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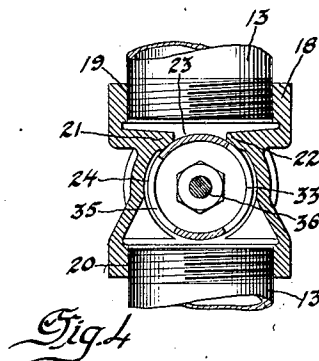
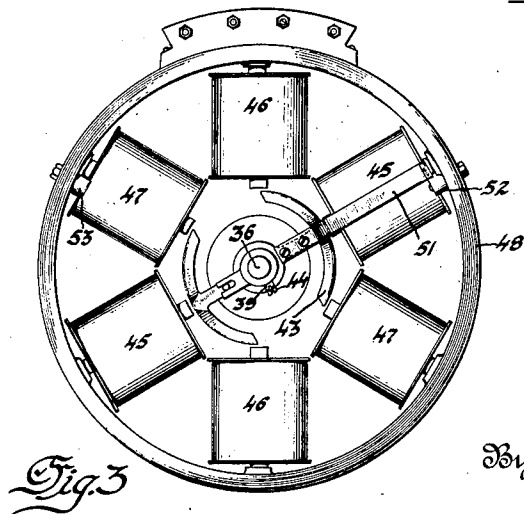
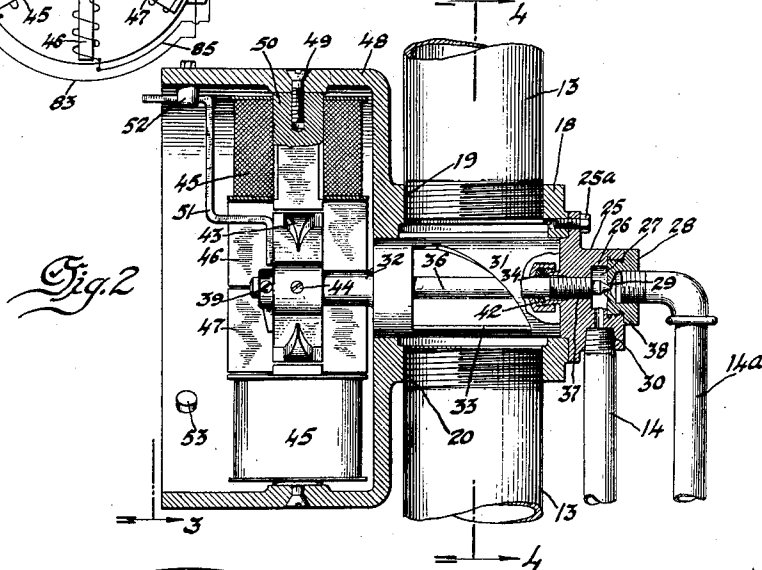
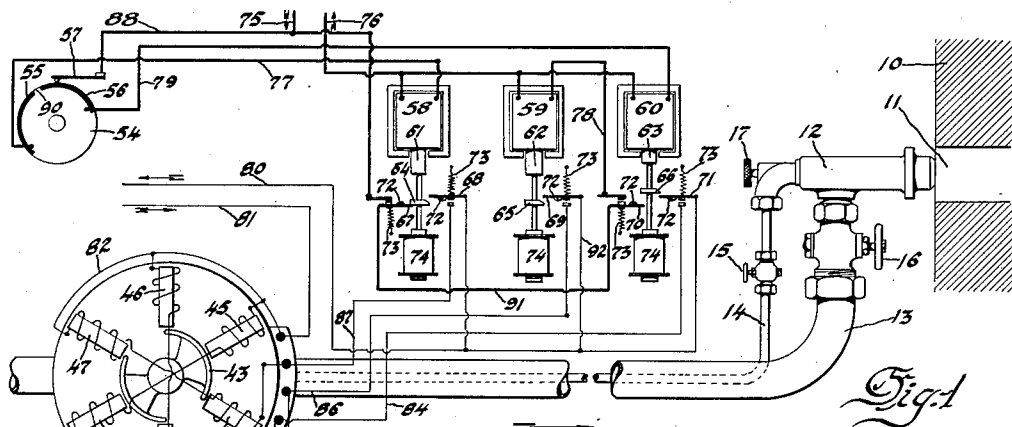
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HEAT REGULATOR

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2 Sheets-Sheet 1



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UNITED STATES PATENT OFFICE

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HEAT REGULATOR

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This invention relates to fuel burners and more particularly to burners employing a mixture of air and fluid or other fuel.

