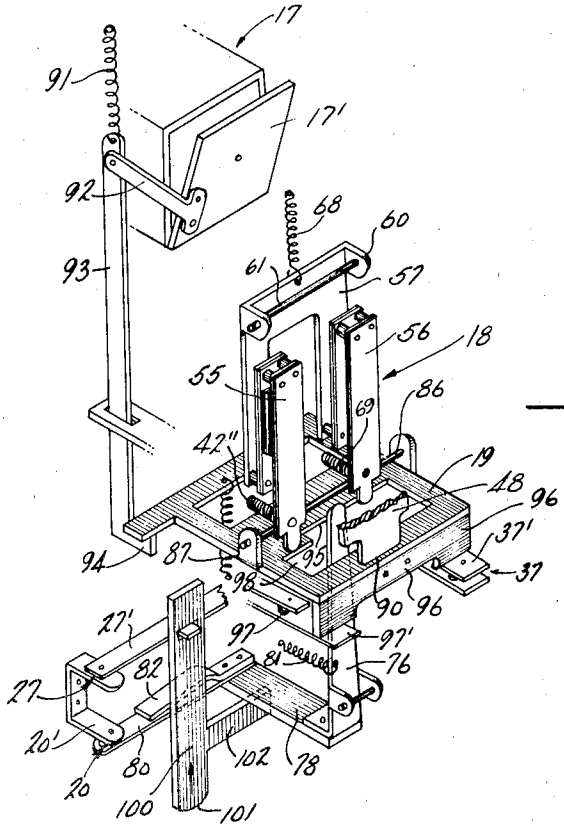
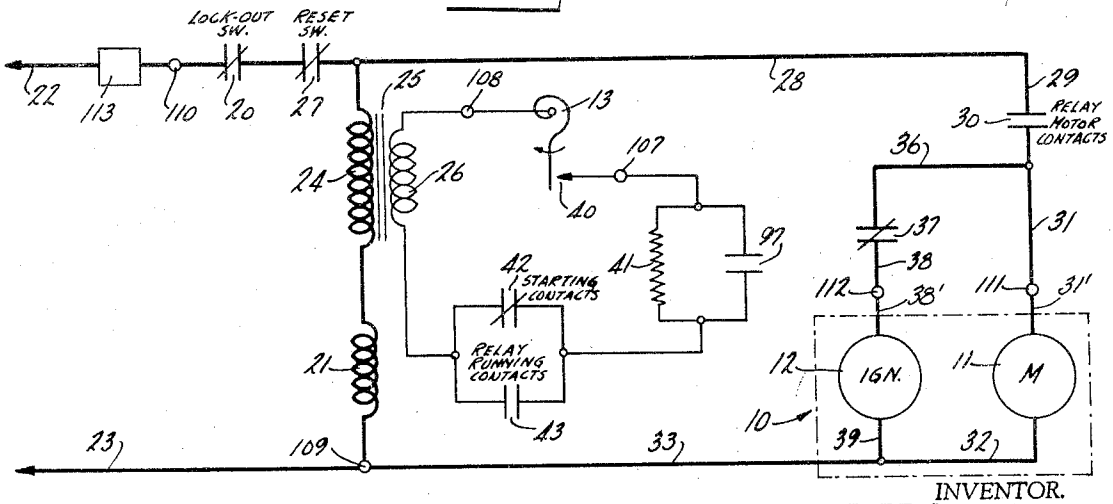



Fig: 3

Fig: 7




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FUEL BURNER SYSTEM

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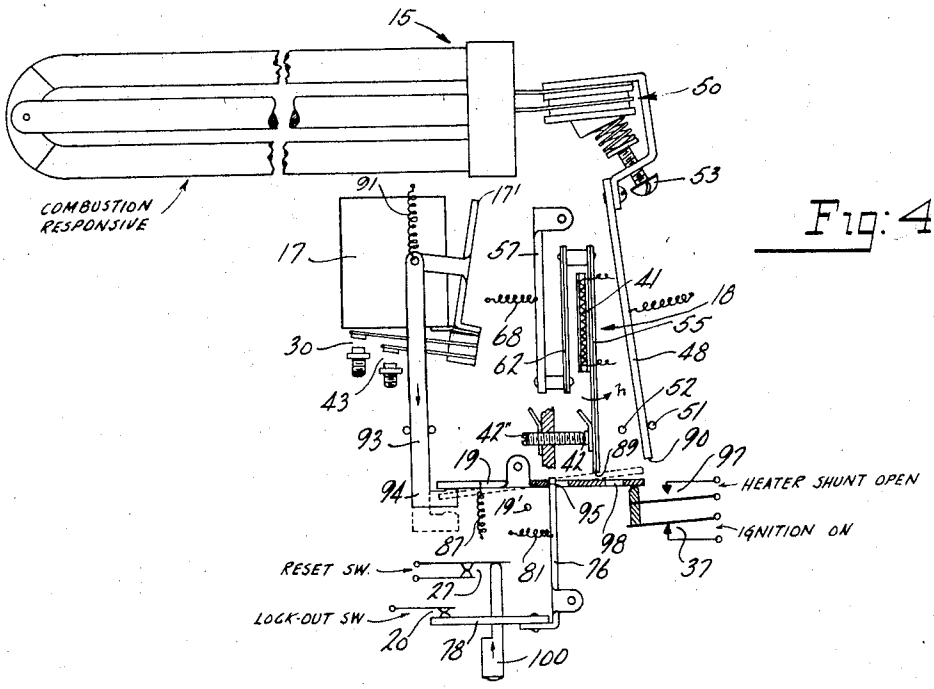
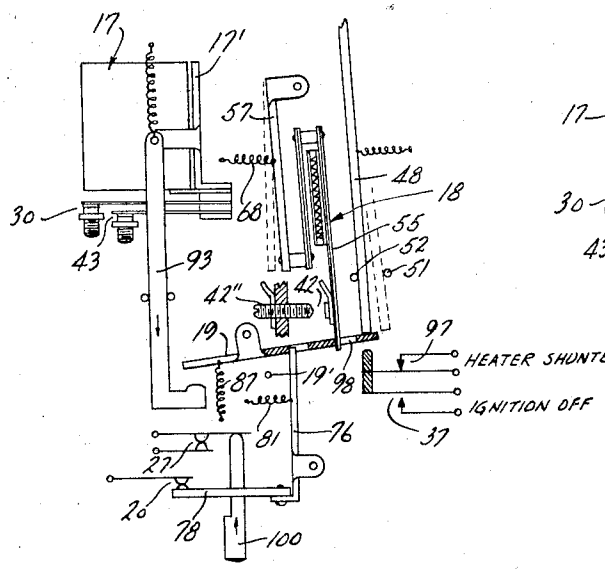



