Nov. 3, 1953 F. B. AUBERT 2,657,743

ELECTRICAL CONTROL SYSTEM FOR BURNER AND CONTROL DEVICE THEREFOR

Filed March 7, 1950 4 Sheets-Sheet 1

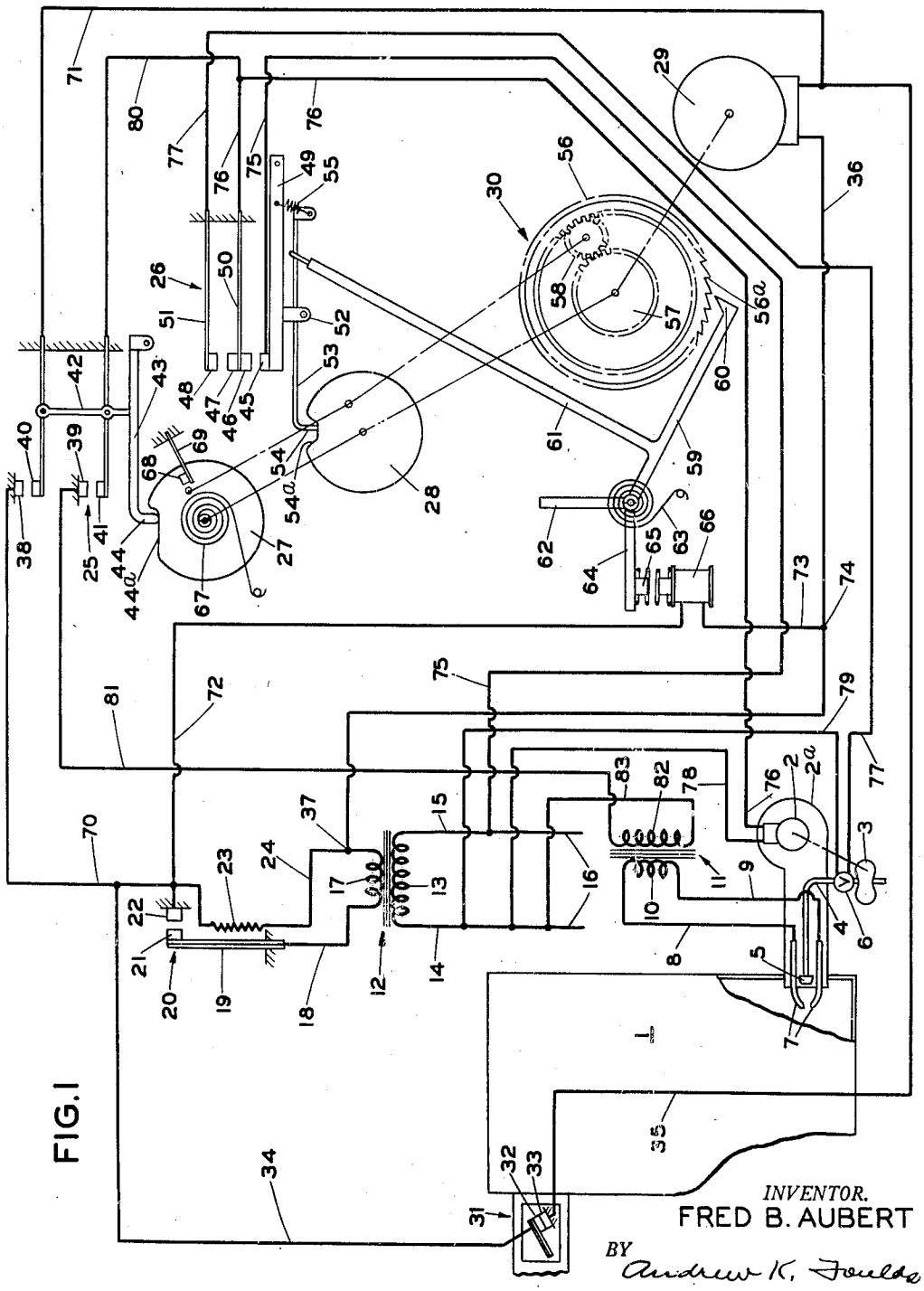


FIG. 1

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ELECTRICAL CONTROL SYSTEM FOR BURNER AND CONTROL DEVICE THEREFOR

Filed March 7, 1950 4 Sheets-Sheet 2

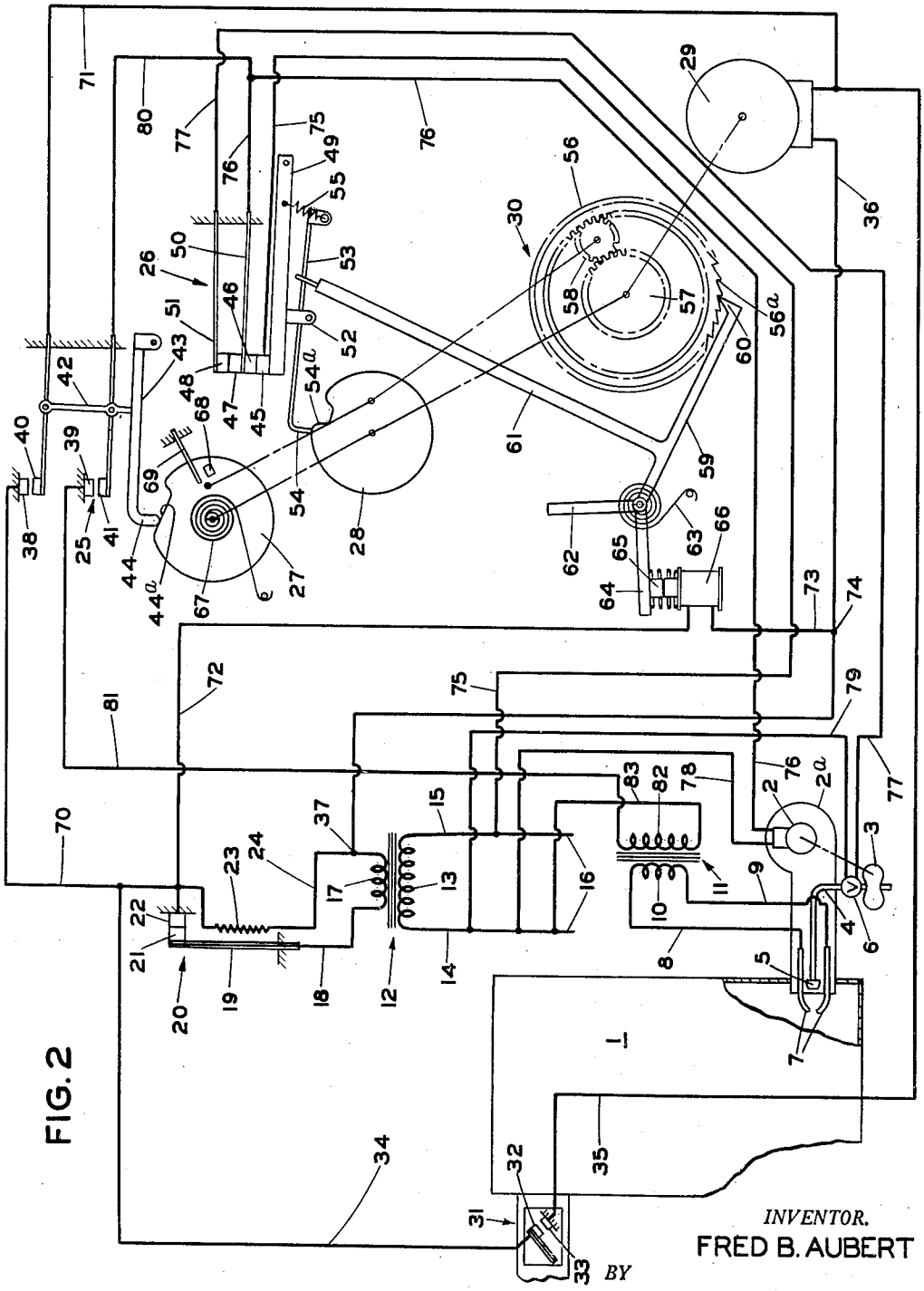


FIG. 2

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ELECTRICAL CONTROL SYSTEM FOR BURNER AND CONTROL DEVICE THEREFOR

Filed March 7, 1950 4 Sheets-Sheet 3

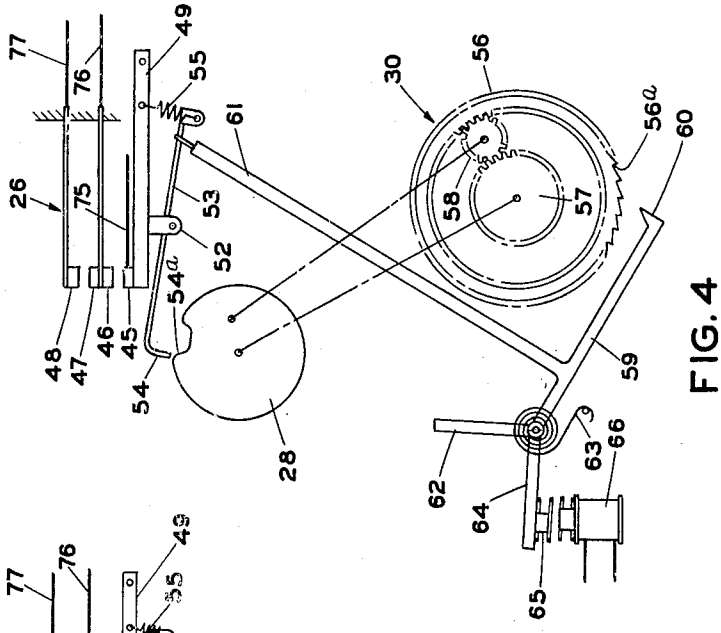


FIG. 4

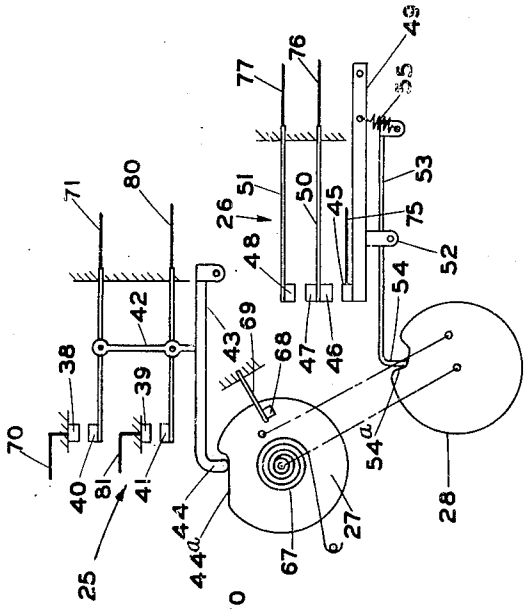
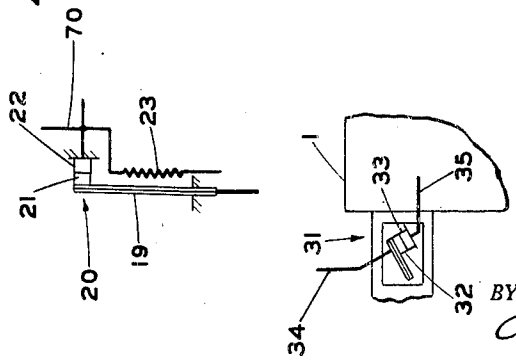


FIG. 3



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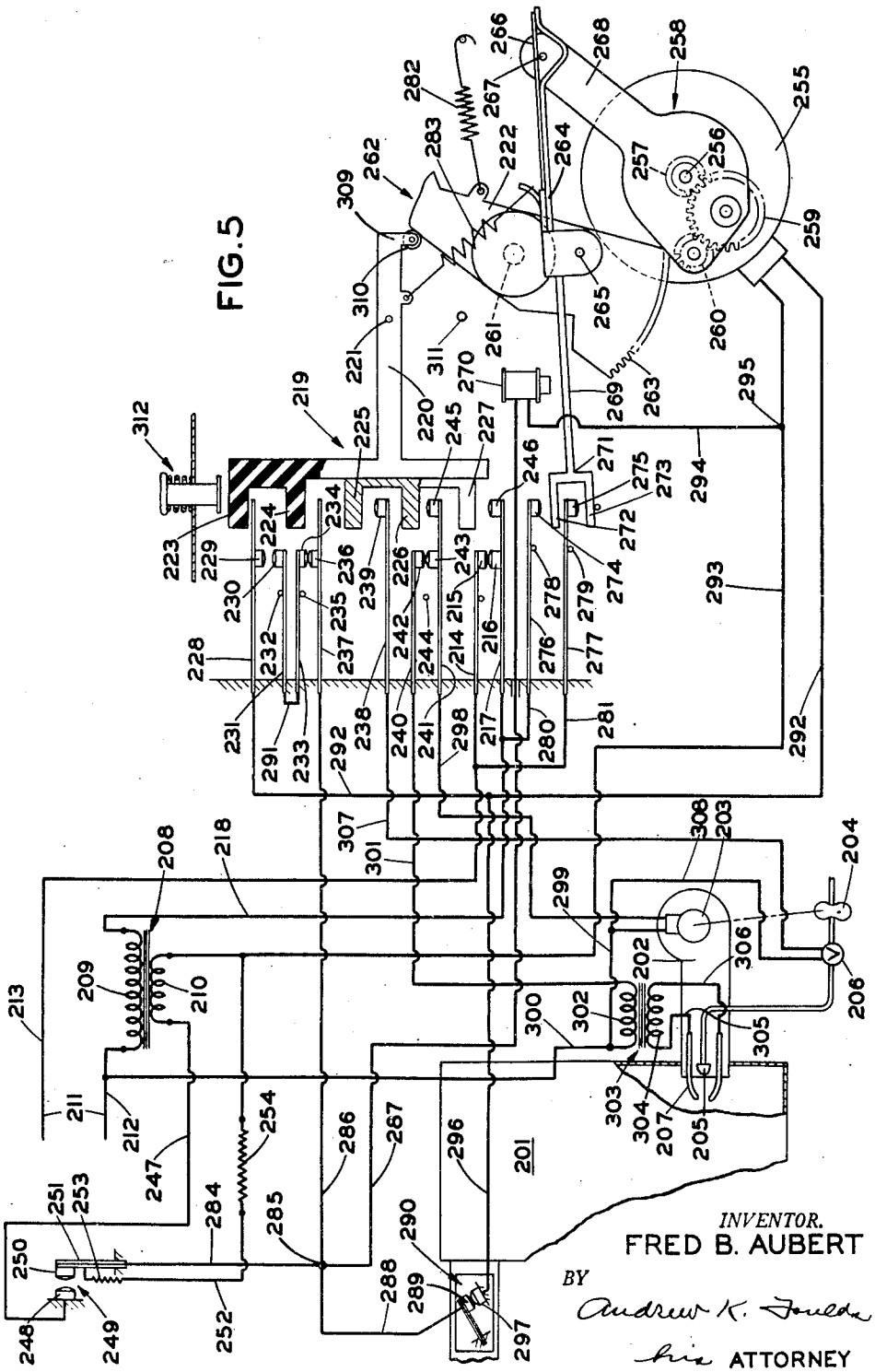
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ELECTRICAL CONTROL SYSTEM FOR BURNER AND CONTROL DEVICE THEREFOR

Filed March 7, 1950 4 Sheets-Sheet 4

FIG. 5



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UNITED STATES PATENT OFFICE

2,657,743

ELECTRICAL CONTROL SYSTEM FOR BURNER AND CONTROL DEVICE THEREFOR

Fred B. Aubert, Grosse Pointe, Mich.

Application March 7, 1950, Serial No. 148,232

24 Claims. (Cl. 158—28)

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This invention relates to new and useful improvements in control systems for liquid fuel burners and to new and improved control devices therefor.

One of the objects of this invention is to provide a new and improved electrical control system for liquid fuel burners.

Another object is to provide a new and improved burner control system which controls the supply of fuel and ignition thereof in response to the occurrence or non-occurrence of flame in the burner by any flame responsive means capable of completing an electric circuit or blocking current flow through a circuit.