One of the objects of the invention is the provision of new and improved means for automatically maintaining a heat treating furnace or other type of furnace at a substantially constant temperature.

Another object of the invention is the provision of new and improved thermally controlled means for automatically regulating the supply of air and fuel to a fluid or liquid fuel burner.

A still further object of the invention is the provision of a new and improved valve for controlling the supply of air and fuel.

Other and further objects and advantages of the invention will appear from the description and accompanying drawings, in which, Fig. 1 is a diagrammatic view of the device as applied to a commercial oil burner.

Fig. 2 is a sectional view of a valve mechanism with parts broken away.

Fig. 3 is a side elevation of the valve operating mechanism with parts broken away, looking in the direction of the arrow 3 in the Fig. 2.

Fig. 4 is a section on line 4—4, Fig. 2;

Fig. 5 is a diagrammatic view of a modified form of the device.

Fig. 6 is a view similar to Fig. 3 but showing a modified form of the device; and,

Fig. 7 is a section on line 7—7 of Fig. 6.

Figure 8 is a diagrammatic view showing the operating mechanism of the temperature control.

On the drawing the reference numeral 10 indicates a heat treating furnace of any well known construction having the opening 11 in the wall thereof, through which fuel is delivered to the furnace by means of a burner 12, of any suitable construction. The air and fuel are delivered to the burner through separate conduits as is common in the art, the air being delivered through a conduit as the pipe 13 and the liquid fuel through a separate conduit as the delivery pipe 14. The pipes or conduits 13 and 14 are provided with the usual hand operated valves 15 and 16, for manually adjusting the supply of oil and air

to the burner 12. The burner 12 may also be supplied with the usual adjusting valve 17 as is usual in burners of this type.

In the use of liquid fuel burners for commercial ovens or furnaces that are adapted to be operated on a large production basis it is highly advantageous to provide means for automatically regulating the supply of air and fuel to the burner for maintaining the furnace at a predetermined temperature. In order to do this, it is not only necessary to control the supply of air and fuel but it is also necessary to properly regulate the supply of each so that the two will form a proper combustible mixture at all points within the range of the controlling mechanism.

In order that the controls for both the air and the fuel shall operate simultaneously it is desirable that both controls be positively operated by the same mechanism. Any suitable means may be employed for this purpose. One form of device for accomplishing this function is illustrated on the accompanying drawings in which the valve for controlling the air is rigidly mounted on and operated by the fuel valve stem. As shown on the drawing, a valve housing 18, provided with screw threaded ends 19 and 20 for connecting adjacent ends of the pipe 13, is provided with a restricted portion having transversely extending therethrough a cylindrical opening 24 in which is adapted to be rotatably mounted a cylindrical air valve, as will presently appear. The inwardly extending ledges 21 and 22 form a port 23 leading into the cylindrical opening 24. A cover 25 is attached to the housing by suitable fastening means 25^a, which is adapted to close one end of the cylindrical opening 24. The cover 25 is provided with an axial bore 26, to form a recess or compartment 27 that is closed by the cap 28, secured in a counterbore in the outer end of the cover 25. The cap 28 is provided with a screw threaded opening in which is secured the inner end of the fuel supply pipe or conduit 14^a. The cap 28 is also provided with a valve seat 29 for a purpose that will presently appear. The side of the cap 25 is provided with an opening 30 extending into the recess or compartment 27. The

opening 30 is counterbored to receive the end of the fuel delivery pipe 14.

Rotatably mounted in the cylindrical opening 24 is a cylinder or valve member 31 having the reduced portion 32 extending axially therefrom. The valve member 31 is in the form of a drum and has on one side thereof an opening 33. The opposite side of the member 31 is also provided with an opening 35 which may be in the form of a rectangle or any other suitable form.