Fig: 4

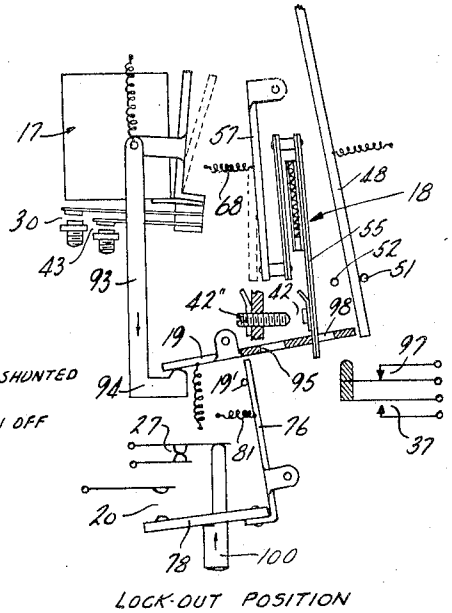
OFF AND STARTING POSITIONS

Fig: 5




RUNNING POSITION

Fig: 6




LOCK-OUT POSITION

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Patented June 20, 1944 2,351,622

# UNITED STATES PATENT OFFICE

2,351,622

## FUEL BURNER SYSTEM

Homer E. Malone, Milwaukee, Wis., assignor to Perfex Corporation, Milwaukee, Wis., a corporation of Wisconsin

Application June 22, 1940, Serial No. 341,795

19 Claims. (Cl. 158—28)

The invention relates generally to fuel burning systems, and more particularly to the automatic control of such systems whereby safety in automatic starting and running of such systems is assured.

Where an oil fired fuel burner is used, as for example, in a domestic heating plant, the fuel feed is normally controlled by a room thermostat to start the burner when low temperature is sensed by the thermostat, and to stop the burner, and thereby completely extinguish the flame when the thermostat senses the presence of the desired temperature. Since continued feeding of fuel to the burner in the absence of combustion would result in dangerous accumulation of fuel in the combustion chamber, it is essential to provide safety means in dominating controlling relation to the burner whereby abnormal combustion conditions, and particularly failure of combustion in the starting or running of the burner, will result in disabling of the burner operating and controlling means in such a manner as to prevent further feeding and accumulation of fuel. Such safety means usually include a safety lock-out switch which is opened and latched in open position when failure of combustion is sensed and prevents further operation of the burner until the lock-out switch has been manually re-set by the householder or attendant.

The primary object of the present invention is to provide a new and improved oil burner system of such a character wherein simplicity and reliability are attained in all of the component elements and with which safety of operation in an oil burner is assured.

Another important object is to provide a new and improved oil burner system wherein a safety lock-out switch tending constantly to assume its lock-out or safety position is retained in its closed position by the successive restraining action of a plurality of shiftable mechanical abutment devices which in normal starting, running and stopping of the burner are shifted in a predetermined normal sequence which maintains the lock-out switch in its closed position, and which in an abnormal functioning of the burner are shifted in a different sequence which results in the release and lock-out of the safety switch.

A further object of the invention is to provide an oil burner system wherein a safety lock-out switch is governed by a series of inter-acting latches in such a manner that the frictional forces between the several latch elements are compartively slight, thereby to render the operation of the system more dependable and uniform.

Another object of the present invention is to provide such an oil burner system wherein the burner governing relay cooperates with the other control elements in establishing the desired sequence of operation of such other control elements.

Another object is to provide a new and improved burner system wherein the safety lock-out switch is governed by a shiftable latch member which in the course of a normal burner starting operation has a limited shifting movement adapted to be utilized for attaining supplemental control operations such as the termination of the ignition operation; and a further object is to provide such a system wherein this shiftable latch member is returned to its normal or initial position by the main burner control relay as an incident to the burner stopping operation of the relay.

Another object is to provide an improved electrically ignited oil burner system in which a burner starting operation is impossible in the event that the line voltage falls below the minimum required for satisfactory ignition of the fuel.

A further object is to provide an automatic oil burning system having the energizing coil of its control relay constantly connected across the power leads and embodying means operable to prevent chattering of the relay when open or de-energized.

Other objects and advantages reside in certain features of construction, circuit arrangement and operation of the various parts and arrangements which will hereinafter be more fully described in the specification and particularly pointed out in the appended claims, and which are illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a front elevational view showing the assembly of the control elements of the oil burner system of the present invention, the outer cover and inner guard member being removed so as to show the disposal of the various operative elements;

Fig. 2 is a side elevational view, partially in section, showing the assembly of the control elements of the oil burner system of the present invention;

Fig. 3 is a fragmental perspective view showing

the details of arrangement of the timer and various control elements;

Fig. 4 is a diagrammatic view generally similar to Fig. 2, showing the various control elements in their normal idle or burner stopped relation;

Fig. 5 is a similar view showing the control elements in the positions which they assume during normal running of the burner;

Fig. 6 is a view showing the lock-out relationship of the control elements, and

Fig. 7 is a schematic wiring diagram illustrating the oil burner system of the present invention.

In the form chosen for disclosure herein the invention is embodied in an oil burner system of the intermittent ignition type having an oil burner 10 (Fig. 7) including an actuating motor 11 and ignition means 12 governed in its normal starting and running operation by the cooperative action of a conventional snap acting room thermostat 13 and a safety control device 14, which is shown in detail in Figs. 1 to 3. The safety control device 14 is adapted for mounting adjacent to the combustion chamber, or on the stack, so that a combustion responsive means 15 carried by the mounting base 16 of the control device may be subjected to the heat of combustion produced by the burner. The mounting base 16 also carries a main control relay 17, a timer 18, and a shiftable control member 19 which cooperate in controlling a lock-out switch 20 to disable the burner 10 upon failure of ignition or combustion.

The relay 17 has an actuating coil 21 which, as shown in Fig. 7, is preferably connected across the power leads 22 and 23 in series with the primary 24 of a transformer 25. The secondary 26 of the transformer acts as a choke to prevent appreciable current flow to the relay so long as the circuit of the secondary is open. With this arrangement, the room thermostat 13 or other suitable control means may be utilized to close the circuit to the secondary 26 and thereby energize the relay 17, or to open the circuit to secondary 26 and thereby release the relay 17.