Another object is to provide a burner control system having electric timing means operable to initiate supply of fuel to the burner and to energize an electric ignition therefor and having a flame responsive means operable to deenergize the timing means upon occurrence of flame subsequent to the deenergization of the ignition by the timing means, the timing means being operable to deenergize the system in the event that flame does not occur in the burner.

Another object is to provide a burner control system for a liquid fuel burner having a blower, ignition, and electrically operated fuel valve which is operable to energize the ignition and blower prior to the opening of the fuel valve and which is operable to deenergize the ignition and stop the supply of fuel to the burner in the event of non-occurrence of flame.

Another object is to provide a burner control device having novel switch operating mechanism including an electric timer motor and a rotary switch operating member and having a novel gear engaging means for transmission of motion from the timer motor to the switch operating member.

Another object is to provide a burner control system including an electric timing mechanism which will assume a safety shut off position upon failure of flame in the burner either from a starting or a running condition.

Another object is to provide a control device for a burner control system which is operable to shut off the supply of fuel to the burner in the event of failure of flame therein.

Another object is to provide a control device for a burner control system which is operable to effect a supply of fuel to the burner and its ignition and which is operable to shut off the supply of fuel to the burner in the event that flame does not occur therein within a predetermined time.

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Another object is to provide a burner control device having a novel timing means which will operate uniformly independently of varying ambient temperatures and fluctuating line voltages.

Other objects will become apparent from time to time throughout the specification and claims as hereinafter related.

The novelty of this control system and control device therefor will be fully and completely described and claimed in the specification and claims which follow.

