Jan. 19, 1971 J. B. MELLETT ET AL 3,556,705

ELECTRICAL IGNITION AND CONTROL SYSTEM FOR FUEL BURNER

Original Filed July 1, 1968

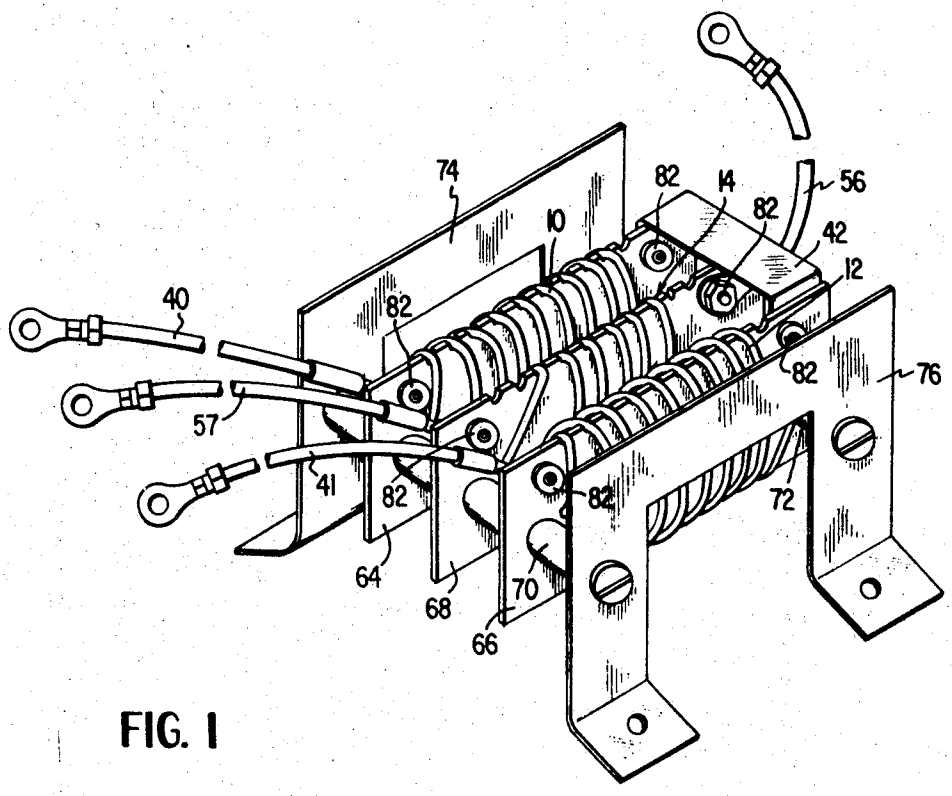


FIG. 1

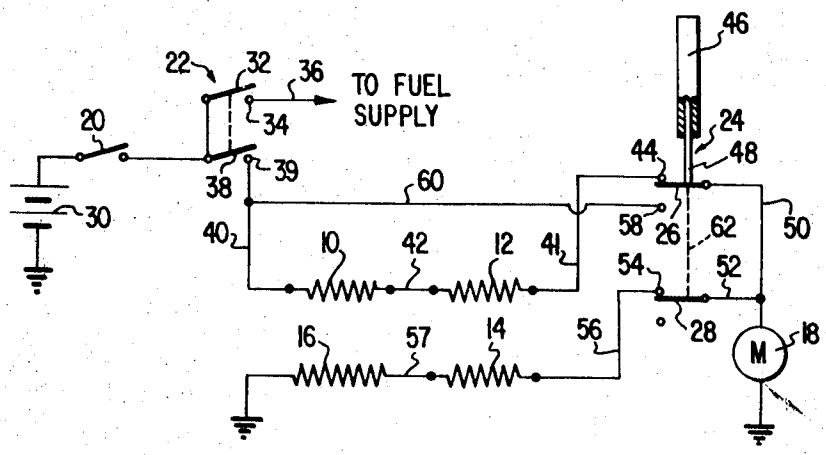


FIG. 2

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United States Patent Office 3,556,705
Patented Jan. 19, 1971

3,556,705

ELECTRICAL IGNITION AND CONTROL SYSTEM FOR FUEL BURNER

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Original application July 1, 1968, Ser. No. 741,430. Divided and this application Oct. 8, 1969, Ser. No. 864,853

Int. Cl. F23g 7/06

U.S. Cl. 431—258 4 Claims

ABSTRACT OF THE DISCLOSURE

A temperature responsive switching circuit for a fuel burner which employs an assembly of resistances having positive temperature coefficients resistance for insuring a constant low voltage across the blower motor and the resistance igniter during burner start-up regardless of voltage fluctuation.