Since the amount of air that will flow through a given orifice in a given interval of time depends on the difference in pressure on both sides of the orifice, it follows, that as the valve 31 reaches its maximum opening the differential pressure becomes less and less and consequently the valve opening must be correspondingly increased to compensate for the decrease in differential pressure. In order that the supply of air may increase uniformly throughout the range of movement of the valve in which there is a substantial feed of air or as the differential pressure decreases the opening 33 must be so constructed that it increases in area in an increasing ratio as the valve is moved. As shown, the opening is in the form of a trapezoid whereby an increasingly larger area of the opening of the valve will be caused to register with the port 23 for each increment of movement of the valve as it is rotated to uncover said port. The reduced portion 32 of the valve member 31 is provided with an axial bore in which is mounted the shaft 36. The inner portion of the shaft 36 extends axially through the drum 31 and its inner end is screw threaded as at 37 for engaging corresponding screw threads in the axial opening in the cover 25. The inner end of the shaft 36 is provided with a conical valve 38, which is adapted to engage the valve seat 29 in the cap 28 of the cover 25, for regulating the supply of fuel to the fuel delivery pipe 14. The drum 31 is adjustably mounted on the shaft 36, in any suitable manner as by means of the set screw 39. The parts are so adjusted, that when the shaft 36 is turned to unseat the valve 38, the opening 33 will register with the port 23 whereby liquid fuel may pass through the fuel supply pipe 14^a, to the delivery pipe 14 and at the same time sufficient air to form the proper combustible mixture, will pass through the valve member 31. The cover 25 may if desired be provided with a lateral extension 34 for the purpose of forming a gland 42 to prevent escape of the fuel along the shaft 36.

Means are provided for automatically turning the shaft 36 for regulating the supply of air and fuel to the burner 12. Any suitable controller means may be provided for this purpose. As shown, an armature 43 which is adapted to be operated by electro-magnets is adjustably secured to the reduced portion 32 in any suitable manner, as by means of the

set screw 44. The armature 43 is operated by means of a plurality of electro-magnets 45, 46 and 47, which are arranged in pairs and for convenience in description the members of each pair are designated by the same reference character. These magnets are secured within a housing 48, in any suitable manner as by means of screws 49, which engage the cores 50 of said magnets. The housing 48 may be integral with or rigidly attached to the valve housing 18. The armature 43 may be provided with an extension having a handle 51 thereon for manually operating the valves. Stops 52 and 53 are provided for limiting the movement of said armature in either direction.

The magnets 45, 46 and 47, are energized for operating the armature and thereby opening and closing the valves 31 and 38 by any suitable thermally controlled mechanism. One form of control for accomplishing this purpose is shown diagrammatically in Fig. 1 of the drawing in which a relay system is employed. As shown, the reference numeral 54 indicates a contact switch of a commercial pyrometer or potentiometer recording machine having two electrical contact members 55 and 56, which are adapted to be engaged by the pointer or arm 57. In Figure 8, I have shown the operating mechanism for the contact switch 54. This mechanism comprises a thermocouple exposed to the temperature adjacent the burner, and controlling the galvanometer in the usual manner. The galvanometer, in turn, controls the mechanism for operating the contact disc 54. Since the deflection of the galvanometer is proportional to the temperature in the thermocouple, and the rotation of the disc is in proportion to the deflection of the galvanometer, the disc when properly calibrated, will indicate the temperature at the burner. I have made use of the disc to control the circuit of the furnace control mechanism as will be later described in detail. However, any preferred form of thermally controlled device such as a thermostat or the like, may be used in place of the thermocouple if found to be desirable under particular operating conditions.

The relay system comprises a plurality of solenoids 58, 59 and 60, there being as many solenoids as there are pairs of electro-magnets. The solenoids are provided with cores or plungers 61, 62 and 63. In Figure 1 the electrical connections are shown with solenoid 60 energized. The plungers are adapted to open and close electric switches for energizing the electro-magnets 45, 46 and 47. In order to accomplish this, the plungers are provided with extensions on which are mounted switch operating members 64, 65 and 66, which are adapted to engage the switch levers 67, 68, 69, 70 and 71, for closing the various switches. The switch levers 67, 68, 69, 70 and 71 are each pivoted as at 72, and

are held in open position by any suitable means such as the springs 73. Dash pots 74 may be provided for retarding the movement of the plungers 61, 62 and 63. The two electric leads 75, 76 supply current to the solenoids for operating the plungers thereof. One member of the switch 67 is connected to the lead 75 and to the arm 57. The lead 76 is connected to one end of each of the solenoid windings. The free end of the wire of the solenoid 58 is connected by means of the conductor 77 to the contact member 55 on the switch 54. The free end of the winding of the solenoid 59 is connected by means of the conductor 78 to one member of switch 70; while the free end of the winding of the solenoid 60 is connected by means of the conductor 79 to the contact member 56, of said contact switch 54.