In the accompanying drawings to be taken as part of this specification there are clearly and fully illustrated two preferred embodiments of the invention in which drawings:

Figure 1 is a diagrammatic view of one form of control system and control apparatus in its initial inert position prior to energization,

Fig. 2 is a diagrammatic view of the apparatus shown in Fig. 1 wherein the operating parts are shown in a burner operating or running position,

Fig. 3 is a fragmentary diagrammatic view of the switch operating cams of Fig. 1 in a "locked out" position,

Fig. 4 is another fragmentary diagrammatic view showing the operation of the manual reset mechanism for releasing the switch operating cams from a "locked out" position, and

Fig. 5 is a diagrammatic view of a modification of the control system shown in Figs. 1 to 4.

Referring to the drawings by characters of reference and to Fig. 1 in particular, there is shown an oil burner generally designated as 1 having an electrically driven fuel supply means comprising a burner motor 2 driving a blower 2a for the supply of air and a fuel pump 3 for the supply of fuel. There is a fuel line 4 leading from the fuel pump 3 to a burner nozzle 5 and having an electrically operated valve 6 therein for controlling admission of fuel to the burner. The fuel which is discharged into the burner through the nozzle 5 is ignited by an electric ignition means comprising spark electrodes 7 which are connected by lead wires 8 and 9 to the secondary 10 of an igniton transformer generally designated as 11. For controlling the operation of this burner arrangement there is provided an electrical control system having a transformer 12 with a primary 13 connected by lead wires 14 and 15 to an electric power source indicated as 16. The transformer 12 has a secondary coil 17 which is connected on one side by a wire 18 to the bimetallic blade 19 of a room thermostat 20. The blade 19 carries the movable contact

21 of the thermostat 20 which is cooperable with a fixed contact 22 which in turn is connected through a compensating heater 23 and lead wire 24 leading back to the other side of the transformer secondary 17. There are provided a plurality of switches comprising a pair of operating switch structures generally designated as 25 and 26 which are operated by a movable switch operating means, comprising cams 27 and 28 respectively, driven by an electric timing motor 29 through a planetary gear mechanism generally designated as 30. The burner 1 is provided with a stack switch 31 which has its contacts 32, 33 closed when in a cold position. The movable contact 32 of the stack switch 31 is connected by a lead wire 34 to the fixed contact 22 of the room thermostat 20. The fixed contact 33 of the stack switch 31 is similarly connected by a lead wire 35 to one side of the electric timing motor 29. The other side of the timing motor 29 is connected by a lead wire 36 to the transformer secondary 17 at the terminal 37. The switch mechanism 25 comprises a pair of fixed contacts 38, 39 and a pair of movable contacts 40, 41 respectively. The movable contacts 40, 41 are arranged for sequential operation by a connecting linkage 42 operated by an operating lever 43. The lever 43 has an end portion 44 forming a cam follower riding on the cam 27 for operation thereby. The switch mechanism 26 comprises a plurality of contacts 45, 46, 47 and 48. The contact 45 is operated by an operating lever 49 which is operable to move it into engagement with contact 46. Contacts 46 and 47 are carried by a flexible arm 50 which is operable to be flexed for movement of the contact 47 into engagement with the contact 48 subsequent to engagement of the contacts 45 and 46, the contact 48 being carried by another flexible contact carrying arm 51. The switch operating lever 49 has a pivot or fulcrum 52 thereon on which is pivoted a lever member 53 having an end portion 54 riding on the cam 28 and providing a cam follower. The cam follower lever 53 is held in its initial position underlying the lever 49 by a spring 55 connected to the operating lever 49. The cams 27, 28 are connected for movement together by the planetary gear mechanism 30 and the timing motor 29, the connection in commercial construction being a pinned connection but being shown diagrammatically by the dash-dot lines therein. The planetary gear mechanism 30 comprises an outer drum gear 56 and inner sun and planet gears 57, 58 respectively, the sun gear 57 being driven by the timing motor 29. To hold the drum gear 56 in position to cause the sun and planet gears 57 and 58 to transmit movement to the cams 27 and 28, there is provided a rachet clutch or brake member 59 having an end tooth 60 engageable with the outer teeth of the drum gear 56 to prevent movement thereof. The clutch member 59 has an arm 61 engageable with the cam lever 53 on the switch operating lever 49, the operation of which will be hereinafter described and has an arm 62 provided for manual operation. A spring 63 is provided for the rachet member 59 to hold the tooth portion 60 in an initial position out of engagement with the drum gear 56. The rachet member 59 also has an arm 64 carrying an armature 65 arranged for operation by an electromagnet 66. The cams 27 and 28 and planetary gear mechanism 30 are held in their initial position shown in Fig. 1 by a return spring 67 which holds a stop pin 68 carried by the cam 27 in engagement with a stop member 69. A second parallel energizing circuit for the timing motor 29 is provided by a lead wire 70 extending from the fixed contact 22 of the room thermostat 20 through the contacts 38 and 40 of the switch mechanism 25 and a lead wire 71 connected to one side of the timing motor 29. The clutch operating relay 66 is energized through a circuit comprising a lead wire 72 connected from the fixed contact 22 of the room thermostat 20 and a lead wire 73 connected as at 74 to wire 36 extending back to the transformer secondary 17. From the hot side of the power source 16 a lead wire 75 is connected to the movable contact 45 of the switch mechanism 26. The switch contact arms 50 and 51 are connected by lead wires 76 and 77 to the burner motor 2 and fuel valve 6 respectively. The burner motor 2 and fuel valve 6 are in turn connected to the ground side of the power source 16 by lead wires 78 and 79 respectively. The contact arm 50 of the switch structure 26 is also connected by a lead wire 80 to the contact arm for the switch contact 41. The contact 39 with which contact 41 cooperates is connected by lead wire 81 to one side of the primary 82 of the ignition transformer 11, the other side of which is connected by lead wire 83 to the ground side of the power source 16. The cams 27 and 28 are interconnected for operation together in such a manner that the cam 27 leads cam 28 in operation by a small predetermined amount. By this arrangement the cam 27 will operate the lever 43 to close the contacts 40 and 41 against the contacts 38 and 39 slightly in advance of the operation of the cam 28 which first closes contact 45 against contact 46 and subsequently closes the contact 47 against contact 48.

Operation

The system diagrammatically shown in Fig. 1 and just described illustrates the condition just prior to energization. The room thermostat 20 would be normally positioned for response to temperature of the space being heated by the burner 1. When the room temperature falls sufficiently to close the contacts 21 and 22 of the room thermostat 20 a circuit is established from the secondary 17 of the transformer 12 through wire 18, thermostat blade 19, contacts 21 and 22, lead wire 34, closed contacts 32 and 33 of the stack switch 31 and lead wire 35 leading to one side of the timing motor 29, the other side of which is connected by way of lead wire 36 to terminal 37 on the other side of the transformer secondary 17. This circuit energizes the timing motor 29 to commence actuation of the cams 27 and 28 for controlling the supply of fuel and air to the burner and for controlling the ignition therefor. Simultaneously with the energization of the timing motor 29 a circuit is established from the fixed contact 22 of the thermostat 20 by way of lead wire 72 to the clutch operating electromagnet 66 which is in turn connected by way of lead wire 73 to lead wire 36 extending back to the transformer secondary 17. The energization of the electromagnet 66 will cause the arm 64 to be pulled down and rotate the clutch tooth 60 into engagement with the peripheral teeth 56a of the drum gear 56 to hold the same against rotation. When the drum gear 56 is held against rotation by the clutch mechanism 59 and electromagnet 66 the sun gear 57 and planet gear 58 will then operate to commence rotation of the cams 27 and 28 for actuation of the switch mechanisms 25 and 26 respec-