This application is a divisional application of application Ser. No. 741,430, filed July 1, 1968, now Pat. No. 3,498,731. Vehicular liquid fuel burners normally include a battery or other source of voltage for supplying the required electrical energy for both the electrical ignition means and a blower motor which forces combustion air to pass through the burner. Igniters in the form of electrical resistance coils have been employed for initially igniting the fuel and air mixture whereupon the resultant flame sustains combustion and the ignition means are deenergized. On the other hand, the blower motor remains continually energized to deliver the required combustion and ventilating air.

One type of electrical resistance ignition means is set forth in copending United States patent application Ser. No. 741,738, which employs an ordinary automobile cigarette lighter which consists of a thin disc-like resistance coil of many turns which conventionally operates on direct current of 12 volts such as that delivered by an automobile battery. Since extended operation of this resistance igniter at 12 volts would burn it out, it is necessary to operate the same at less than 12 volts and preferably not much over 10 volts despite battery voltage variation. In turn, the blower motor which supplies both combustion and ventilating air must be operated during burner start-up at something less than full battery voltage and thereafter for a very short time since, if the blower motors were placed across full battery voltage it would rotate at high speed, and the high velocity air would quench the flame.

In order to insure the required reduction in voltage across both these elements during start-up, there has been suggested various schemes for accomplishing this purpose, such as complicated and expensive transistorized voltage control circuits and the like. Ordinary voltage dropping elements which are conventional resistances or potentiometers are useless since the voltage across the motor and the resistance igniter would correspond to the applied battery voltage which is likely to change irrespective of need.

It is, therefore, a primary object of this invention to provide an improved voltage control system for a burner resistance igniter and an electrical blower motor wherein the voltage across both of these elements is maintained at a desirable low value during burner start-up, regardless of battery voltage fluctuation.

It is a further object of this invention to provide an improved ignition and blower motor control system for a liquid fuel burner which is extremely reliant, inexpensive, and places the blower motor directly across the battery subsequent to the production of the stable flame.

It is a further object of this invention to provide an improved ignition and blower motor control system which insures operation of the blower motor at low speed during ignition start-up, regardless of supply voltage fluctuation but readily allows high speed blower operation subsequent to establishment of a sustained flame.

Other objects of this invention will appear from examination of the following detailed description and the claims together with the accompanying drawing which discloses, by way of example, the best mode contemplated to date by the applicant for applying the principles of the invention.

In the drawing:

FIG. 1 is a perspective view of the improved multiple resistor assembly forming a portion of the control circuit of the present invention.

FIG. 2 is an electrical schematic view of the ignition and control circuit of the present invention.

In general, the improved ignition and control system for the fuel burner comprises a normally closed flame detector switch for selectively coupling respective resistance elements of positive temperature coefficient of resistance in series with the blower motor and the electrical resistance igniter during blower motor start-up and burner ignition. The flame detector switch further operates in response to a sustained flame to place the blower motor directly across the voltage source and disconnect the resistance igniter.

A compact resistor assembly forming a part of the circuit comprises three spaced, fixedly positioned, generally parallel flat glass filled epoxy wafers, each carrying a resistance element having a large positive temperature coefficient of resistance in the form of a helical coil with the coil turns in contact with the wafers at opposed edges only whereby the resistance elements are truly responsive to the current generated heat for maintaining the desired low voltage across the igniter and blower motor during ignition and start-up.

Turning to FIG. 2 of the drawing, the ignition and control circuit of the present invention advantageously employed three resistance elements **10**, **12** and **14** as the voltage regulating means for both the resistance type igniter **16** and the blower motor **18**. It is important to note that the resistance elements **10**, **12** and **14** have positive temperature coefficients of resistance such that as their temperatures increase due to current passage therethrough their resistance values rapidly increase by 3 to 4 times. The resistance wire used may comprise an alloy of 70% nickel and 30% iron manfactured under the trade name "Balco" by the Wilbur B. Driver Co. of Newark, N.J. This characteristic is in contrast to the normal characteristic of electrical resistance elements in that, as the current increases their resistance increases slightly.