When the relay 17 is energized and moves to its burner starting position, a circuit is closed to the burner motor 11 from the power lead 22, through the lock-out switch 20, a normally closed re-set switch 27, wires 28 and 29, a relay switch 30 which has been closed by the relay, wires 31 and 31', the motor 11, and wires 32 and 33 to the other power lead 23. By closure of the switch 30 the ignition circuit is also closed from the wire 29, through a wire 36 from the switch 30 to a normally closed switch 37, wires 38 and 38', the ignition means 12, wire 39, and wire 33 to the other power lead 23.

When the thermostat 13 engages its contact 40 the circuit through the secondary 26 includes a heater 41 for the thermal timer 18 and a starting switch 42 which is normally closed by the timer 18 in its initial or cold position, and upon closure of the relay 17, a shunt circuit is provided about the starting switch 42 by closure of a relay switch 43, thereby to provide a continued closed circuit to the secondary 26 after opening of the starting switch 42 by the timer 18.

The relay actuated switch 30 comprises a pair of connected movable spring contacts, indicated as 30', carried on an insulating member 17' of the pivoted relay armature 17'' so that when the armature is attracted to the relay magnet, these spring contacts 30' engage and bridge corresponding spaced fixed contacts 30'' on the forward face of the mounting base 16. The switch 43, as herein shown, comprises a pair of normally open spring contacts, one of which is on the base 16 and the other of which is carried on the relay armature to close the switch 43 when the relay is energized.

In the event that the line voltage falls to a level which is insufficient to satisfactorily operate the ignition means 12, it is desirable that operation of the burner 10 be prevented. This end is attained in the present system by means such as a permanent magnet 44 (Fig. 1) mounted so as to exert a restraining action on the relay armature 17'' in its open position tending to prevent actuation or closure of the relay. The magnet 44 is herein shown as being mounted in a fixed position and the attractive action on the armature is adjustable by means of a screw 44' which acts as a stop to determine the open position of the armature. By adjusting the stop screw 44', the gap between the armature and the magnet may be varied to provide a minimum pull-in voltage for the relay which is ample to insure proper ignition.

The magnet 44 also functions to prevent chattering of the relay in its open position, since voltage pulsations in the power line are insufficient to overcome the stabilizing or restraining action of the magnet 44. Hence the magnet 44 obviates one of the principal objections to the choke-coil method of controlling the relay; and in addition, serves as a means for assuring adequate ignition voltage in each burner starting operation.

As herein shown the combustion responsive means 15 is of the type shown and claimed in the co-pending application of William Christiansen, Serial No. 236,818, filed October 24, 1938, now Patent No. 2,266,721, December 16, 1941, and comprises, generally, a U-shaped expansive element 45 projecting rearwardly from the mounting base 16 adjacent the central upper edge portion thereof, and having a relatively non-expansible element 46 secured to the closed projecting end of the U-shaped element. The element 46 extends into a sliding bearing (not shown) on the base 16, and has a resilient connecting strip 47 projecting from the other or forward face of the mounting base 16. The movement of the connecting strip 47 induced by expansion or contraction of the element 45 is employed to shift a control element such as a stack arm 48, the upper end of which is pivoted on a horizontal axis above the strip 47 by means such as a flat blade type spring 49 connected at opposite ends to the base 16 and one end of the arm 48. A slip-friction means 50 provides the desired operating connection between the strip 47 and the stack arm 48, so that initial movement of the strip 47 in either direction produces immediate movement of the stack arm 48. The movement of the stack arm 48 in one direction is limited by a cold stop 51 and in the other direction by a hot stop 52, and after abutment of the stack arm with either of these stops, the connecting strip 47 may continue its movement by reason of the slip friction means 50, which may be adjustable, if desired, by means of a screw 53.

The stack arm 48, as shown in Fig. 2, extends downwardly toward the control member 19, generally parallel to the forward face of the mounting base 16 but with a substantial space therebetween, and the thermal timer 18 is mounted in the space between the stack arm 48 and the base 16. The timer 18 as herein shown comprises a pair of bimetallic structures 55 and 56 of similar construction (Figs. 1, 2 and 3) mounted on a carrier 57 which is pivoted on a horizontal axis parallel to and beneath the pivotal axis of the stack arm 48. The pivotal mounting is provided by projecting ears 58 secured to the

insulating plate 59 of the base 16, and the carrier 57, which is formed from a flat sheet metal plate, has corresponding outstanding ears 60 at opposite sides of its upper end which are pivoted to the stationary ears 58 by a pivot pin 61. Preferably each of the bimetallic structures 55 and 56 has one bimetal strip 62 secured at its lower end by a pair of screws 63 and spacing sleeves 64 to the lower forward face of the carrier 57, so as normally to project upwardly in parallel spaced relation to the carrier. Each strip 62 terminates adjacent the upper end of the carrier 57, and has the upper end of a similar bimetal strip 65 secured in spaced relation to its upper end by a pair of rivets 66 and spacing sleeves 67. Thus each bimetal strip 65 is supported by and extends downwardly from and in spaced relation to its strip 62. The bimetal strips 62 and 65 of each pair are disposed in an opposite relation with respect to each other, so that their individual warping movement has an additive action.

In the present instance the bimetal structure 55 serves as the active or heated element of the timer 18, and has the heater 41 mounted between the two bimetal strips 62 and 65 thereof, while the bimetal structure 56 serves as the compensator for the timer. In attaining this compensating function, the strip 65 of the compensating structure 56 projects downwardly beyond the lower end of the carrier 57, and by means of a spring 68 acting on the carrier 57, this projecting lower end of the compensating element 56 is biased into contact with a stop such as an adjustable stud 69 (Fig. 3) so that the initial or cold position of the active element 55 of the timer is maintained the same despite variations in ambient temperature. In the other or active bimetal structure 55, the strip 62 similarly extends below the carrier 57 and carries one contact 42' of the starting switch 42, the other element of which comprises a stationary contact 42'' formed by an adjustable screw stud. The stud 42'' and the stud 69 are so adjusted in practice that the switch 42 is closed when the compensator 56 engages its stop or stud 69.

In accordance with the present invention the timer 18 and the stack arm 48 of the combustion responsive means are arranged to function successively and independently in a normal burner starting operation to maintain the lock-out switch 20 in its closed position. and this end is attained by latching means which is so constructed and arranged as to minimize the force required between the various elements of the latching means, thereby to render the system more sensitive and reliable in its controlling action.