The current for operating the electro-magnets 45, 46 and 47, is supplied by the conductors 80 and 81. One end of the windings of each of the electro-magnets is connected to the conductor 82 which is in electrical contact with the lead 81. The free end of the windings of the magnets 45, is connected by means of conductors 83 and 84 with one member of the switch 71. The free end of the windings for magnets 46 are connected by means of conductors 85 and 86 to one member of the switch 69; while the free end of the windings of the magnets 47 is connected by means of conductors 87, to one member of the switch 68.

When the parts are being moved to the position shown in Figs. 1 and 2, of the drawing the current may be traced as follows: The current has entered through the lead 75 and passed along the conductor 88, through the arm 57, the contact 56, the conductor 79, and through the solenoid 60, energizing the same and elevating the plunger 63, causing the operating member 66 to close the switch 71. The current will pass from the solenoid back to the lead 76. As the plunger 63 is drawn upward by the solenoid the member 66 will release the lever arm of the switch 70 thus permitting the spring 73 to open said switch. The member 66 will engage the end of the lever of the switch 71 with a wiping contact thus closing the switch for a brief interval of time. In Figure 1 the connections are shown in the positions assumed after the above-described movements.

When the switch 71 is closed, a current will enter through the lead 81 and passing through the electro-magnets 45, will energize the same and cause the armature 43 to rotate the valve 31 to close the same. From the electro-magnets 45 the current will pass through the conductors 83 and 84, through the switch 71 back to the lead 80.

The electro-magnets 47 are energized in a similar manner, by the operation of the solenoid 58 for opening the valve to its full ex-

tent. The electro-magnets 46 for opening the valve to its intermediate position are energized in a manner that will now be described.

Assuming that no current is passing through the leads 75 and 76 all the plungers will be at their lower limit of travel and the members 64 and 66 will engage the levers of the switches 67 and 70, thus closing those two switches at that point. Assume also that the arm 57 is at the neutral point 90, between the contact members 55 and 56. If the current now be turned on, it will pass along the lead 75 through the switch 67, along the conductor 91, through the switch 70, the conductor 78, and through the solenoid 59 thus energizing the same and elevating the plunger 62. From the solenoid the current passes back through the lead 76. As the plunger 62 is elevated the contact member 65 engages the lever of the switch 69 and closes said switch. When said switch is closed the current entering through the lead 81 will pass through the conductor 82, the electro-magnets 46, the conductors 85 and 86, and through the switch 69, into the conductor 92, and from thence to the lead 80.

It will be noticed that when either the solenoid 58 or 60 is energized and at the moment the plunger 61 or 63 is elevated the switch 67 or 70 is opened and the solenoid 59 is thereby de-energized, thus enabling the armature 43 to respond to the energized magnet 45 or 47.

The general operation of the regulator will now be described in connection with a batch type furnace although the regulator is equally useful when applied to furnaces of the continuous type, the operation being substantially the same except for the initial stages. When the furnace is freshly charged with material to be treated its temperature is greatly lowered. This results in the pyrometer controlled contact switch 54 moving to a position where arm 57 engages contact 55 bringing into operation solenoid 58 and electromagnets 47 which swing the valves to full open position. The furnace is now fed fuel and air at the maximum rate and the temperature rises. When the temperature reaches a predetermined point, for example 1700° F., the pyrometer mechanism has rotated the contact switch 54 so that arm 57 engages the neutral point 90 on the switch. This results in the energization of solenoid 59 and magnets 46 throwing the valves to mid position. Now in actual practice the temperature in the furnace is not stable but fluctuates frequently and quickly, so that at this point in the operation the contact switch 54 swings back and forth at intervals causing the valves to swing back and forth between full open and mid position. This continues until the furnace temperature rises to a point, depending on the setting of the pyrometer, at which the valves begin to operate between mid position and off position, the valves being moved to the latter position when the arm 57 engages