Circuit control is achieved manually through ignition switch **20**, and heater switch **22** to effect initial energization of both the electrical resistance heater **16** and the blower motor **18**. Deenergization is achieved automatically through the flame sensitive switch carrying normally closed switch contacts **26** and **28**, respectively. A battery **30** or other source of electrical current has one side grounded, and the other connected to the heater switch **22** through the normally open ignition switch **20**. Heater switch **22** employs a movable, normally opened switch contact **32** which closes to deliver current through fixed contact **34** to the burner supply control means (not shown) through line **36**. The other movable contact member **38** selectively delivers electrical current from battery **30** to the control elements including flame detector switch **24** associated with both the resistance igniter **16** and the blower motor **18**. Fixed contact **39** is coupled through line

40 to resistance elements 10 and 12, these two elements being directly connected in series through tie bar 42. Line 40 terminates at fixed contact 44 of the flame detector switch 24. Flame detector switch 24 is conventional, and is carried by and within the combustion chamber of the fuel burner, in such a position that a sustained flame impinges directly upon the end 46 of the flame detector switch. This causes rod-like member or armature 48, due to thermal expansion of the tube carrying the same, to move vertically downward from the position shown, to open the normally closed movable switch contact 26. The movable switch contact 26 is coupled directly to the blower motor 18 through line 50, the opposite side of the blower motor being grounded. The flame detector switch is of the double throw, double pole type and includes a second movable switch member 28 delivering electrical current from line 50 through lead 52 to stationary contact 54. The electrical resistance igniter 16 in series coupled with the third resistance element 14 by means of line 56 and stationary contact 54. Line 60 connects fixed contact 58 to line 40 bypassing resistors 10 and 12. In response to a sustained flame the movable switch member 26 moves away from fixed contact 44 and moves into contact with fixed contact 58 to complete a circuit between battery 30 and blower motor 18, bypassing series connected resistors 10 and 12. Simultaneously, armature 62, which mechanically couples the flame detector movable switch contacts 26 and 28, causes the resistance igniter 16 and its series resistance 14 to be disconnected from voltage source 30.

In the resistor assembly of FIG. 1, the fact that the resistor elements 10, 12 and 14 have large positive temperature coefficients of resistance, enables the control system to operate satisfactorily. The resistance elements 10, 12 and 14 are each wound in a helix on respective flat glass filled epoxy wafers 64, 66 and 68, respectively, the wafers being supported in spaced fashion upon a pair of transverse rods 70 and 72 which are coupled at their ends to respective L-shaped support plates 74 and 76. Note in FIG. 1 the employment of the low resistance tie bar 42 to directly connect resistances 10 and 12, while at the opposite end, leads 40 and 41 allow connection to the heater switch 22 and fixed terminal switch contact 44 of the flame detector switch 46. Lead 56 couples resistance element 14 to fixed contact 54 of the flame detector switch while lead 57 connects the resistance igniter 16 thereto. The winding of each of the resistance elements 10, 12 and 14 on insulated support wafers is such that the resistance wires are in contact with the wafers only at the notched edges. The wires are thus spaced from the wafers and do not tend to lose their heat through the wafers. The loops are spaced closely enough so that they contribute to heat conduction between themselves. Thus, the resistance values of the respective resistance elements 10, 12 and 14 are truly dependent upon the heat generated by the electrical current passing therethrough. The middle resistance element, since it is used only for igniter control, does not require as many turns and is not spaced as far from the wafers as the other two. The unused notches on each side for additional wire turns are plainly visible in FIG. 1. The resistance elements are suitably coupled to their respective leads by conventional wafer carried terminal members 82.