In attaining this desirable control, the lock-out switch 20 is located adjacent the lower edge of the mounting base 16, with its stationary contact 20' located on the back of the insulating plate 59, and having the movable contact 20'' carried on one arm of a bell crank 70. As herein shown, the bell crank 70 is formed from a stamping having mounting ears 71 at the juncture of the arms 76 and 77 thereof, and these ears 71 are mounted on a pivot pin 74 which extends across between the sides of a U-shaped bracket 75 projecting from the forward face of the insulating plate 59. One arm 76 of the bell crank 70 extends upwardly along but in spaced relation to the insulating plate 59, while the other arm 77 of the bell crank has an insulating bar portion 78 which projects through an opening 79 in the plate 59 and has a transverse spring mounting member 80 thereon (Fig. 3) carrying the movable contact 20'' of the lock-out switch 20.

The lock-out switch 20 is constantly urged toward open position by means such as a coil spring 81 acting between the U-shaped bracket 75 and the upwardly projecting arm 76 of the bell crank 70, the spring 81 acting to rock the bell crank in a clockwise direction in Fig. 2 so as to move the contact 20'' downwardly away from the stationary contact 20'. To insure against objectionable sticking of the contacts 20'—20'', a rigid back-up strip 82 is carried on the arm portion 78 over the spring strip 80 to apply a positive contact-separating force in the event that the contacts tend to stick.

In securing the desired latching action upon the lock-out switch 20 under the successive individual control of the timer 18 and the stack arm 48, the present invention utilizes the shiftable control member 19 as an intermediate latch shiftable under the successive individual control of the relay 17, the timer 18 and the combustion responsive means 15 to effect the necessary controlling actions upon the burner in a normal starting and stopping operation, and to effect a lock-out of the safety switch 20 in the event of ignition failure or combustion failure. In the form herein shown the shiftable control member 19 comprises a relatively flat, plate-like lever pivoted intermediate its ends on a horizontal pivot pin 86 located parallel to and just rearwardly of the forward face of the insulating plate 59; so that one arm of the lever 19 projects rearwardly from the plate 59, and the other arm thereof projects forwardly of the plate 59.

The control lever 19 is constantly biased in a clockwise direction (Fig. 2) by a spring 87 so that its forward end tends to move upwardly toward abutment faces 89 and 90 formed respectively by the lower end of the active bimetal 55 and the lower end of the sack arm 48. When the relay 17 is de-energized, or released, its pivoted armature 17'' is biased toward its open position by a spring 91 and acts through an arm 92 fixed to the armature to raise a vertical link 93 to the elevated position of Figs. 1, 2 and 4, and in such movement a projection 94 on the lower end of the link 93 engages the lower face of the rear end of the control lever 19 to rock the lever 19 against the force of its spring 87 to an initial or idle position. When in this initial or idle control position, shown in Figs. 1, 2 and 4, the control lever 19 has a latching face 95 engaging the rear side face of the governing arm 76 of the safety switch 20, so that the safety switch is maintained closed.

When the control lever 19 is in its initial or idle control position, an insulating block 96 on the lower face of its forward end acts on the movable spring contact 37' of the switch 37 of the ignition circuit to prevent opening thereof by the spring bias of the arm upon which the contact 37' is mounted; and the block 96 acts on the spring contact 97' of a switch 97 to hold it from its spring biased closed position wherein it would act to complete a shunt circuit around the heater 41.

When the control of Figs. 1 and 2 is packed for shipment, the armature of relay 17 is fixed, by means such as a screw, in its open or released position so as to hold the lever 19 against movement in one direction through the part 94 of the link 93. To prevent appreciable movement in

the other direction, a stop arm 75' is mounted on the bracket 75 so as to underlie the insulating block 96 (Fig. 2) of the lever 19. Thus movement of the lever 19 is limited during shipment to but a slight range which will not disrupt the operative relation of the mechanism.

When in a normal burner starting operation the lever 19 is released by closure of the relay 17, the lever 19 shifts from the full line position of Fig. 4 to a first active position shown in dotted outline in Fig. 4 wherein the lever 19 is restrained or latched against further movement by engagement of the upper surface of the lever 19 with the lower end face or abutment 89 of timer 18. When in this first active control position, the latching action on the lock-out latch arm, or governing arm, 76 is maintained even though there has been a slight movement of the latch face 95 toward the end of the arm 76. In this first active position of the control lever 19 the switch 97 is maintained open and the switch 37 is maintained closed; so that the ignition device 12 and the heater 41 are both energized, it being noted that the relay switch 30 controlling the ignition and motor circuits has been closed by the relay 17. Thus this first active control position of the control lever 19 may be termed its burner starting control position.

Since the heater 41 is energized while the control member 19 is in its burner starting position, the active bimetal structure 55 warps so as to move its lower abutment face 89 forwardly or to the right (Fig. 4) along the upper face of the control lever 19. At the end of a predetermined burner-starting period, for example 90 seconds, the abutment 89 of the timer moves into alinement with an opening 98 in lever 19, as illustrated in Fig. 5, so as to release the control lever 19 for movement by its spring 87 to a second active control position which is determined by the abutment 90 formed by the lower face of the stack arm 48 which lies in the path of movement of the lever 19 when the stack arm is in its hot position. Thus if combustion has been created in the 90 second starting period, the control lever 19 will be restrained or latched in a second active control position by the stack arm. This position, which is shown in Fig. 5, may be termed the running position of the control lever 19.

As the control lever 19 shifts from its normal starting position, shown in dotted outline in Fig. 4, to the normal running position of Fig. 5, the switch 97 is allowed to close, due to upward withdrawal of the forward end of the lever 19, and the shunt circuit around the heater 41 is completed by this closure of the switch 97, so that the heater 41 is de-energized; and the ignition cut-off switch 37 is, by the same action of the lever 19, opened so as to cut off the ignition. In this running position of the control lever 19, its latching relation with the lock-out lever arm 76 is maintained so as to retain the lock-out switch 20 in its closed relation.

Since the heater 41 has been shunted, due to movement of the control lever 19 to its running position, the timer 18 starts to cool immediately, but is restrained against return to its initial or normal cold position by the latching action of the control lever 19 upon the active bimetal structure 55. This latching action of the lever 19 on the timer is caused by the projection of the bimetal element 55 into the opening 98 in the lever 19. Hence in a normal running period of the burner the timer cools to the ambient temperature, so that the abutment face of the compensating bimetal structure 56 is shifted away from its sto 59. Thus the two bimetal structures 55 and 5 return to their normal relation to each othe and the carrier 57 is rocked outwardly away fror the mounting base 16 against the force of th spring 68. Hence the timer 18 is reconditione or cooled during normal burner operation, an upon return of the control lever 19 to its initia position of Figs. 2 and 4, the timer 18 is release by the lever 19 and is returned to its initial po sition by its spring 68. Upon its return to its ini tial position, the timer 18 closes the startin switch 42 so that the thermostat circuit is con ditioned for a subsequent burner starting opera tion.