tively. As the cams 27 and 28 are rotated by the timing motor 29, the cam 27, being set slightly in advance of the cam 28, will operate to close the switch contacts 40 and 41 against the fixed contacts 38 and 39 respectively. The closing of contacts 38 and 40 will establish a parallel circuit for energization of the timing motor 29 which circuit comprises the lead wire 70 extending from the fixed contact 22 of the room thermostat 20, the closed contacts 38 and 40 and the lead wire 71 connecting with the timing motor 29. The closing of contacts 39 and 41 is operable to close a portion of the circuit for the ignition transformer 11 which circuit remains open however until closure of the contacts 45 and 46 is effected a short predetermined time (of say 3 seconds) after actuation of the switch mechanism 25 by the cam 27. The switch structure 25 is constructed so that the contacts 38 and 40 are slightly closer together than contacts 39 and 41 when in an open position. Thus when the lever 43 is actuated the contacts 38 and 40 will close first, the contact arm for contact 40 will then be flexed slightly to permit the contacts 39 and 41 to close. This arrangement causes the ignition contacts to be opened slightly in advance of the timing motor contacts an opening movement. The cam 28 will engage and move the cam follower 54 to pivot the operating lever 49 for operation of the switch mechanism 26. As the switch operating lever 49 is moved upward by the cam 28 it will first make contact between contacts 45 and 46 and will flex the contact arm 50 upward so that a short predetermined time later contact 47 will engage contact 48. When the contacts 45 and 46 are first closed by the cam 28 a high voltage circuit is initiated for operation of the burner motor 2 and the ignition transformer 11. This high voltage circuit is completed from the hot side of the power source 16 through lead wire 75 to the movable contact 45 which is in engagement with the contact 46. From this point the circuit extends through the flexible contact arm 50 and through lead wire 76 to the burner motor 2 which is in turn connected to the ground side of the power source 16 by way of lead wire 78. From the contact arm 50 a parallel circuit is established through lead wire 80, the closed contacts 39 and 41 and lead wire 81 to one side of the primary 82 of the ignition transformer 11, the other side of which is connected by way of lead wire 83 to the ground side of the power source 16. At this point in the operation the timing motor 29 is still moving the cams 27 and 28. The ignition transformer 11 is energized and the blower 2a and fuel pump 3 are in operation for supplying fuel and air to the burner. As the cam 28 moves further it will cause the lever 49 to flex the contact arm 50 upward to engage the switch contacts 47 and 48 to establish a circuit for opening the fuel valve 6. This last-mentioned circuit is completed from the high voltage power source by way of lead wire 75, contacts 45, 46, 47 and 48, contact arm 51 and lead wire 77 connecting to one side of the electrically operated fuel valve 6, the other side of which is connected by way of lead wire 79 to the ground side of the power source 16. By this arrangement the ignition and air supply are brought on in advance of the opening of the fuel valve 6. This functions to prevent extinguishment of the ignition arc by the air current supplied by the blower 2a during conditions of low voltage and also operates to insure a proper air supply at the time fuel is

allowed to discharge from the burner nozzle 5 thus reducing the danger of carbonization on the burner nozzle when operating with catalytic oils. With the fuel and air being supplied to the burner and the ignition energized the fuel will normally be ignited and flame occurs in the burner. Upon occurrence of flame in the burner the normally closed contacts 32 and 33 of the stack switch 31 will be opened thus breaking one leg of the parallel circuits for the timing motor 29. As the timing motor continues to operate through the circuit extending through the closed switch contacts 38 and 41 the cams 27 and 28 will continue to rotate until the cam follower 44 moves on to the sloping cam surface 44a at the end of its travel which permits the lever 43 to move downward and opens the contacts 38, 40, 39 and 41 sequentially thus opening first the energizing circuit for the ignition transformer 11 and secondly the other energizing circuit for the timing motor 29. This stage of operation is illustrated in Fig. 2. When the burner is in its normal running operation, the reverse rotation of the timing motor 29 by the spirng 67 is prevented by the internal mechanical and magnetic friction of the motor and the mechanical friction in the gear train associated with the motor.

When the space being heated by the burner is warmed sufficiently the contacts 21 and 22 of the room thermostat 20 will open thus deenergizing the electromagnet 66 and releasing the clutch 59 and permitting the planetary gear mechanism 30 and cams 27 and 28 to be rotated back to the initial position shown in Fig. 1.

In the event that fuel has not ignited in the burner and no flame has occured therein by the time required for the cams 27 and 28 to be rotated to the position shown in Fig. 2 the system will be in the condition shown in Fig. 2 except that the stack switch contacts will have remained closed. At this position, although the timing switch contacts 38 and 40 are opened the timing motor will continue to be energized through the stack switch circuit and will move the cams further until the cam follower 54 drops off the cam shoulder 54a and opens the switch contacts 45 and 47 from the contacts 46 and 48 respectively thus deenergizing the circuits to the burner motor, ignition, and fuel valve. At this point the cam stop member 68 will have been rotated against its stop 69 and the timing motor 29 will then stall in that position, the motor being so constructed so that it may be stalled without burning out. This last-named condition which is a "lock out" position is illustrated by the fragmentary diagrammatic view shown in Fig. 3.

When the system has moved to the "lock out" position shown in Fig. 3 the cams will not be released for return to the initial position of Fig. 1 upon opening of the room thermostat circuit since the cam follower portion 54 will be engaging the shoulder 54a preventing return of the cams. This position requires manual resetting and is illustrated in Fig. 4. When the manual operating member 62 of the clutch member 59 is rotated in a clockwise direction facing Fig. 1 the clutch tooth 60 is moved out of engagement with the peripheral teeth 56a on the drum gear 56 and the arm 61 engages the cam follower lever 53 and rotates the same to move the cam follower portion 54 out of engagement with the cam shoulder 54a as is shown in Fig. 4. This reset mechanism is operable to hold the switch contacts 45 and 46 open while releasing the cams 27 and 28 so that the burner

may not be energized. It should also be noted that this operation maintains the clutch tooth 60 out of engagement of the peripheral teeth 56a on the drum gear 56 so that the planetary gear mechanism 30 may not be operated to move the cams 27 and 28 while held in a resetting position. This last-mentioned arrangement prevents the system from being operated in the event that the reset mechanism is jammed or otherwise held in a resetting position.

From the foregoing description we have seen that when the system is energized by operation of the room thermostat 20 the timing motor 29 is energized and the clutch mechanism 59 operated by the electromagnet 66 to cause the planetary gear mechanism 30 to transmit movement to the cams 27 and 28. The cams 27 and 28 thereupon operate the switch mechanisms 25 and 26 sequentially first to establish a portion of the ignition circuit and to close a parallel circuit for energization of the timing motor 29 and secondly to energize sequentially the blower and fuel valve circuits. If normal ignition occurs in the burner the cams are stopped before the fuel and valve switches are reopened but after the ignition and timing switches are opened. On the other hand, we have seen that if there was a failure of ignition upon starting of the system the cams 27 and 28 are moved through to the lock out position shown in Fig. 4 which requires manual resetting. Now let us consider the operation of this system in response to certain abnormalities of system operation.

If there is a loss of power from the main circuit or power source 16 or if there is a chattering or fluttering of the thermostat contacts 21 and 22 the clutch operating relay 66 will be released each time its source of power is deenergized and the system will thus return to its initial position and begin a new cycle of operation.

If the stack switch contacts 32 and 33 freeze together or if there is a short circuit in the stack switch circuit there will be an indication of the absence of flame which will cause the timing motor to continue to operate until the cams 27 and 28 reach their locked-out position and the fuel and ignition and valve circuits are thus deenergized.

If, after a normal starting operation, the stack switch contacts 32 and 33 should flutter (whether due to a poorly constructed switch or to variations in stack temperature due to momentary losses of flame in the burner) the circuit for the timing motor 29 will be made momentarily each time the stack switch contacts are closed thus causing the cams 27 and 28 to be moved slightly each time the timing motor is energized. This momentary energization of the timing motor 29 will cause the cams 27 and 28 to "creep" until the cam follower 54 drops off the cam shoulder 54a and the system is thus locked out.

From the foregoing description it is seen that there is provided herein a simple control system whereby the ignition and air supply are energized sequentially in advance of the opening of the fuel valve and upon occurrence of flame within the predetermined rotation period of the switch operating cams the timing motor will be stopped at a point deenergizing the ignition but maintaining supply of fuel for combustion. The system thus provided produces a maximum of safety with great simplicity in construction.

It is seen that upon failure of power the system will recycle and upon failure of flame from either a starting or a running position or upon fluttering of the stack switch contacts the timing motor will operate to move the system to a "locked out" position.

It should be noted that in commercial construction, the transformer 12, the timing motor 29, planetary gear mechanism 30, electromagnetic clutch mechanisms 66, 59 and the cams 27 and 28 and their respective switch structures 25 and 26 would be mounted within a casing or upon a terminal board for unitary assembly as a separate control mechanism commonly known in the heating art as a "primary control". It should also be noted that this construction also is adapted to the inclusion of the stack switch with the primary control so that they may be provided as a single control mechanism for the burner which would require only wiring to the ignition transformer, blower, valve and room thermostat to set the system in operation.