contact 56 on the contact switch 54, energizing solenoid 60 and magnets 45. The operation between mid position and off position continues until the temperature of the furnace reaches a predetermined maximum, say about 1710°. After the furnace has thus come up to the maximum temperature for which the pyrometer was set, the valves will continue to fluctuate between mid position and off position holding the furnace at that temperature. If it is desired to operate the furnace at a higher or lower temperature than that taken as an example it is merely necessary to adjust the pyrometer controlled contact member 54.

The above mechanism thus provides an effective control of furnace temperature throughout the working range and the temperature is also prevented from rising above a certain maximum whether the furnace is working or idle, the arrangement being such that a minimum of fuel is used under the latter condition. The system also possesses great flexibility in that the fluctuation of the valves between zero and mid position permits almost any maximum temperature desired. The mechanism also preferably has incorporated in it, as previously described, the special valve arrangement which provides a correct proportioning of fuel and air throughout the feeding range of the valves.

In Figs. 5, 6 and 7, is shown a modified form of the device in which the electro-magnets for rotating the valves are provided with circuit breakers whereby the armature will automatically open the circuit when it moves to its adjusted position, opposite the energizing magnet. In this form of the device, only two solenoids 95 and 96 need be employed. The pivoted switch arm 97 is provided with an armature 98 whereby when the solenoid 96 is energized the arm is moved to engage the contact member 71^a, and when the solenoid 95 is energized the arm will engage the contact member 67^a. The solenoids 96 and 95 are energized when the arm 57^a engages the contacts 55^a and 56^a, respectively. When the arm 57^a engages the neutral point on the contact switch 54 and the solenoids 95 and 96 are de-energized, the arm 97 will be caused to engage the contact member 69^a by any suitable means such as the light springs 99 and 100.

With the contact switch in the position shown in Fig. 5 of the drawing, the current entering the lead 75^a will energize the solenoid 96 and return through the lead 76^a. The energized solenoid 96 will cause the armature 98 on the switch arm 97 to engage the contact 71^a and complete the circuit from the lead 80^a, through the electro-magnets 45^a along the conductor 82^a to the lead 81^a. The energized electro-magnets 45^a will cause the armature 43^a to rotate the valve shaft 36^a and

the valves thereon to cut off the supply of air and fuel.

The armature 43^a is provided with an extension 101, which is adapted to contact the inner end of a pivoted lever or a circuit breaker 102, for opening the circuit. Suitable means are provided for holding the pivoted arms of the circuit breakers in circuit closing position as the springs 103. As the armature 43^a turns to its adjusted position opposite the energized magnets, the extension 101 will engage the inner end of the pivoted lever 102 and thereby open the circuit through said magnets. Each set of electro-magnets is provided in a similar manner with circuit breakers 102 which operate in the same manner as has just been described.

The regulator herein disclosed has been shown applied to a heat treating furnace but it is to be understood that it is not limited to that use but may find application wherever it is desired to control temperatures produced by combustion. Furthermore, certain of the features of the invention are capable of broad application apart from their use in a heat regulator; thus the arrangement of valves which affords correct proportioning of fuel and air throughout the range of adjustment thereof may be used wherever it is desired to secure correct combustion not only in furnaces but in heat engines and the like; the multiple valve operating device may be used in connection with other than fuel feeding apparatus; and so on. It is the intention of applicant to claim the parts as well as the whole of this organization broadly as well as specifically.

It is thought from the foregoing taken in connection with the accompanying drawings that the construction and operation of my device will be apparent to those skilled in the art, and that various changes in size, shape, proportion and details of construction may be made without departing from the spirit and scope of the appended claims.

What I claim is:

1. In combination, a heat treating furnace, a burner for supplying fuel to said furnace, a conduit for supplying fuel to said burner, a conduit for supplying air to said burner, a valve shaft, valves on said shaft for controlling the supply of air and fuel to said burner, and means for preventing the temperature of said furnace from rising above a predetermined point, said means including mechanism for operating said valves and thermally controlled means for operating said mechanism.