In the event that combustion has not beer produced within the timed burner starting period the stack arm 48 remains in its cold position o Figs. 2, 4 and 6, so that when the control lever 1 is released by the timer 18, the lever 19 move through and beyond its normal running positior of Fig. 5 to a terminal or lock-out position o Fig. 6, wherein the latching face 95 of the control lever 19 moves off of the end of the lock-out lever arm 76, thereby to unlatch the safety lock-out switch 20 and cause opening thereof by its spring 81. As the lock-out switch 20 is opened the end of the lever arm 76 moves beneath the lower surface of the control lever 19 to an extent limited by stop 19', thereby to lock the lever 19 against return movement to its initial position by the relay link 93. This stop 19' is shown diagrammatically in Figs. 4 to 6, but in practice is formed by a lug projecting downwardly from the lever 19, as shown in Fig. 2. The burner system is thus rendered inoperative, and the burner cannot be re-started until the lock-out switch 20 has been manually restored to its closed position. In the present instance this manual restoring means comprises a vertical slide 100 having a finger piece 101 projecting from the lower edge of the mounting base 16, and having a projecting arm 102 (Fig. 3) engageable with the lower face of the insulating block 78 of the bell crank 76. Thus by upward actuation of the slide 100, the end of the arm 76 is rocked forwardly to release the control lever 19, which is then returned to its initial position of Figs. 2 and 4 by the link 93 of the relay, thereby to again latch the switch 20 in its closed position. To prevent disabling of the safety switch 20 as by blocking of the reset member 100 in its elevated position, the re-set switch 27 has its movable contact 27' formed by a resilient bar which is interconnected to the slide 100 so as to open the switch 27 whenever the slide 100 is moved into contact with the safety switch lever 78. Thus the resilient bar which forms the contact 27' also serves to maintain the slide 100 in its downward or inactive position.

In the event of flame failure during a normal running period of the burner 10, immediate lock-out of the system results, since the control member 19 is then under the sole control of the stack arm 48, as shown in Fig. 5. When such a flame failure results in cooling of the combustion responsive means 15, the first movement of the transmitting strip 47 acts through the slip friction means 50 to shift the stack arm 48 from its left hand or hot position of Fig. 5 to its right hand or cold position of Fig. 6. The control lever 19 is thereby released and moved to its lock-out position of Fig. 6, so that the lock-out switch 20 is allowed to open and the system is disabled. Hence the system cannot operate until the safety

switch 20 has been manually re-set as hereinbefore described.

Where the combustion responsive means and its stack arm are mounted along the central vertical portion of the rectangular mounting base 16, as shown in Fig. 1 with the control lever 19 and the lock-out switch 20 located beneath the stack arm, the relay 17 and the transformer 25 are preferably mounted on opposite sides of the stack arm 48 adjacent the upper edge of the mounting base. This arrangement provides two relatively remote terminal mounting areas 105 and 106 disposed on opposite sides of the stack arm 48 and lock-out switch 20. The left hand area as shown in Fig. 2 contains two thermostat terminals 107 and 108 through which the room thermostat 13 is connected in low voltage circuit shown in Fig. 7. The other area 106 has four line voltage terminals 109, 110, 111, and 112 mounted therein, so that in connecting the control into the oil burner system, the terminal 109 is connected to the line voltage lead 23, and the terminal 110 is connected through a limit control 113 to the hot line 22 of the line voltage source. The terminal 109 is also connected by wire 33 and branch lead 32 to one terminal of the motor 11, and by a branch lead 39 to one terminal of the ignition means 12. The terminal 111 is connected by the wire 31' to the other terminal of the burner motor 11 while the other terminal 112 is connected by the wire 38' to the other terminal of the ignition means 12. The locations of the several terminals in the electrical circuits are shown in Fig. 7 of the drawings.

Since the timer 18 is located behind the broad flat lower portion of the stack arm 48, the stack arm 48 is preferably made in two sections, with the lower section which overlies the timer 18 removably secured to the upper section by means such as screws 115. When the lower section of the stack arm 48 is thus secured in position, the narrow lower portion of a keyhole slot 116 therein loosely embraces a fixed stud 117 so that movement of the arm 48 toward its cold position is limited by the enlarged head of the stud 117, the head of the stud 117 thereby constituting the cold stop 51. The stud 117 is mounted on the cross bar of a U-shaped bracket 118, the side members of which are fixed to the insulating plate 59 of the base 16. This bracket 118 extends over the timer 18 in spaced relation thereto, and its cross bar extends behind the stack arm 48 so as to function as the hot stop 52. A leaf spring 118' is preferably mounted on the bracket 118 so as to urge the stack arm 48 toward its cold position, so that in case the elements 45 or 46 break or are burned away, the stack arm will assume its cold position and thereby insure lock-out of the system.

Since the terminals in the mounting area 105 form part of the low voltage circuit, a mechanical barrier between the area 105 and the line voltage terminal area 106 is desirable, and in the present instance such mechanical barrier is formed so as to function additionally as a protecting means for the safety switch 20 and the timer 18, thereby to avoid damage to these parts during the connection of the wires to the various terminals. To this end a combined guard and barrier structure 120 (Fig. 2) is provided which is removably positioned on the forward face of the base 16 and overlies the stack arm 48, the timer 18 and the safety switch lever 70. The structure 120 as herein shown comprises a strap-like sheet metal stamping having leg portions 122 and 123 at its opposite ends connected by a face member 124. The end of the upper leg portion 122 has an ear 125 thereon which is secured to the base 16 by a screw 126 directly above the combustion responsive means 15, so that the face member 124 extends downwardly along and in spaced, protecting relation to the stack arm 48, timer 18 and lock-out switch lever 70. At the lower end of the face member 124 the lower leg 123 extends beneath the lock-out switch lever 70 to the base 16, and is secured to the base by screws 127 passing through attaching ear 128 formed on the leg 123. To more fully protect timer 18 and the lock-out switch mechanism, the structure 120 also includes a U-shaped wall structure formed from an insulating fibre material and having its cross member 130 secured to the face member 124 so that its sides 131 extend from the face member 124 to the base 16 on opposite sides of the structure which is to be protected. The wall structure preferably extends from the lower end of the structure 120 to a point relatively close to the lower portions of the relay 17 and the transformer 25. At their rear edges the side members 131 have projecting ears 132 formed in spaced relation along their edges and projecting into complemental slots 133 (Fig. 1) in the base 16. These ears 132 provide an interlocked relation with the base 16 which renders the side members 131 more effective in protecting the switch structure, and in addition, facilitate mounting of the structure 120 on the base 16.