System of Fig. 5

In Fig. 5 there is shown a modified burner control system which is somewhat similar to the one previously described. In this system there is a burner 201 which is supplied with air by a blower 202 driven by a burner motor 203 which also drives a fuel pump 204. The fuel pump 204 is operable to supply fuel to the burner nozzle 205 and the supply of fuel to the nozzle is controlled by an electrically operated fuel valve 206, as was the system shown in Fig. 1. There is also provided electric ignition 207, the circuits for which will be described hereafter. There is a transformer 208 having a primary 209 and a secondary 210 which controls the energization of this system. The transformer primary 209 is supplied with electric current from the main power source 211 by conductors 212 and 213. The conductor 213 leads to the contact arm 214 and switch contact 215 which is initially engaged with another contact 216 on a contact arm 217. The circuit for the primary is completed by conductor 218 from the contact arm 217 back to the primary 209. There is a switch means or switch structure generally designated as 219 for controlling the various circuits in this system and which includes a switch operating lever 220 which is pivoted at 221 and which is operable to be moved for switch actuation by a pivoted cam means or operating member 222. The switch lever 220 carries on its operating end a plurality of switch operating fingers 223, 224, 225, 226 and 227, the fingers 225, 226 and 227 being of electrical conducting material and intereconnected for conduction of electric current to various circuits herein. There is a flexible contact arm 228 carrying a switch contact 229 and which is arranged for movement by the finger 223. The contact 229 is cooperable with a contact 230 which is carried by a flexible contact arm 231 and is limited in its movement by a stop 232. There is another flexible contact arm 233 which carries a contact 234 and which is limited in its downward movement by a stop 235. The contact 234 is cooperable with a contact 236 which is carried by a contact arm 237 which is arranged for operation by the finger 224. There is also provided another contact arm 238 which carries a contact 239 cooperable with the electrical conducting finger 225. There are also provided contact arms 240 and 241 which carry initially closed contacts 242 and 243, the contact arm 240 being limited in its downward movement by a stop 244. The contact arm 241

also carries a contact 245 which is cooperable with the electrical conducting finger 226. The contact arm 217 also carries a contact 246 which is arranged for engagement with the electrical conducting finger 227. One side of the transformer secondary 210 is connected by a conductor 247 to the fixed contact 248 of a room thermostat generally designated as 249. The room thermostat 249 is operable to control the energization of this control system in accordance with the heat requirements of the space being heated by the burner 201. This thermostat may or may not be of the anticipating type but is shown as such for this circuit diagram. The movable contact 250 of the thermostat 249 is carried by a bimetallic blade 251 which is connected to the other side of the secondary 210 by a conductor 252 having an anticipating heater 253 and resistor 254 therein. There is an electric timer motor 255 which is operable to transmit movement to the operating member 222 for operating the switch structure 219. The motor 255 has a shaft 256 with a pinion gear 257 thereon. There is a member 258 pivoted on the shaft 256 for carrying a pair of gears 259 and 260 thereon. The operating member 222 is pivoted as at 261 and has a cam face at its upper end generally designated as 262. The member 222 has at its lower end a sector gear portion 263 which is cooperable with the gear 260. The member 258 is operable to move the gear 260 into and out of engagement with the sector gear 263. There is a gear engaging lever 264 which is pivoted as at 265 and which has a leaf spring portion 266 cooperable with a pin 267 on an extension 268 of the gear engaging member 258. The lever 264 has a portion 269 which is operable as a magnetic armature and is cooperable with the electromagnet 270. The lever 264 has an end portion 271 which is of electrical conducting material and which has two fingers 272 and 273 cooperable with contacts 274 and 275 carried by the flexible contact arms 276 and 277 respectively. The contact arms 276 and 277 are limited in their downward movement by stops 278 and 279. The contact arms 276 and 277 are connected by conductors 280 and 281 to the conductors 213 and 218 and provide a circuit for the transformer primary 209 which is in parallel with the switch contacts 215 and 216. There is a spring 282 which is connected to the operating member 222 and is operable to hold it in the position indicated in Fig. 5. A spring 283 interconnects the lever 264 and the lever 220 and is operable to hold the lever 220 in the initial position indicated in Fig. 5. The blade 251 of the room thermostat 249 is connected by a conductor 284 to a terminal point 285 at which point the circuits divide. From the terminal point 285 conductor 286 leads to the contact arm 237, conductor 287 leads to one side of the electromagnet 270, and conductor 288 leads to the movable contact 289 of a stack switch generally indicated as 290. The switch contact arms 231 and 233 are connected together as at 291 and a conductor 292 leads from the contact arm 228 to one side of the timer motor 255. The other side of the timer motor 255 is connected by a conductor 293 to the transformer secondary 210. The other side of the electromagnet 270 is connected by a conductor 294 to a point 295 on the conductor 293 from the timer motor 255. There is a conductor 296 which connects the fixed contact 297 of the stack switch 290 to the conductor 292 which leads to the timer motor 255. The contact arm 241 is connected by a conductor 298 to one side of the burner motor 203, the other side of which is connected by conductors 299 and 300 to the high voltage primary wire 212. The contact arm 240 is connected by conductor 301 to one side of the primary 302 of the ignition transformer 303, the other side of which is connected by conductor 300 to the high voltage wire 212. The ignition transformer secondary 304 is connected by conductors 305 and 306 to the ignition 207. The switch contact arm 238 is connected by conductor 307 to one side of the fuel valve 206, the other side of which is connected by conductors 308, 299 and 300 to the high voltage wire 212. The switch lever 220 has a downturned end portion 309 forming a cam follower which carries a bearing roller 310 against which the cam face 262 moves for operating the switch structure 219. There is also provided a stop 311 limiting the movement of the switch operating member 222 and a reset member 312 which is engageable with the lever 220 for resetting the same.

Operation of Fig. 5

In operation this system functions generally as follows: When the room thermostat 249 closes calling for heat circuits are established for energizing the timer motor 255 and the gear engaging electromagnet 270. These circuits extend from the transformer secondary 210 by way of conductor 247, contacts 248 and 250, conductors 284 and 288, stack switch contacts 289 and 297, conductors 296 and 292, to one side of the motor 255. From the terminal point 285 conductor 287 runs to one side of the electromagnet 270, the other side of which is connected by conductor 294 to the conductor 293 leading from the other side of the motor 255 to the transformer secondary 210. There is a parallel circuit for energization of the timer motor 255 which bypasses the stack switch 290 and extends from the terminal point 285 by way of conductor 286, switch contacts 236, 234, 230, and 229, and conductor 292 to the motor 255. The last-mentioned circuit for the motor is initially open at contacts 229 and 230 as is seen by reference to Fig. 5. Prior to the closing of the room thermostat contacts the various switches shown are in the positions as indicated in Fig. 5. When the room thermostat 249 is closed and the electromagnet 270 and the timer motor 255 energized the gear 260 is moved into engagement with the sector gear 263 on the switch operating member 222 and this member begins to move for operating the switch structure 219. When the electromagnet 270 moves the lever 264 for engaging the aforementioned gears the end portion 271 is moved to engage the contact fingers 272 and 273 with the switch contacts 274 and 275 to establish a holding circuit for the primary 209 of the transformer 208. The cam face 262 of the switch operating member 222 is operable to be moved by the timer motor 255 under the bearing roller 310 for pivoting the lever 220 and operating the switch structure 219. The cam face 262 is so contoured as to move the lever 220 through successive movements to operate the various switch contacts sequentially as will be described hereafter. Upon initial movement of the cam face 262 under the bearing roller 310 the lever 220 is pivoted to engage the finger 223 with the contact arm 228 and move the contact 229 into engagement with the contact 230. When the contacts 229 and 230 are in engagement the aforementioned parallel circuit for energizing the motor 255 is closed. The fingers 226 and 227 on the lever 220 are positioned to engage the con-

tacts 245 and 246 respectively and to break the contact 216 away from the contact 215. The establishment of the last-named contacts and the breaking of the contacts 215 and 216 are operable to open the initial circuit for the transformer primary 209 which remains energized through the switch contacts 274 and 275 and to establish a circuit for the blower and ignition. The blower and ignition are energized by a high voltage circuit extending by way of conductor 218, switch contact arm 217, contacts 227 and 246, and contacts 226 and 245. From contact 245 the circuit splits and goes by way of contact arm 240 and conductor 301 to the ignition transformer and by way of contact arm 241 and conductor 298 to the burner motor. A short predetermined further movement brings the cam face 262 to a slightly higher contour to move the lever 220 a small distance further necessary to make contact between the finger 225 and contact 239 to establish a circuit by way of conductor 307 to the fuel valve 206. By this construction the sequential operation of the blower and ignition and fuel valve is accomplished similarly to that described for the previous forms of control system. Upon a short predetermined further movement of the operating member 222 the cam face 262 is moved to a still higher contour which pivots the lever 220 further and causes the finger 226 to flex the contact arm 241 and move the contact 243 away from the contact 242, the contact arm 240 by this time having engaged the stop 244. Upon opening of the contacts 242 and 243 the circuit to the ignition transformer is broken but the circuits to the burner motor and fuel valve are maintained as their contacts are still in engagement. Upon a predetermined further movement of the operating member 222 the cam face 262 is moved to its highest contour at the extreme right edge thereof and the finger 224 is operable thereby to engage the contact arm 237 and open the contacts 234 and 236. By the opening of the contacts 234 and 236 one of the parallel circuits for energizing the timer motor 255 is opened and the control of this motor is at this point entirely determined by the stack switch 290. The stack switch 290 has normally closed contacts which are operable to be opened upon occurrence of flame in the burner and so if flame has occurred in the burner by the time the contacts 234 and 236 are opened or occurs in the burner a very short time thereafter the stack switch contacts 289 and 297 will be opened and the timer motor 255 deenergized to stop further movement of the operating member 222. If flame does not occur in the burner within the predetermined time required for the cam face 262 to move completely under the bearing roller 310 the motor 255 will continue movement of the member 222 until the bearing roller 310 drops over the edge of the member 222 and pivots the lever 220 upward to open the switches which were previously closed and close the switches which were previously opened thereby and assume a locked-out position, the cam follower portion of the lever 220 preventing return movement of member 262 to its initial position. The lever 220 can be manually moved by the reset member 312 to move the bearing roller 310 and downturned lever portion 309 out of latching engagement with the operating member 222 to permit the system to be re-started after a safety operation. If the system has started normally and flame has occurred in the burner the timer motor 255 is stopped and the aforementioned safety operation does not occur but, if for some reason, flame fails from a running or operating position the stack switch contacts 289 and 297 will reclose and establish a circuit to start the timer motor 255 and thus move the operating member 222 through to a safety lock-out position. Further movement of the operating member 222 after reaching a lock-out position is prevented by engagement thereof with the stop member 311 which is operable to stop further movement and thus stall the motor 255. Any other abnormalities of operation will cause the system to function substantially as described for Fig. 1.