The operation of the ignition control circuit will be described in conjunction with typical values being applied to the elements forming the system. For instance, the voltage source 30 may comprise a conventional 24 volt automobile battery and the circuit may employ two large series connected resistance elements 10 and 12, having a total resistance of approximately .37 ohm at 68° F. With switches 20, 22 and 24 closed, these resistances will carry about 11 amps with the current generating sufficient heat to bring the temperature of the resistances to about 1000° F. The positive temperature coefficients of resistance lying in the range of 300 to 400% changes are in great contrast to those of conventional resistances in which the normal increase is less than 10% for this temperature range and may, in fact, be negative. At 1000°, the resistance value of the two resistances 10 and 12 approaches two ohms. This greatly reduces the current passing both to blower motor 18 and the resistance igniter 16. Further, the third resistance element 14 has its resistance changes from a value of approximately .13 ohm at 68° F. to .6 ohm at 1000° F. with this resistance carrying approximately 6 amps of current. The result is that the voltage drop across the first two resistance elements 10 and 14 increases within seconds after the circuit is initially closed to reduce the voltage across the motor 18 to a desired value of between 11 and 13 volts, depending on battery voltage. Of course, immediately upon closing of the switches 20 and 22, a large voltage is available to the motor 18 for starting, but within seconds, this voltage is greatly reduced to insure slow blower speed to prevent quenching of the flame. During ignition and start-up, the third resistance element 14 is series connected with resistance elements 10 and 12 and the resistance igniter 16 and, thus, brings the voltage across the resistance igniter 16 down to a value which lies between 9½ and 10½ volts, regardless of battery voltage fluctuation.

Meanwhile, upon the creation of a sustained flame within the burner, the impingement of the same on the end 46 of the flame detector switch causes the expanding tube surrounding solid rod 48 to force movable switch contacts 26 and 28 away from the fixed contacts 44 and 54, respectively. The opening of contacts 28 and 54 deenergizes the resistance igniter 16. Contact 26 in moving from fixed contact 44 to fixed contact 58, causes the blower motor 18 which is operating at low speed due to the series resistors 10 and 12, to be placed directly across the available supply voltage from battery 30, whereupon, the blower motor 18 continues to operate at high speed due to increase of current flow. Operation continues until burner shutdown, in which case, the flame detector switch 24 again moves to the postion shown in FIG. 2, that is, a normally closed position. Upon reenergization of the control and ignition circuit, by closure of ignition switch 20 and heater switch 22, ignition is achieved with controlled blower motor operation in repeat fashion.

Because of the large change in resistance of elements 10, 12 and 14 with increase in temperature, fluctuations in battery voltages are largely immaterial. For example, a nominal 24 volt battery may deliver 28 volts but, with the present control circuit the igniter voltage is less than 10½ volts and the motor voltage is likewise retained within desired limits. At lower battery voltage the resistors will not become as hot and, therefore, their resistances will be considerably smaller leading to a proportionately smaller voltage drop and thus maintain voltages in the desired range between 9½ and 10½ volts for the resistance igniter and between 11 and 13 volts for the blower motor. The same circuit, of course, may be important for systems incorporating a 12 volt supply rather than the 24 volt supply shown. At the same time, while the large resistance elements 10 and 12 are shown as being positioned on either side of the small resistance element 14 in a three part assembly, it is obvious that resistance elements 10 and 12 may be united and carried by a single flat glass-filled epoxy wafer. The resistance wire employed in the winding of resistance elements 10, 12 and 14 may comprise any material having the desired positive temperature coefficient of resistance and may be, for example, formed of iron and nickel wire, such as those manufactured under the aforementioned trade name "Balco."

While the invention has been particularly shown and described with reference to a preferred embodiment, it will be understood by those skilled in the art that the foregoing and other changes in form and details may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. In a fuel burner including an electrical resistance igniter for connection to a voltage source through a nor-

mally closed temperature responsive flame detector switch for coupling said voltage source across said resistance igniter, the improvement comprising: a plurality of longitudinally spaced resistance wire supporting wafers, means for fixedly positioning said wafers on a support member in spaced parallel positions, and helical coils of resistance wire having a positive temperature coefficient of resistance carried by each wafer with the turns of said coils being in contact with the respective wafers along only the edges and connected in series with said resistance igniter.

2. The assembly as claimed in claim 1, further including notches formed in the opposed edges of each wafer for spacing the respective resistance wire turns to insure contact of said turns and the respective wafer at the edges of the respective wafer.

3. The assembly as claimed in claim 2 in which said wafers are formed of flat glass-filled epoxy and are spaced in side by side relationship with one wafer located intermediate two wafers and carrying fewer coils of resistance wire than said two wafers, said resistance wire comprising an iron-nickel alloy.

4. The assembly as claimed in claim 3, further including a low resistance tie bar coupling the ends of the two outer resistance wire coils.

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U.S. Cl. X.R.

317—98; 338—22, 299