In making the connections to the thermostat terminals 107 and 108 the incoming wires are passed through a guiding and positioning means such as a rubber knock-out grommet 135 (Fig. 1) which is supported in an opening in a flange 136 located along one side of the base 16 adjacent the area 105. The flange 136 is relatively narrow, and is formed from the metal which is struck from the base 16 in forming the enlarged open area 137 therein. It is through this open area 137 that a substantial portion of the forward face of the insulating plate 59 is exposed for mounting of the terminals and other elements thereon.

A similar apertured flange 138 is formed along the lower edge of the terminal area 106 through which wires from the motor 11 and ignition means 12 may be extended into the terminal area 106. Along the side edge of the terminal area 106 another apertured flange 139 is formed through which the line voltage leads 22 and 23 are extended into the terminal area 106 for connection with terminals 109 and 110.

After connection of the various leads to the terminals, all of the structure on the forward face of the base 16 is enclosed by a box-like housing or cover 140 the side walls 141 of which abut the base 16 adjacent its edges. The side walls 141 have suitable clearance slots therein which register with the openings in the flanges 136, 138 and 139. The cover 140 is secured in position by a screw 142 which projects through the front face of the cover with its enlarged head outside thereof. The inner end of the screw 142 is screwed into a threaded aperture formed in the face member 124 of the guard structure 120. Thus the guard structure 120 serves the additional function of holding the cover 140 in place.

Since portions of the switch structure and control levers extend beyond the rear face of the insulating plate 59, the base 16 has a rearwardly projecting flange 145 about its edge, and this flange, together with the plate 59 and a removable rear wall 146, define a chamber or space 147 to

enclose and protect these elements and provide wiring space. The rear wall 146 comprises an inner insulating sheet and an outer metallic heat shield supported on studs 149 by means of screws 150 extending through the elements of the wall 146 and threaded into the studs 149. Preferably the wall 146 is spaced slightly from the flange 145 so as to provide for ventilation and cooling of the space 147.

From the foregoing description it will be evident that the present invention provides an improved oil burner system wherein a dependable and uniform control is obtained. It will also be apparent that the shiftable control element which governs the lock-out switch of the present system is simple in construction, and is adaptable in its movements to effect supplemental control functions such as the control of the ignition means.

Since the burner system of the present invention embodies a thermal timer which cools during normal burner operation, immediate recycling takes place after short power failures; and since the timer is inactive during normal burner operation and the safety lock-out switch is governed solely by the latching action of the combustion responsive means, a flame failure during such period results in an immediate lock-out of the system.

In the control device of the present system the arrangement and disposal of the several component parts upon the mounting base is of particular advantage, since it provides two remotely located terminal mounting areas between which portions of the operative mechanism are disposed; and with this arrangement, the guard which protects this intermediate mechanism serves also to provide a mechanical barrier between the two terminal areas.

What is claimed is:

1. In a control system for a burner, the combination of a control circuit for the burner, a safety lock-out mechanism comprising two primary latch members, an intermediate latch member adapted to be governed by either of said primary latch members, a terminal latch member adapted to be governed by said intermediate latch member and operable when released to govern re-setting of said intermediate latch member, a safety lock-out switch controlling said circuit and governed by said terminal latch member, a timer governing one of said primary latch members, and a combustion responsive means governing the other of said primary latch members.

2. In a control system for a burner, the combination of a relay for placing the burner into and out of operation, a safety lock-out mechanism comprising two primary latch members, an intermediate latch member adapted to be governed by either of said primary latch members, a terminal latch member adapted to be governed by said intermediate latch member, a safety lock-out switch for preventing said relay from maintaining the burner in operation and held in position permitting burner operation by said terminal latch member, means operated by said relay upon stopping of the burner for moving said intermediate latch member to starting position, a timer controlling one of said primary latch members in a manner to prevent said intermediate latch member from releasing said terminal latch member until the expiration of a timed period, and a combustion responsive lever for controlling the other primary latch member in a manner to prevent said intermediate latch member from releasing the terminal latch member when combustion is present.

3. In a control system for a burner having a motor and ignition means, the combination of, a relay controlling the motor and ignition means for the burner, a lock-out switch for preventing operation of said motor, operating mechanism for said lock-out switch for normally maintaining said lock-out switch in position permitting motor operation while maintaining the same in position preventing motor operation when said mechanism shifts to a terminal position, means actuated by said relay upon de-energization thereof for shifting said mechanism to a starting position, means including timing means for preventing shifting of said mechanism toward said terminal position until after a timed period, means operated upon presence of combustion to limit the degree of shifting of said mechanism to prevent it from reaching its terminal position, and a permanent magnet associated with said relay for aiding said relay in assuming its de-energized position and shifting said mechanism to its starting position.

4. In a control system for a burner having a motor and ignition means, the combination of, a relay controlling the motor and ignition means for the burner, a lock-out switch for preventing operation of said motor, operating mechanism for said lock-out switch for normally maintaining said lock-out switch in position permitting motor operation while maintaining the same in position preventing motor operation when said mechanism shifts to a terminal position, means actuated by said relay upon de-energization thereof for shifting said mechanism to a starting position, means including timing means for causing shifting of said mechanism toward said terminal position after a timed period, means operated upon presence of combustion for preventing said mechanism from reaching its terminal position, and permanent magnet means associated with said relay for aiding said relay in assuming its de-energized position and shifting said mechanism to its starting position, said permanent magnet means also resisting pulling in of said relay, and means for adjusting said permanent magnet means so as to prevent said relay from pulling in unless line voltage is at a sufficiently high value to insure proper operation of the ignition means.

5. In a control system for a burner having a motor and ignition means, the combination of, a relay having a coil continuously connected across a source of alternating current electric power through a choke, a thermostat for controlling said choke to energize and de-energize said relay, said relay controlling the motor and ignition means for the burner, a lock-out switch for preventing operation of said motor, operating mechanism for said lock-out switch for normally maintaining said lock-out switch in position permitting motor operation while maintaining the same in position preventing motor operation when said mechanism shifts to a terminal position, means actuated by said relay upon de-energization thereof for shifting said mechanism to a starting position, means including timing means for causing shifting of said mechanism toward said terminal position after a timed period, means operated upon presence of combustion for preventing said mechanism from reaching its terminal position, and a permanent magnet associated with said relay for aiding said relay in assuming its de-energized position and shifting said mechanism to its starting position,

said permanent magnet also preventing said relay from pulling in unless line voltage is at a sufficiently high value to insure proper operation of the ignition means and preventing chattering of the relay when in de-energized position.