From the foregoing it is seen that there is provided herein a simple burner control system whereby the blower, ignition, and fuel supply are turned on for a predetermined time and the ignition is then turned off, all this done by a timing motor and switch structure associated therewith and if flame does not occur within a predetermined time in the burner, the timing motor moves the operating member and switch structure to a safety lock-out position. It should be noted that although the gear engaging mechanism shown for this form of system is different from that illustrated in Fig. 1, any suitable alternate form could be used by merely adding the switch structure 271, 272 and 273 on the end of the member which is actuated by the gear engaging electromagnet. It should also be noted that although a normally closed thermostatic stack switch is shown for deenergizing the timer motor upon occurrence of flame a photocell circuit or any other flame response could be used which would be satisfactory for opening a normally closed switch controlling the timer motor. By use of the two sequential switches formed by contacts 229, 230 and contacts 234, 236 which are initially open and subsequently close and later reopen a parallel circuit for the timer motor, the timer motor is prevented from operating in the event of a false indication of a flame by the flame responsive switch or in any event that the flame responsive switch is held open. It should also be noted by providing two circuits for energizing the transformer primary 209, one of which is initially closed and is opened by the timer motor and the other of which is initially open and is closed by the gear engaging electromagnet, the system is prevented from functioning in the event that the switch operating lever 220 is jammed down in an actuated position.

This application is a continuation in part of my copending application, Serial No. 85,064, filed April 2, 1949, now Patent No. 2,618,323, granted November 18, 1952.

Having described the invention what is claimed and desired to be secured by Letters Patent of the United States is:

1. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, a plurality of switches controlling energization of said fuel supply means and said ignition, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to operate said switches sequentially to energize first said fuel supply means and said ignition and subsequently to deenergize said ignition and upon further movement to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, an electric circuit for said timing means, means in-

cluding a switch controlling said timing means circuit, releasable mechanical means having an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means for actuating said mechanical means, an electric circuit for said electric means connected in parallel with said timing means circuit and controlled by said timing means controlling switch, and switch means including means responsive to the occurrence of flame in said burner and operable to deenergize said timing means subsequent to the deenergization of said ignition and prior to the deenergization of said fuel supply means by said switch operating means.

2. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, a plurality of switches controlling energization of said fuel supply means and said ignition, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to operate said switches sequentially to energize first said fuel supply means and said ignition and subsequently to deenergize said ignition and upon further movement to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, means including a switch controlling said timing means, releasable mechanical means having an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means connected for actuation by said timing means controlling switch to actuate said mechanical means, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, and a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the deenergization of said ignition and prior to the deenergization of said fuel supply means thereby.

3. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, a plurality of switches controlling energization of said fuel supply means and said ignition, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to operate said switches sequentially to energize first said fuel supply means and said ignition and subsequently to deenergize said ignition and upon further movement to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, an electric circuit for said timing means, means including a switch controlling said timing means circuit, releasable mechanical means having an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means for actuating said mechanical means, an electric circuit for said electric means connected in parallel with said timing means circuit and controlled by said timing means controlling switch, and switch means including means responsive to the occurrence of flame in said burner and operable to deenergize said timing means subsequent to the deenergization of said ignition and prior to the deenergization of said fuel supply means by said switch operating means, said mechanical means being operable upon release from its actuated position to release said switch operating means for return in said one direction to its initial inoperative position.

4. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, a plurality of switches controlling energization of said fuel supply means and said ignition, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to operate said switches sequentially to energize first said fuel supply means and said ignition and subsequently to deenergize said ignition and upon further movement to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, means including a switch controlling said timing means, releasable mechanical means having an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means connected for actuation by said timing means controlling switch to actuate said mechanical means, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the deenergization of said ignition and prior to the deenergization of said fuel supply means thereby, said mechanical means being operable upon release from its actuated position to release said switch operating means for return in said one direction to its initial inoperative position, and means cooperable with said switch operating means upon movement thereof to said fuel supply deenergizing position to hold the same in that position independently of and subsequent to its release by said mechanical means.

5. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, circuits for said fuel supply means and said ignition, a first switch in said fuel supply and ignition circuits, a second switch in said ignition circuit, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to first close said first switch to energize said fuel supply means and said ignition, to secondly open said second switch to deenergize said ignition, and upon predetermined further movement in said other direction to reopen said first switch to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, means including a switch controlling said timing means, releasable mechanical means biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means connected for actuation by said timing means controlling switch to actuate said mechanical means, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits

responsive to the occurrence of flame in said burner, and a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the opening of said second switch and prior to the reopening of said first switch.

6. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, circuits for said fuel supply means and said ignition, a first switch in said fuel supply and ignition circuits, a second switch in said ignition circuit, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to first close said first switch to energize said fuel supply means and said ignition, to secondly open said second switch to deenergize said ignition, and upon predetermined further movement in said other direction to reopen said first switch to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, means including a switch controlling said timing means, releasable mechanical means biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, electric means connected for actuation by said timing means controlling switch to actuate said mechanical means, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the opening of said second switch and prior to the reopening of said first switch, said mechanical means being operable upon release from its actuated position to release said switch operating means for return in said one direction to its initial inoperative position, and means cooperable with said switch operating means upon movement thereof to the position reopening said first switch to hold the same in that position independently of and subsequent to its release by said mechanical means.

7. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, circuits for said fuel supply means and said ignition, a first switch in said fuel supply and ignition circuits, a second switch in said ignition circuit, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to first close said first switch to energize said fuel supply means and said ignition, to secondly open said second switch to deenergize said ignition, and upon predetermined further movement in said other direction to reopen said first switch to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, mechanical means biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, an electromagnet arranged for actuating said mechanical means and having an electric circuit, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the opening of said second switch and prior to the reopening of said first switch, a room thermostat controlling said electromagnet and timing means circuit.

8. In a burner control system, a burner, electrically controlled means for supplying fuel to said burner, an electric ignition for said burner, circuits for said fuel supply means and said ignition, a first switch in said fuel supply and ignition circuits, a second switch in said ignition circuit, movable switch operating means biased in one direction to an initial inoperative position, said switch operating means being operable upon movement in the other direction to first close said first switch to energize said fuel supply means and said ignition, to secondly open said second switch to deenergize said ignition, and upon subsequent movement to reopen said first switch to deenergize said fuel supply means, electric timing means operable to move said switch operating means in said other direction, mechanical means biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing means to said switch operating means, an electromagnet arranged for actuating said mechanical means and having an electric circuit, parallel electric circuits for energizing said electric timing means, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, a switch in the other leg of said parallel circuits arranged to be opened by said switch operating means subsequent to the opening of said second switch and prior to the reopening of said first switch, a room thermostat controlling said electromagnet and timing means circuits, said mechanical means being operable upon release from its actuated position to release said switch operating means for return in said one direction to its initial inoperative position, and means cooperable with said switch operating means upon movement thereof to the position reopening said first switch to hold the same in that position independently of and subsequent to its release by said mechanical means.

9. In a burner control system, a burner, a burner motor controlling the supply of air and fuel to said burner, an electric ignition for said burner, circuits for said burner motor and said ignition, a first switch initially open in said burner motor and said ignition circuits, a second switch initially closed in said ignition circuit, a switch operating lever, a pivoted operating member biased in one direction and engageable with said lever upon movement in the opposite direction to move said lever for actuating said switches, said operating member having a cam face engageable with said lever and operable to vary the movement thereof so that upon initial movement said lever will close said first switch and upon subsequent movement will open said second switch, said operating member being operable upon further movement to move out of operating engagement with said lever and thus cause said lever to reopen said first switch; an electric motor operable as a timing means for moving said operating member in said opposite direction, gear means having an initially inoperative position and operable upon actuation to transmit movement from said timing motor to said operating member and upon release from actuation to permit said operating member to

return in said one direction to its initial position, an electromagnet arranged for actuating said gear means and having a circuit, a circuit for energizing said timing motor and having two parallel legs, a third switch in one of said legs and arranged to be opened by said lever subsequent to the opening of said second switch and to be closed upon the reopening of said first switch thereby, a thermostatic stack switch in the other leg of said timing motor circuit and being operable to be opened by the occurrence of flame in said burner, said stack switch being operable to deenergize said timing motor upon occurrence of flame in said burner during the period that said third switch is opened, and a room thermostat controlling said electromagnet and timing motor circuits.