2. In a device of the class described, a burner, a plurality of conduits for supplying said burner with combustible fluid, a valve shaft, a valve in each conduit mounted on said shaft, an armature on said shaft and electro-magnets for operating said armature, to simultaneously open and close said valves.

3. In an automatic heat regulating device of the class described, a burner, a plurality of

conduits for supplying a combustible fluid to said burner, a valve shaft, a valve in each conduit mounted on said shaft, an armature on said shaft, electro-magnets for operating said armature and thermally controlled means for automatically energizing said mechanism for opening and closing said valves.

4. In a device of the class described, a burner, a fuel supply conduit and an air supply conduit for said burner, a valve for each of said conduits, a shaft common to said valves for operating the same, an armature on said valve shaft, a plurality of pairs of magnets for rotating said armature for opening and closing said valves, a relay mechanism for energizing said armatures, said relay mechanism including a solenoid for each pair of magnets and thermally controlled means for automatically energizing said solenoids.

5. In a device of the class described, a burner, a plurality of conduits for supplying a combustible fluid to said burner, a valve shaft, a cylindrical valve rotatably mounted in one of said conduits and secured to said shaft, a valve seat in the other of said conduits, a housing for said valve seat, a screw threaded opening through one side of said housing, said valve shaft being screw threaded into said opening and a valve on the inner end of said shaft for engaging said valve seat, and means for rotating said shaft.

6. In a fuel control device of the class described, a valve housing having a cylindrical opening extending transversely therethrough and an opening at right angles to said cylindrical opening, a control housing extending laterally from said valve housing, a closure for one end of said cylindrical opening, said closure being provided with a valve seat and with a screw threaded opening in alignment with said valve seat, a cylindrical valve having an irregular opening rotatably mounted in said cylindrical opening, a shaft extending axially of said cylindrical valve, means for securing said cylindrical valve to said shaft, the inner end of said shaft being screw threaded for engaging screw threaded opening in said closure, a valve rigidly secured to the inner end of said shaft for engaging said valve seat, an armature on the outer end of said shaft, a plurality of pairs of electro-magnets mounted in said housing, means for automatically energizing said electro-magnets and a handle on said shaft for operating the same.

7. In a device of the class described, a fluid conduit, a fuel conduit, a burner common to said conduits, a valve for said fluid conduit, a valve for said fuel conduit, electrical means responsive to temperature changes at the burner, electro-magnets for effecting adjustment of said valves and relays interposed between said electrical means and said electro-magnets and controlled by said electrical means for energizing said electro-magnets.

8. The combination of a burner, a conduit for conducting an element of combustion to the burner, a valve in said conduit, said valve having a substantially closed position and a plurality of open positions, and normally occupying one of said positions, and thermally controlled electromagnetic means for moving said valve to any of said other positions, a conduit for conducting a second element of combustion to the burner, a valve in said conduit, and means for actuating said second-named valve along with the first named valve to maintain proper proportions of the elements of combustion.

9. In the combination as defined in claim 8 said valves being mounted on a common shaft.

10. The combination of a burner, a conduit for conducting fuel to the burner, a conduit for conducting air to the burner, valves in said conduits, and quick acting temperature controlled means for varying the degree of opening of said valves, said last named means embodying electro-responsive devices acting directly on the valves for imparting step by step movement to the valves.

11. In a furnace control the combination of a burner, a conduit for supplying an element of combustion to the burner, a valve for said conduit having a closed position and a plurality of open positions, and a plurality of electromagnets each adapted to move the valve to a different one of said positions, a conduit for supplying a second element of combustion to said burner, a valve in said conduit having a closed position and a plurality of open positions, said valve being arranged to be operated by said electro-magnets in synchronism with the first-named valve.

12. In a furnace control the combination of a seat of combustion, means for supplying an element of combustion thereto including control devices having a closed position and a plurality of open positions, and means solely responsive to temperature changes at the seat of combustion for causing said control devices to fluctuate between closed position and one of said open positions, or between the two open positions to effectively control the temperature of the burner, and means for supplying another element of combustion to said seat of combustion, said last named means being controlled by said first named supplying means to maintain proper proportions of the elements of combustion throughout the range of adjustment.

In testimony whereof I affix my signature.

FLOYD E. HARRIS.