6. In a control system for a burner having a motor and ignition means, the combination of, a relay having a coil continuously connected across a source of alternating current electric power through a choke, a thermostat for controlling said choke to energize and de-energize said relay, said relay controlling the motor and ignition means for the burner, and permanent magnet means for attracting said relay toward de-energized position, said permanent magnet means being constructed and arranged to prevent the relay from pulling in unless line voltage is at a sufficiently high value to secure proper ignition, and to prevent chattering of the relay in its de-energized position.

7. In a control system for a fuel burner, a control relay governing said burner, a thermal timer having an electric heater, combustion responsive means, a control member governed by said timer and said combustion responsive means and movable under such governing action in one direction from an initial position through a series of control positions including starting, running and disabling control positions, switch means governed by said control member to de-energize said heater when said control member is in said running position, a safety lock-out switch controlling said burner normally biased toward a position preventing burner operation and held latched in position permitting burner operation in all positions of said control member except said disabling position and said control member being operable to unlatch and release said safety switch when said control member moves to said disabling position, means operable by said relay as it moves to open position to apply a yielding force to said control member urging the control member to its initial position, means operable to latch said control member in said disabling position to prevent return movement of said control member by said relay, and manually operable means to unlatch said control member from said disabling position and return it to said initial position.

8. A control system for a fuel burner, in combination, a starting and running circuit for said burner, a relay in said burner starting and running circuit to control the starting and stopping of said burner and having burner starting and burner stopping positions, a combustion responsive means having an abutment shiftable in response to combustion from a cold position to a hot position, a timer having an abutment movable during a predetermined timed burner-starting period from an active position to an inactive position, a safety lock-out switch included in a dominating controlling relation to said burner starting and running circuit, a shiftable switch operating member operatively associated with said lock-out switch to control the opening and closing thereof, said switch operating member having a releasing position in which the switch is in lock-out position and at least two operative positions in which it acts to maintain said switch in position permitting burner operation, means biasing said switch operating member from said operative positions toward said releasing position, said timer abutment being operable when in its active position to hold said switch operating member in one of said operative positions, and the other abutment being operable when in its hot position to hold said switch operating member in the other of said operative positions, and means operable after the completion of a timing movement of said timer abutment to hold said timer in said inactive position until said relay is returned to its burner stopping position.

9. A control system for a fuel burner, in combination, a starting and running circuit for the burner, a safety switch dominating said circuit, a relay for normally controlling said circuit and having burner starting and burner stopping positions, means for maintaining said switch closed during normal starting and running of said burner comprising a timer mechanism the timing operation of which is initiated as an incident to the movement of said relay to its burner starting position and having an abutment movable during a predetermined burner starting period from an initial position to a second position, a combustion responsive means having an abutment movable thereby in response to combustion from an initial cold position to a hot second position, a first shiftable latch element operatively connected to said switch to control the opening and closing thereof, a second shiftable latch element biased in one direction away from a normal latching relation to said first latch element wherein said second latch element holds said first latch element in switch closing relation, said second latch element being held in said latching relation during normal burner starting and running by successive action of said timer abutment in its initial position and by the abutment of said combustion responsive means in its hot position, and said first latch element when in its switch-opening position acting on said second latch element with a latching action to prevent return of said second latch element to said normal latching relation.

10. An automatic fuel burning heating system comprising, in combination, a fuel burner including an operating motor and an energizing circuit therefor, automatic means controlling said circuit for normally starting and stopping said burner, a safety lock-out switch controlling said circuit, a latch element operatively connected to said switch for movement as the switch shifts between open and closed positions, a thermal timer having a heater energized during a predetermined timed period and then de-energized, a heater circuit for energizing said heater including a starting switch closed when said timer is cold and open after said timer is heated, a shunt circuit for said heater around said starting switch closed by said automatic means as an incident to the starting of said burner, a combustion responsive means having an abutment shiftable thereby, and a control member shifted to an initial position by said automatic means as an incident to the normal stopping of said burner and constantly urged away from said initial position toward a terminal position, said control member having a latching action upon said latch element to hold said switch closed when said control member is in said initial position and until said control member reaches said terminal position and then to release said latch element, said latch element then being operable upon said control member to latch the same in said terminal position, said thermal timer being operable during its energized timing period to latch said control member against movement toward said terminal position, a switch for de-energizing said heater governed by said control member to de-energize said heater at the end of said timing period, said control member being operable upon the de-ener-

gized thermal timer after completion of the timing period to restrain said timer against return movement and thereby prevent closure of said starting switch, and said abutment of said combustion responsive means being operable in response to combustion to restrain said control member against movement toward said terminal lock-out position.

11. An automatically controlled fuel burner system comprising, in combination, a fuel burner, a control circuit therefor, a safety switch included in a dominating controlling relation to said circuit, a relay for normally controlling said circuit and having burner starting and burner stopping positions, means for maintaining said switch closed during normal starting and running of said burner comprising a timer mechanism the timing operation of which is initiated as an incident to the movement of said relay to its burner starting position and having an abutment movable during a predetermined burner starting period from an initial position to a second position, a combustion responsive means having an abutment movable thereby in response to combustion from an initial cold position to a hot second position, a first shiftable latch element operatively connected to said switch to control the opening and closing thereof, a second shiftable latch element biased in one direction away from a normal latching relation to said first latch element wherein said second latch element holds said first latch element in switch closing relation, said second latch element being held in said latching relation during normal burner starting and running by successive action of said timer abutment in its initial position and the abutment of said combustion responsive means in its hot position, and said first latch element when in its switch releasing position acting on said second latch element with a latching action to prevent return of said second latch element to said normal latching relation, resetting means for manually shifting said first latch element from its latching relation to said second latch element, and means operated by said relay in its motor stopping position to restore said second latch element to its latching switch closing relation upon acuation of said resetting means.

12. In a fuel burner system, a fuel burner, an energizing circuit therefor, a control relay governing said circuit, a timer, combustion responsive means, a control member governed by said timer and said combustion responsive means and movable under such governing action in one direction from an initial position through a series of control positions the terminal of which is a disabling control position, a safety lock-out switch governing said circuit, said switch being normally biased to open position and held latched in closed position in all positions of said control member except said terminal position and said control member being operable to unlatch and release said safety switch when said control member moves to said terminal position, means operable by said relay as it moves to open position to apply a yielding force to said control member urging the control member to its initial position, means operable to latch said control member in said terminal position to prevent return movement of said control member by said relay, and manually operable means to unlatch said control member from said terminal position and return it to said initial position.