10. A burner control system as defined in claim 9 wherein the switch operating lever has a cam follower portion engageable with said operating member cam surfaces, the cam follower portion being positioned so that upon said further movement of the operating member reopening said first switch it will engage the operating member as a catch to prevent the return thereof in said one direction to its initial inoperative position.

11. In a burner control system, a burner, a blower for supplying air to said burner, an electrically operated valve controlling the flow of fuel to said burner, an electric ignition for said burner, circuits for said blower, said ignition, and said fuel valve, a first switch initially open in said blower and said ignition circuits, a second switch initially open in said fuel valve circuit, a third switch initially closed in said ignition circuit, a switch operating lever operable upon pivotal movement in one direction to operate said switches sequentially to first close said first switch, secondly to close said second switch, and thirdly to open said third switch, a pivoted operating member for moving said lever and having a cam face with at least three different points of operating engagement engageable with said lever upon pivotal movement to produce said sequential switch operation, said operating member being operable upon continued movement beyond the opening of said third switch to move out of operating engagement with said lever and thus permit said lever to pivot in the opposite direction and open and close the respective switches in reverse sequence; an electric motor operable as a timing means for moving said operating member, gear means for transmitting movement from said motor to said operating member and having an initial inoperative position, an electromagnet operable upon energization to establish an operative motion transmitting engagement of said gear means, circuits for said motor and said electromagnet, a transformer for said system, said blower, ignition, and fuel valve circuits being connected in parallel with the primary of said transformer, a first transformer controlling switch initially closed in the circuit of said primary and arranged to be opened by said lever upon closing of said first switch thereby, a second transformer controlling switch initially open in the circuit of said primary and arranged to be closed by said gear engaging electromagnet upon energization thereof, said motor and said electromagnet circuits being connected to the secondary of said transformer, a room thermostat in said motor and said electromagnet circuits, said motor circuit having first and second parallel legs, a thermostatic stack switch in said first motor circuit leg responsive to the occurrence of flame in said burner and operable to open upon occurrence of flame, a first motor controlling switch in said second motor circuit leg and having an initially open position, a second motor controlling switch in said second motor circuit leg and having an initially closed position, said first motor controlling switch being arranged to be closed by said lever with the closing of said first switch, and said second motor controlling switch being arranged to be opened by said lever immediately subsequent to the opening of said third switch thereby.

12. In a burner control system, a burner, a burner motor, an electric ignition for said burner, a plurality of switches controlling said burner motor and said ignition, a pair of switch operating cams biased in one direction to an initial inoperative position, said cams being interconnected for movement together and operable upon rotation in the other direction to operate said switches sequentially to energize first said burner motor and said ignition, subsequently to deenergize said ignition, and upon further rotation to deenergize said burner motor, an electric timing motor operable to rotate said cams in said other direction, an electric circuit for said timing motor, means including a switch controlling said timing motor circuit, releasable gear means movably biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing motor to said cams, and upon release from actuated position to release said cams for rotation in said one direction to their initial position, electric means for actuating said gear means, an electric circuit for said electric means connected in parallel with said timing motor circuit and controlled by said motor controlling switch, and switch means including a thermostatic stack switch operable in response to the occurrence of flame in said burner to deenergize said timing motor subsequent to the deenergization of said ignition and prior to the deenergization of said burner motor by said cams.

13. In a burner control system, a burner, a burner motor, an electric ignition for said burner, a plurality of switches controlling said burner motor and said ignition, a pair of switch operating cams biased in one direction to an initial inoperative position, said cams being interconnected for movement together and operable upon rotation in the other direction to operate said switches sequentially to energize first said burner motor and said ignition, subsequently to deenergize said ignition, and upon further rotation to deenergize said burner motor, an electric timing motor operable to rotate said cams in said other direction, means including a switch controlling said timing motor, releasable gear means movably biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing motor to said cams, and upon release from actuated position to release said cams for rotation in said one direction to their initial position, electric means connected for actuation by said timing motor controlling switch to actuate said gear means, parallel electric circuits for energizing said timing motor, a thermostatic stack switch in one leg of said parallel circuit responsive to the occurrence of flame in said burner, and a switch in the other leg of said parallel circuits arranged to be opened by one of said cams subsequent to the deenergization of said ignition and prior to the deenergization of said burner motor.

14. In a burner control system, a burner, a burner motor, an electric ignition for said burner, circuits for said burner motor and said ignition, a first switch in said burner motor and ignition circuits, a second switch in said ignition circuit, a pair of switch operating cams biased in one direction to an initial inoperative position, said cams being interconnected for movement together and having cam surfaces such that upon rotation in the other direction said switches will be operated sequentially first to close said first switch to energize said burner motor and ignition, secondly to open said second switch to deenergize said ignition, and upon predetermined further rotation in said other direction to reopen said first switch to deenergize said burner motor, an electric timing motor operable to rotate said cams in said other direction, a gear mechanism for transmitting movement from said timing motor to said cams and having a movable portion biased initially to a position preventing transmission of movement and operable upon actuation to effect a motion transmitting operation, an electromagnet having a circuit and arranged to move said gear portion into and out of actuated position, said gear mechanism being operable upon release from actuated position to release said cams for rotation in said one direction to said initial position, parallel circuits for said timing motor, a thermostatic stack switch in one leg of said parallel circuits arranged to be opened in response to flame, a switch in the other leg of said parallel circuits arranged for actuation by the cam controlling said second switch and opened subsequent thereto and prior to the reopening of said first switch, and a room thermostat in and controlling said timing motor and electromagnet circuits.

15. In a control device for a burner control system, a first switch adapted to control a burner motor and an ignition, a second switch adapted to control an ignition, movable cam means biased in one direction to an initial inoperative position, said cam means being operable upon rotation in the other direction to first close said first switch, secondly to open said second switch, and upon further rotation to reopen said first switch, electric timing means operable to rotate said cam means in said other direction, means including a switch controlling said timing means; gear means for transmitting movement from said timing means to said cam means, said gear means comprising two portions one of which is movably biased to an initial non-operative position, operable upon actuation to effect transmission of movement, and upon release from actuation to release said cam means for return to said initial position; electric means connected for actuation by said timing means controlling switch to actuate said one gear means portion, parallel circuits for said timing means, one leg of said parallel circuits being adapted to be controlled by a flame responsive means, and a switch in the other leg of said parallel circuits arranged for actuation by said cam means subsequent to the opening of said second switch and prior to the reopening of said first switch thereby.

16. In a control device for a burner control system, a first switch adapted to control a burner motor and an ignition, a second switch adapted to control an ignition, movable cam means biased in one direction to an initial inoperative position, said cam means being operable upon rotation in the other direction to first close said first switch, secondly to open said second switch, and upon further rotation to reopen said first switch, electric timing means operable to rotate said cam means in said other direction, means including a switch controlling said timing means; gear means for transmitting movement from said timing means to said cam means, said gear means comprising two portions one of which is movably biased to an initial non-operative position, operable upon actuation to effect the transmission of movement, and upon release from actuation to release said cam means for return to said initial position; electric means connected for actuation by said timing means controlling switch to actuate said one gear means portion, parallel circuits for said timing means, one leg of said parallel circuits being adapted to be controlled by a flame responsive means, a switch in the other leg of said parallel circuits arranged for actuation by said cam means subsequent to the opening of said second switch and prior to the reopening of said first switch thereby, and means including a cam follower and cooperating shoulder on said cam means operable to restrain said cam means from return movement subsequent to the reopening of said first switch.

17. In a control device for a burner control system, a first switch adapted to control a burner motor and an ignition, a second switch adapted to control an ignition, movable cam means biased in one direction to an initial inoperative position, said cam means being operable upon rotation in the other direction to first close said first switch, secondly to open said second switch, and upon further rotation to reopen said first switch, electric timing means operable to rotate said cam means in said other direction; gear means for transmitting movement from said timing means to said cam means, said gear means comprising two portions one of which is biased to an initial non-operative position, operable upon actuation to effect the transmission of movement, and upon release from actuation to release said cam means for return to said initial position; an electromagnet having a circuit and operable upon energization to actuate said one gear portion, parallel circuits for said timing means, one leg of said parallel circuits being adapted to be controlled by a flame responsive means, a switch in the other leg of said parallel circuits arranged for actuation by said cam means subsequent to the opening of said second switch and prior to the reopening of said first switch thereby, said electromagnet circuit and said timing means circuits being connected in parallel and adapted to be controlled by a room thermostat, and means including a cam follower and cooperating shoulder on said cam means operable to restrain said cam means from return movement subsequent to the reopening of said first switch.