13. An automatic fuel burning heating system comprising, in combination, a fuel burner including an operating motor and an energizing circuit therefor, automatic means controlling said circuit for normally starting and stopping said burner, a safety lockout switch controlling said circuit and biased toward open position, a latch element operatively connected to said switch for movement as the switch shifts between open and closed positions, a thermal timer energized during a predetermined timed period and then de-energized, a combustion responsive means having an abutment shiftable thereby, and a control member shifted to an initial position by said automatic means as an incident to the normal stopping of said burner and constantly urged away from said initial position toward a terminal lock-out position, said control member having a latching action upon said latch element to hold said switch closed when said control member is in said initial position and until said control member reaches said terminal position and then to release said latch element, said latch element then being operable upon said control member to latch the same in said terminal position, said thermal timer being operable during its energized timing period to latch said control member against movement toward said terminal position and said control member being operable upon the de-energized thermal timer after completion of the timing period to restrain said timer against return movement, and said abutment of said combustion responsive means being operable in response to combustion to restrain said control member against movement toward said terminal lock-out position.

14. In a fuel burning heating system, a fuel burner including an operating motor and an energizing circuit therefor, a relay controlling said circuit and having burner starting and burner stopping positions, a combustion responsive means having an abutment shiftable in response to combustion from a cold position to a hot position, a timer having an abutment movable at the end of a predetermined timed burner-starting period from an active position to an inactive position, safety lock-out switch means, a shiftable latch member operatively associated with said lock-out switch means to control the opening and closing thereof, said latch member having one switch releasing position and at least two operative positions in which it acts to maintain said switch means in position permitting operation of the burner, means biasing said latch member from said operative positions toward said releasing position, said timer abutment being operable when in its active position to hold said latch member in one of said operative positions and being operable in its inactive position to release said latch member for movement to the other one of said operative positions, and the other abutment being operable when in its hot position to hold said latch member in said other one of said operative positions and being operable in its cold position to release said latch member for movement from said other one of its operative positions to its switch releasing position, means on said latch member operable after completion of a timing movement of said timer abutment to hold the same in said inactive position until said relay is returned to its burner stopping position, and means operable upon said latch member in its switch releasing position to latch said latch member in said switch releasing position.

15. In a control system for a fuel burner, the combination of, automatic means to start and

stop said burner, safety control switch means for said burner, latch means for governing said switch means including a shiftable control member normally urged from a latched relation in which the switch means is positioned to permit burner operation to an unlatched relation in which the switch means is positioned to prevent burner operation, a timer operable upon said control member during a timed burner starting period to maintain said control member in said latched relation and thereafter to release said control member, a combustion responsive means operable in response to combustion to maintain said control member in said latched relation and in the absence of combustion to release said control member, and means operable upon said control member when released by both said combustion responsive means and said timer to latch said control member in switch releasing position.

16. In a control system for a fuel burner having electric ignition means, operating circuits for said burner and said ignition means, a relay governing said circuits and having an armature shiftable from a normal open position to a closed position, an actuating coil for operating said armature, and a permanent magnet means attracting said armature in its open position, said permanent magnet means being constructed and arranged to establish a minimum pull-in voltage for said relay which is sufficient to insure operation of said electric ignition means.

17. In a control system for a fuel burner, the combination of, safety cut-off means for the burner having a first position permitting operation of the burner and a second position in which the burner is prevented from operating, means responsive to the demand for heat from the burner for starting and stopping the same, an operating member, separate timing mechanism for controlling said operating member, said operating member having an initial position in which the safety cut-off means is maintained in its first position and being movable successively to an intermediate position and to a terminal position upon movement of said timing mechanism, means for causing such movement of the timing mechanism upon demand for heat from the burner, means controlled by said operating member for preventing return movement of said timer mechanism when the operating member reaches said intermediate position, means actuated by said operating member for causing said safety cut-off means to be in its second position when said operating member is in its terminal position and to remain in said second position until manually reset, combustion responsive means for preventing movement of the operating member to its terminal position when combustion is present, and means for causing said operating member to be in its initial position upon starting of the burner.

18. In a control system for a burner having fuel feeding means and an igniter, the combination of, a condition responsive device responsive to the demand for operation and non-operation of the burner, means including a relay controlled by said condition responsive device and having a relay element movable from a first position which renders the fuel feeding means inoperative to a second position which renders the fuel feeding means operative, a safety switch having a normal position permitting operation of the burner under the control of said condition responsive device and a lock-out position in which the burner is prevented from operating, an operating member for operating said safety switch, biasing means for urging said operating member toward lock-out position causing movement of the safety switch to lock-out position, an ignition switch for controlling the igniter, means including a timer controlled by said condition responsive device for influencing said operating member and controlling said ignition switch, said timer means having an initial position in which it prevents movement of said operating member to its lock-out position and positions said ignition switch for rendering the igniter operative, said timer means being constructed and arranged to move from its initial position a period of time after starting of the burner for actuating the ignition switch to discontinue operation of the igniter, a combustion responsive device having a cold position and a hot position, said combustion responsive device moving from its cold position to its hot position upon occurrence of combustion, means for preventing movement of said operating member to its lock-out position when either the timer means is in its initial position or the combustion responsive means is in its hot position, and means actuated upon said relay moving to burner stopping position for applying a force to said operating member which opposes said biasing means for preventing movement of said safety switch mechanism to its lock-out position irrespective of said timer means or said combustion responsive means.

19. In a control for a fuel burner having an operating motor and an energizing circuit therefor, in combination, a relay controlling said circuit and having burner starting and burner stopping positions, a combustion responsive means having an abutment shiftable in response to combustion from a cold position to a hot position, a timer having an abutment movable at the end of a predetermined timed burner starting period from an active position to an inactive position, safety lock-out switch means, a shiftable latch member operatively associated with said lock-out switch means to control the opening and closing thereof, said latch member having one switch releasing position and at least two operative positions in which it acts to maintain said switch means in position permitting operation of the burner, means biasing said latch member from said operative positions toward said releasing position, said timer abutment being operable when in its active position to hold said latch member in one of said operative positions and being operable in its inactive position to release said latch member for movement to the other one of said operative positions, and the other abutment being operable when in its hot position to hold said latch member in said other one of said operative positions and being operable in its cold position to release said latch member for movement from said other one of its operative positions to its switch releasing position.

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