18. A burner control device as defined in claim 17 wherein said gear means is a planetary gear mechanism comprising sun, planet, and drum gears, respectively, said one gear portion being a brake member for said drum gear; and said brake member being manually movable and having a member engageable, upon predetermined movement away from said drum gear, with said cam follower to dislodge the same from restraining engagement with said cam shoulder.

19. In a control device for a burner control system, a first switch adapted to control a burner motor and an ignition, a second switch adapted to control an ignition, a third switch adapted to control a fuel valve, movable cam means biased in one direction to an initial inoperative position,

said cam means being operable upon rotation in the other direction to first close sequentially said first and third switches, secondly to open said second switch, and thirdly upon predetermined further rotation in said other direction to reopen said first and third switches, electric timing means operable to rotate said cam means in said other direction, means including a switch controlling said timing means; gear means for transmitting movement from said timing means to said cam means, said gear means comprising two portions one of which is movably biased to an initial non-operative position, operable upon actuation to effect the transmission of movement, and upon release from actuation to release said cam means for return to said initial position; electric means connected for actuation by said timing means controlling switch to actuate said one gear means portion, parallel circuits for said timing means, one leg of said parallel circuits being adapted to be controlled by a flame responsive means, and a switch in the other leg of said parallel circuits arranged for actuation by said cam means subsequent to the opening of said second switch and prior to the reopening of said first and third switches thereby.

20. In a control device for a burner control system, a first switch adapted to control a burner motor and an ignition, a second switch adapted to control an ignition, a third switch adapted to control a fuel valve, movable cam means biased in one direction to an initial inoperative position, said cam means being operable upon rotation in the other direction to first close sequentially said first and third switches, secondly to open said second switch, and upon further rotation to reopen said first and third switches, electric timing means operable to rotate said cam means in said other direction; gear means for transmitting movement from said timing means to said cam means, said gear means comprising two portions one of which is biased to an initial non-operative position, operable upon actuation to effect the transmission of movement, and upon release from actuation to release said cam means for return to said initial position; an electromagnet having a circuit and operable upon energization to actuate said one gear portion, parallel circuits for said timing means, one leg of said parallel circuits being adapted to be controlled by a flame responsive means, a switch in the other leg of said parallel circuits arranged for actuation by said cam means subsequent to the opening of said second switch and prior to the reopening of said first and third switches thereby, said electromagnet circuit and said timing means circuits being connected in parallel and adapted to be controlled by a room thermostat, and means including a cam follower and cooperating shoulder on said cam means operable to restrain said cam means from return movement subsequent to the reopening of said first switch.

21. In a control device for a burner control system, a first switch comprising first and second flexible contact arms and cooperating contacts thereon initially open, a second switch comprising a third contact carried by said second contact arm and a fourth contact cooperable therewith initially open, a lever cooperable with said first contact arm to move it first to close said first switch and upon further movement to flex said second contact arm to close said second switch, a cam follower lever pivoted on said switch operating lever and spring biased to a position underlying said lever, a first switch operating cam cooperable with said cam follower and biased in one direction to a position opening said switches, said cam being operable upon rotation in the other direction to close said switches sequentially and having a shoulder from which said cam follower may drop after predetermined rotation to reopen said switches, said first and second switches being adapted to control a burner motor and ignition, and a fuel valve respectively, third and fourth switches respectively formed by third and fourth contact arms carrying contacts cooperable with respective fixed contacts, a lever member having a cam follower portion and arranged to close said third and fourth switches in direct sequence, said fourth switch being adapted to control a burner ignition, a second switch operating cam arranged for movement with said first cam to close said third and fourth switches and upon predetermined rotation to reopen them, said cams being offset from each other so that upon rotation in said other direction said second cam will first close said third switch and then said fourth switch, said first cam will then close said first and second switches and after predetermined rotation will reopen them, said second cam will reopen said fourth switch and said third switch just prior to reopening of said first and second switches, an electric timing motor for rotating said cams and having parallel energizing circuits one of which includes said third switch and the other of which is adapted to be controlled by a flame responsive means, a planetary gear mechanism for transmitting movement to said cams and having a movable drum brake member biased out of operative engagement therewith, an electromagnet having a circuit in parallel with said timing motor and said third switch and operable to move said brake member to effect transmission of movement to said cams, said first-named cam follower being engageable with said first cam shoulder upon reopening of said first and second switches to lock said cams in an actuated position, and said brake member being manually movable away from said planetary gear mechanism and having a finger engageable with said first-named cam follower to pivot the same out of locking position relative to said first cam.

22. In a burner control device, a transformer, a first switch initially closed in the circuit of the primary of said transformer, a second switch initially open in said transformer primary circuit, first and second control circuits connected in parallel with said primary, a third switch initially open in said first and second circuits, a fourth switch initially closed in said first circuit, a switch operating lever operable upon initial movement in one direction to close said third switch and open said first switch and upon continued movement to open said fourth switch, a pivoted operating member for moving said lever, an electric motor operable as a timing means to move said operating member, gear means for transmitting movement from said motor to said operating member and having an initial inoperative position, electromagnetically operated means for effecting an operative motion transmitting engagement of said gear means, circuits for said motor and said electromagnetic means connected with the secondary of said transformer, said motor circuit having first and second parallel legs, a first motor controlling switch initially open in said first motor circuit leg, a second motor controlling switch initially closed in said

first motor circuit leg, said motor controlling switches being arranged for sequential operation by said lever, said second motor circuit leg being adapted to be controlled by a thermostatic stack switch which opens upon occurrence of flame, said second switch being closed by said electromagnetic means upon energization thereof, said operating member having a cam face engageable with said lever and operable to control the movement thereof first to close said third switch, open said first switch, and close said first motor controlling switch, secondly after a predetermined time to open said fourth switch, and thirdly a short predetermined time later to open said second motor controlling switch, said motor being operable in the event that said motor circuit is not completely opened within a predetermined time after the start thereof to continue to move said operating member, and said operating member being operable upon predetermined continued movement to move out of operating engagement with said lever and permit the same to pivot in the opposite direction to reopen said third switch.

23. In a burner control system, a burner, a burner motor, an electric ignition for said burner, a plurality of switches controlling said burner motor and said ignition, a pair of switch operating cams biased in one direction to an initial inoperative position, said cams being interconnected for movement together and operable upon rotation in the other direction to operate said switches sequentially to energize first said burner motor and said ignition, subsequently to deenergize said ignition, and upon further rotation to deenergize said burner motor, a cam follower associated with one of said cams and positioned for actuating one of said switches, said one cam having a shoulder cooperable with said cam follower to lock said cams in an actuated position after said cams have moved to a position deenergizing said burner motor, an electric timing motor operable to rotate said cams in said other direction, means including a switch controlling said timing motor, releasable gear means movably biased to an initial inoperative position and operable upon actuation to effect the transmission of movement from said timing motor to said cams, and upon release from actuated position to release said cams for rotation in said one direction to their initial position, electric means connected for actuation by said timing motor controlling switch to actuate said gear means, parallel electric circuits for energizing said timing motor, a thermostatic stack switch in one leg of said parallel circuits responsive to the occurrence of flame in said burner, and a switch in the other leg of said parallel circuits arranged to be opened by one of said cams subsequent to the deenergization of said ignition and prior to the deenergization of said burner motor.

24. In a burner control system, a burner, a burner motor, an electric ignition for said burner, circuits for said burner motor and said ignition, a first switch in said burner motor and ignition circuits, a second switch in said ignition circuit, a pair of switch operating cams biased in one direction to an initial inoperative position, said cams being interconnected for movement together and having cam surfaces such that upon rotation in the other direction said switches will be operated sequentially first to close said first switch to energize said burner motor and ignition, secondly to open said second switch to deenergize said ignition, and upon predetermined further rotation in said other direction to reopen said first switch to deenergize said burner motor, a lever actuator for said first switch, a cam follower comprising a lever carried by said first-named lever and spring biased at one end toward engagement with said lever, one of said cams having a shoulder from which said cam follower drops upon said predetermined further rotation to reopen said first switch, said cam follower being engageable with said cam shoulder to hold said cams in an actuated position after reopening said first switch, an electric timing motor operable to rotate said cams in said other direction, a gear mechanism for transmitting movement from said timing motor to said cams and having a movable portion biased initially to a position preventing transmission of movement and operable upon actuation to effect a motion transmitting operation, an electromagnet having a circuit and arranged to move said gear portion into and out of actuated position, said gear mechanism being operable upon release from actuated position to release said cams for rotation in said one direction to said initial position, means to rotate said cam follower out of engagement with said cam shoulder after reopening said first switch without moving said actuator lever to close said first switch, said last-named means comprising a finger carried by said movable gear portion and operated by moving the same further away from motion transmitting engagement, parallel circuits for said timing motor, a thermostatic stack switch in one leg of said parallel circuits arranged to be opened in response to flame, a switch in the other leg of said parallel circuits arranged for actuation by the cam controlling said second switch and opened subsequent thereto and prior to the reopening of said first switch, and a room thermostat in and controlling said timing motor and electromagnet circuits.

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